4.3.6 Flood

Hazard Profile

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

Hazard Description

Flooding occurs when water overflows onto land that is normally dry. They can happen during heavy rains, rapid snow melt, or when dams or levees break (NOAA National Severe Storms Laboratory 2023). Floods are one of the most frequent and costly natural disasters in the United States and the State of New York.

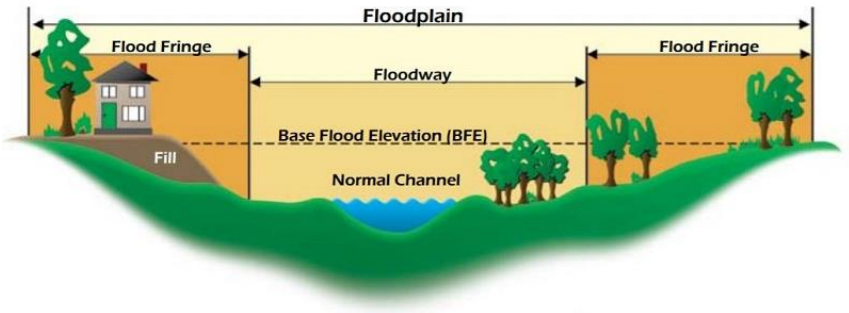
The flood-related hazards most likely to impact Rockland County are riverine (inland) flooding, flash flooding, ice jam flooding, stormwater/urban flooding due to insufficient drainage during heavy rain events, and flooding as a result of a dam or levee break. Dam and levee failure are discussed in Section 4.3.1 (Dam and Levee Failure).

Riverine Flooding

Riverine flooding, or fluvial flooding, is when streams and rivers exceed the capacity of their natural or constructed channels to accommodate water flow and water overflows the banks, spilling out into adjacent low-lying, dry land. This occurs when the flow of a river exceeds the bank sides and causes damage or obstruction to a nearby floodplain. Riverine flooding can turn into a flash flood if the river is at or above its flood stage and if the soil is saturated (FEMA 2019).

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 Rockland County, floodplains line the rivers, streams, and lakes of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques.

Figure 4.3.6-1. Characteristics of a Floodplain



Source: FEMA 2022

Flash Flooding

Flash floods occur when heavy or excessive precipitation falls in a short period of time, generally less than 6 hours. Flash floods are usually characterized by raging torrents after heavy rains that rip through riverbeds, urban streets, or mountain canyons sweeping everything before them. They can occur within minutes or a few hours of excessive rainfall. They can also occur even if no rain has fallen, for instance after a levee or dam has failed, or after a sudden release of water by a debris or ice jam (NWS 2009).

Stormwater/Urban Flooding

Heavy precipitation may produce stormwater/urban flooding in areas other than delineated floodplains or along recognizable channels. If local conditions cannot accommodate intense precipitation through a combination of infiltration and drainage capacity, water may accumulate. 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 2007).

Figure 4.3.6-2. Stormwater/Urban Flooding in Rockland County

Note: Stormwater/urban flooding in Rockland County following a December 18, 2023 period of heavy rains.

High groundwater levels can be a concern and cause problems even where there is no surface flooding. Basements are susceptible to high groundwater levels. Seasonally high groundwater is common in many areas, while elsewhere high groundwater occurs only after a long period of above-average precipitation (USGS 2016).

Figure 4.3.6-3. Stormwater/Urban Flooding in Rockland County

Note: Stormwater/urban flooding in Rockland County following a December 18, 2023 period of heavy rains.

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

Urban flooding is the flooding of streets, underpasses, low lying areas, or storm drains (NWS 2009). Urban development and inadequate drainage systems can increase precipitation runoff, elevating the risk for flooding. Drainage systems remove surface water by channeling water away from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. 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 (T. Harris 2008).

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 (NESEC 2021). 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 throughout 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 (FEMA 2018).

Location

The FEMA Special Flood Hazard Area (SFHA) establishes the area that has flood insurance and floodplain management requirements (FEMA 2020). SFHA are defined as the area that will be inundated by the flood event having a 1-percent chance of being equaled to or exceeded in any given year. It should be noted that areas outside of the SFHA can be subject to flooding of different types or magnitudes. Flooding outside of the SFHA area may include stormwater/urban flooding and flash flooding.

Flooding can occur anywhere in Rockland County; however, areas in and around floodplains and those areas impacted by stormwater issues are more susceptible to flooding. In Rockland County, floodplains line the rivers and streams of the County. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques. Figure 4.3.6-6 visualizes the FEMA designated flood hazard area for Rockland County. The total land area in the floodplain, exclusive of waterbodies, is summarized in Table 4.3.6-1. Refer to Section 9 for a map of each jurisdiction depicting the floodplains.

Table 4.3.6-1. Number of Acres Rockland County Is Exposed to 1-Percent and 0.2-Percent Annual Chance Flood

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Flood Hazard Areas			
		Total Acres Located in the 1-Percent Annual Chance Flood Event	Percent of Total	Total Acres Located in the 0.2-Percent Annual Chance Flood Event	Percent of Total
Airmont (V)	2,844	60	2.1%	73	2.6%
Chestnut Ridge (V)	3,109	93	3.0%	114	3.7%
Clarkstown (T)	23,295	1,023	4.4%	1,261	5.4%
Grand View-on-Hudson (V)	106	2	1.9%	106	100.0%
Haverstraw (T)	11,066	210	1.9%	319	2.9%
Haverstraw (V)	1,254	43	3.4%	58	4.6%
Hillburn (V)	1,364	65	4.8%	92	6.7%
Kaser (V)	103	2	1.9%	3	2.9%
Montebello (V)	2,704	259	9.6%	314	11.6%
New Hempstead (V)	1,747	65	3.7%	68	3.9%
New Square (V)	220	2	0.9%	3	1.4%
Nyack (V)	492	3	0.6%	22	4.5%

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Flood Hazard Areas			
		Total Acres Located in the 1-Percent Annual Chance Flood Event	Percent of Total	Total Acres Located in the 0.2-Percent Annual Chance Flood Event	Percent of Total
Orangetown (T)	13,958	894	6.4%	1,169	8.4%
Piermont (V)	411	83	20.2%	169	41.1%
Pomona (V)	1,488	61	4.1%	62	4.2%
Ramapo (T)	19,415	569	2.9%	623	3.2%
Sloatsburg (V)	1,564	166	10.6%	196	12.5%
Spring Valley (V)	389	1	0.3%	197	50.6%
Stony Point (T)	1,285	76	5.9%	88	6.8%
Suffern (V)	17,910	592	3.3%	621	3.5%
Upper Nyack (V)	1,317	106	8.0%	144	10.9%
Wesley Hills (V)	738	2	0.3%	4	0.5%
West Haverstraw (V)	2,102	40	1.9%	52	2.5%
Rockland County (Total)	**988**	**39**	**3.9%**	**55**	**5.6%**

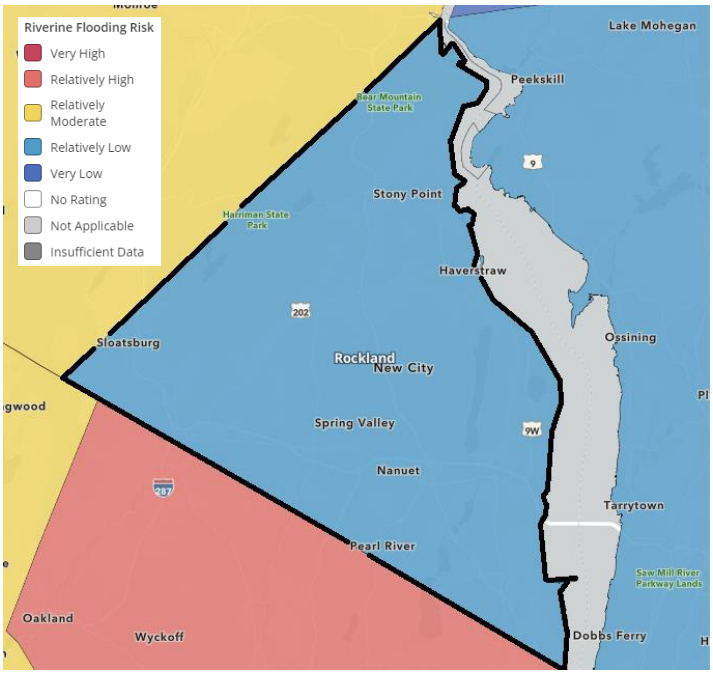
Source: Rockland County 2020; USGS, NHD 2023; FEMA
Note:
1) Excludes areas designated as water
2) Values are rounded to the nearest whole value

Riverine Flooding

Riverine flooding is most severe around major creeks and riverbeds, including the Antrim Creek, Hackensack River, Hudson River, Montebello Creek, Pascack Brook, Ramapo River, Saddle River East and West Branches, and Stony Brook. According to the County's FIS Report, flooding can occur in Rockland County during any season of the year, but most likely occurs from rainfall associated with hurricanes, tropical storms, and nor'easters (FEMA 2014).

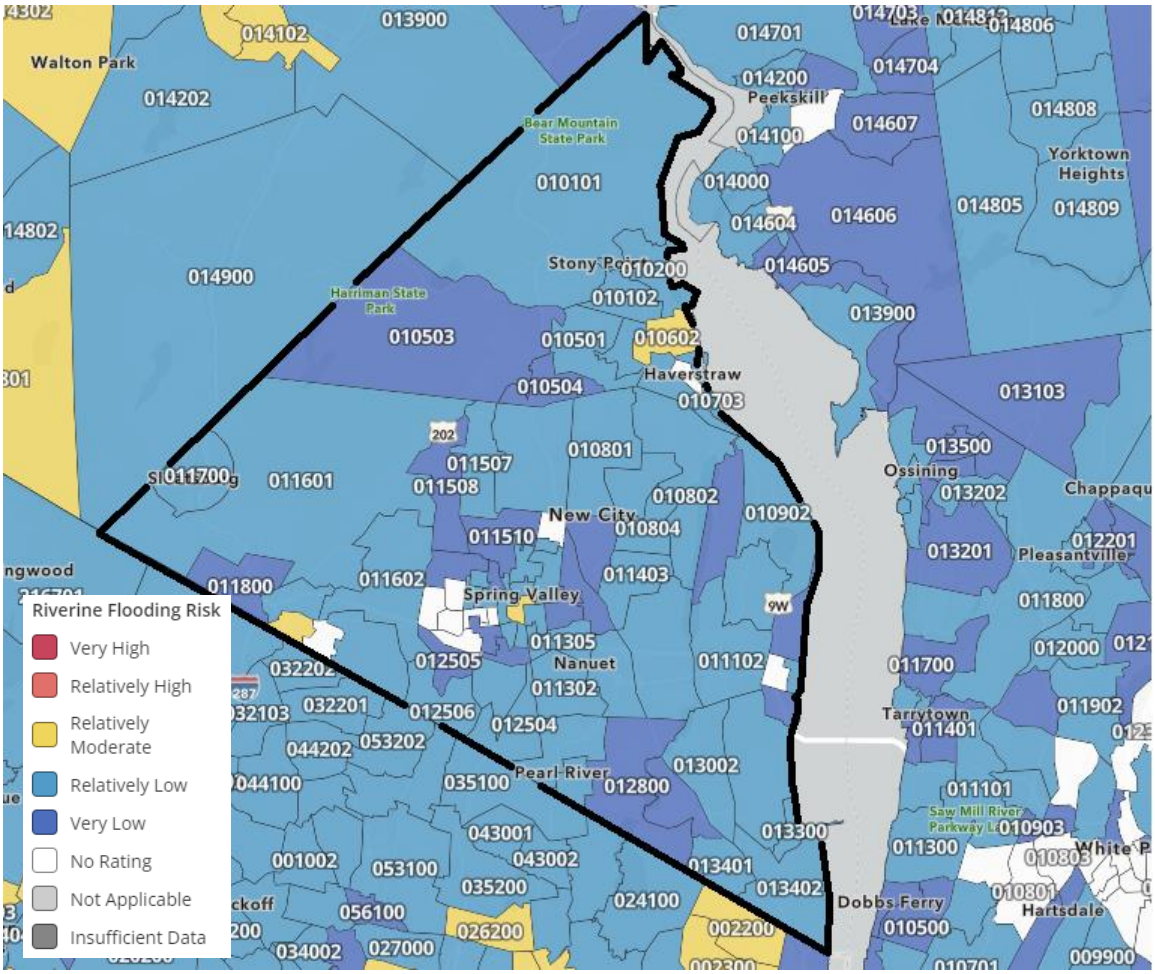
Figure 4.3.6-4 and Figure 4.3.6-5 show the Riverine Flooding Risk Index for Rockland County on the county and census tract scales, respectively. This index helps to understand the susceptibility of the County to riverine flooding. According to the National Risk Index, on the county scale, the County has a relatively low risk to riverine flooding; on the census tract scale, portions of the County has no rating, however, most census tracks range from a very low risk to a relatively moderate risk (FEMA 2019).

Figure 4.3.6-4. National Risk Index, Riverine Flooding Risk Index Score Using the County Scale



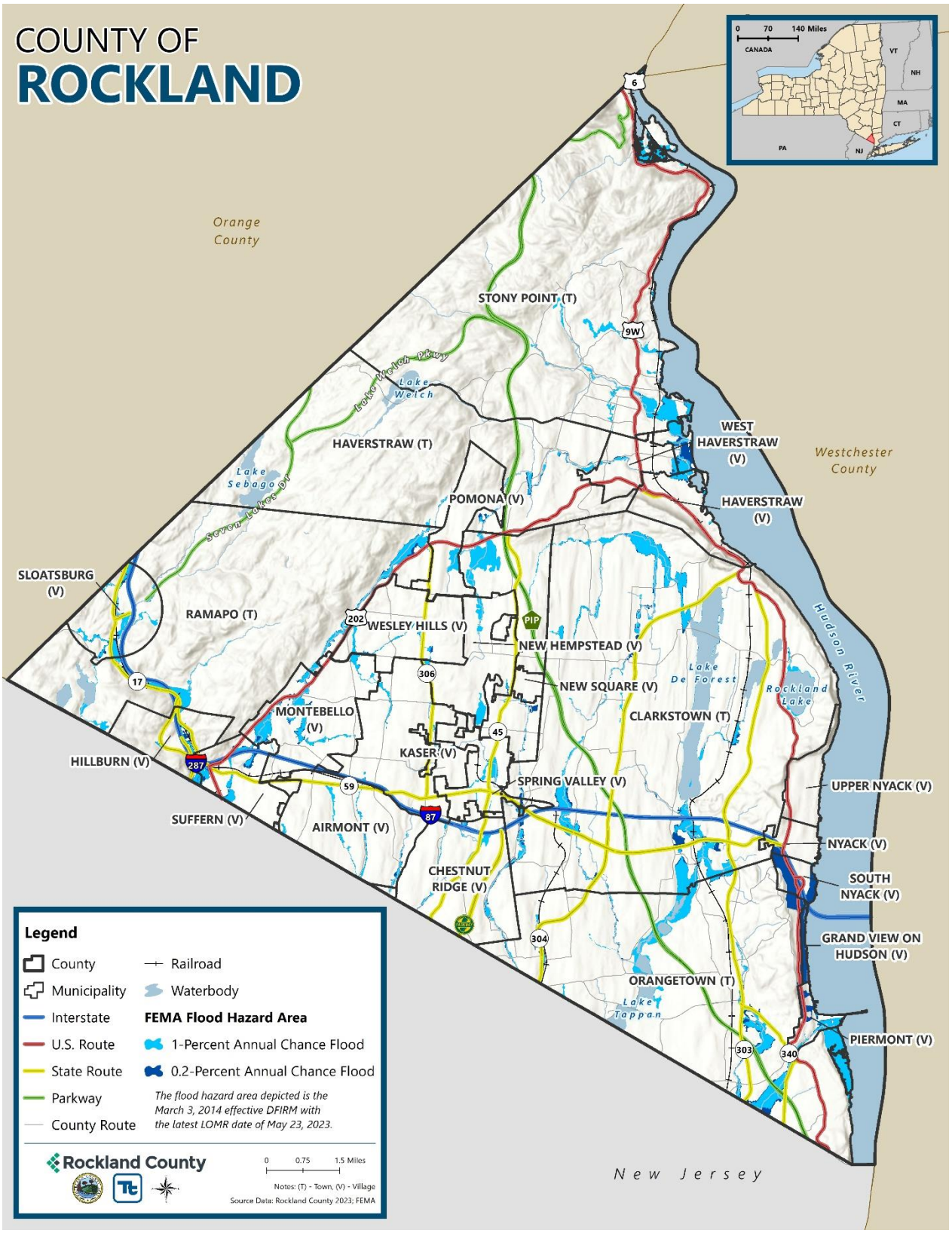
Source: FEMA 2023
Notes: Rockland County is outlined in bold, black lines.

Figure 4.3.6-5. National Risk Index, Riverine Flooding Risk Index Score Using the Census Tract Scale



Source: *FEMA 2023*
Notes: *Rockland County is outlined in bold, black lines.*

Figure 4.3.6-6. FEMA Flood Hazard Areas in Rockland County



Flash Flooding

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

Stormwater/Urban Flooding

Stormwater/urban flooding is not mapped by the State or FEMA but is most likely to occur in highly developed areas with high percentages of impervious coverage that contribute to high rates of runoff.

Ice Jam Flooding

Ice jams are common in the northeast United States, including the State of New York. According to the US Army Corps of Engineers (USACE), the State ranks second in the nation for total number of ice jam events, with over 1,600 incidents documented between 1780 and 2022. Areas of the State that include characteristics lending to ice jam flooding, such as waterbodies with a quick increase in water levels and high flow velocities, are the northern counties of the Finger Lakes region and far western New York, the Mohawk Valley of central and eastern NYS, and the North Country (NYS DHSES 2019).

The Ice Jam Database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL), currently consists of over 19,000 records from across the nation. According to the USACE-CRREL, Rockland County underwent or may have been impacted by 2 historic ice jam incidents between 1780 and 2022, though no events have occurred since 1994 (USACE 2022). Ice jams have formed along the Ramapo River in Suffern (1994) and the Stony Brook in Sloatsburg (1961).

Extent

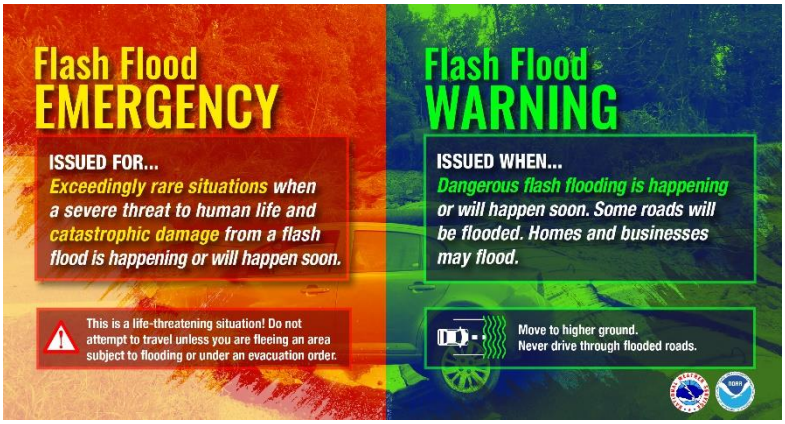
The strength or magnitude of a flood varies based meteorological, environmental, and geological factors, including latitude, altitude, topography, and atmospheric conditions. Flood is also affected by seasonal variation, storm characteristics, warning time, speed of onset, and duration. Most floods are preceded by a warning period that allows emergency managers to communicate the need to prepare for the event. A flood may last from minutes to days (O'Connor, Grant and Costa 2002).

Figure 4.3.6-7. NWS Flood Advisories

Source: NWS 2023

Warnings issued through official sources, such as the NWS and the Storm Prediction Center, provide the most reliable and timely preparedness

Figure 4.3.6-8. NWS Flash Flood Advisories



Source: NWS 2023

information, but the exact flood location and depth depends on the amount, duration, and location of rainfall. Many floods, especially flash floods, occur outside of FEMA-designated flood zones.

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 (NOAA 2021).

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 (T. Harris 2001).

The frequency and severity of flooding are measured using a discharge probability, which is the probability that a certain river discharge (flow) level will be equaled or exceeded in a given year. Flood studies use historical records to determine the probability of occurrence for the different discharge levels. The flood frequency equals 100 divided by the discharge probability. For example, the 100-year discharge has a 1-percent 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 in a short time period. The same flood can have different recurrence intervals at different points on a river.

The extent of flooding associated with a 1-percent annual probability of occurrence (the base flood or 100-year flood) is used by the NFIP as the standard for floodplain management and to determine the need for flood insurance, as well as the regulatory flood boundary by many agencies. Also referred to as the Special Flood Hazard Area (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. A structure located within a SFHA shown on an NFIP map has a 26-percent chance of suffering flood damage during the term of a 30-year mortgage.

The term "500-year flood" is the flood that has a 0.2-percent chance of being equaled or exceeded each year. The 500-year flood could occur more than once in a relatively short period of time. Statistically, the 0.2-percent (500-year) flood has a 6-percent chance of occurring during a 30-year period of time, the length of many mortgages. The 500-year floodplain is referred to as Zone X500 for insurance purposes on FIRMs. Base flood elevations or depths are not shown within this zone and insurance purchase is not required in this zone (FEMA 2022).

Flood Gages

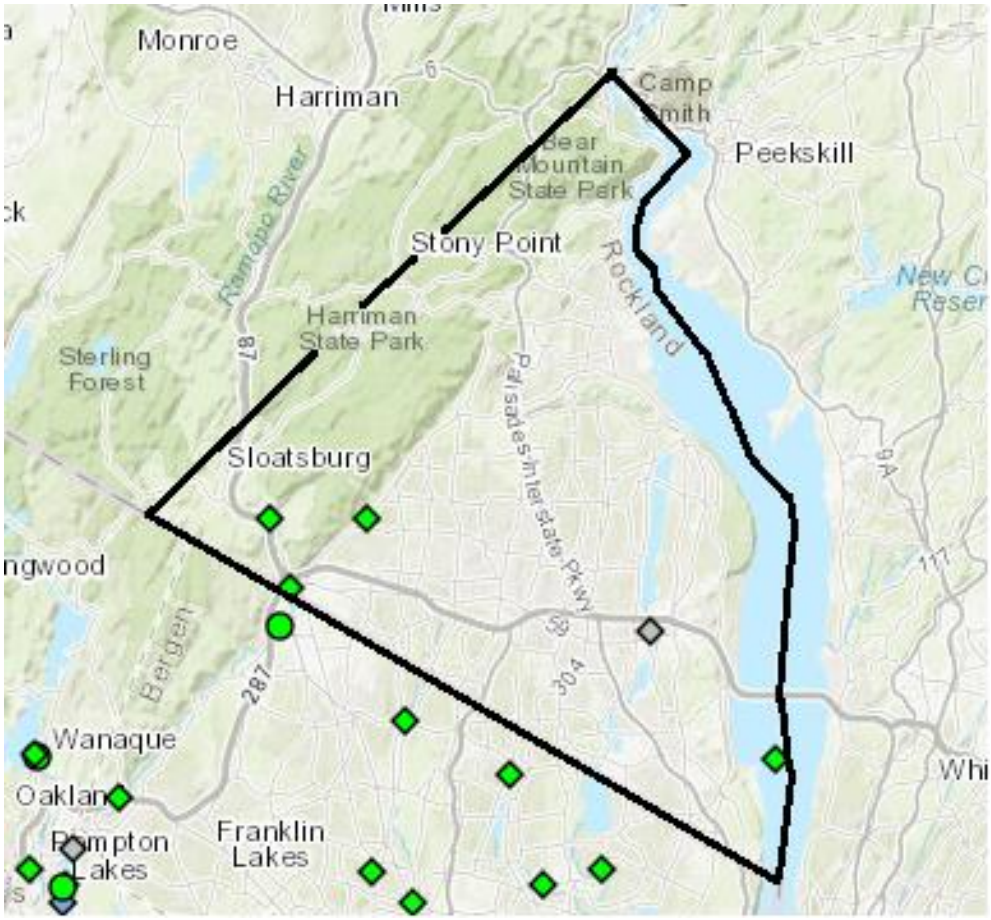
The US Geological Survey (USGS) National Water Information System (NWIS) collects surface water data from more than 850,000 stations across the country. The time-series data describes stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall. The data is collected by automatic recorders and manual field measurements at the gage locations. USGS uses stream gages to determine the severity of flood at different points along a body of water. There are numerous gages in Rockland County, in addition to others just outside of the County's boundary, that provide critical flood data for waterways affecting the County. There are five stream gages in the County. Table 4.3.6-2 provides details about the stream gages in the County. Figure 4.3.6-9 shows the location of the gages in the County.

Table 4.3.6-2. Flood Gages in Rockland County

Gage Site Number	Site Name	Action Stage (ft)	Flood Stage (ft)	Moderate Flood Stage (ft)	Major Flood Stage (ft)	Historic Crest
01387400	Ramapo River at Ramapo	9	10	12	14	N/A
01387420	Ramapo River at Suffern	14.8	15.2	16.5	17.5	N/A
01387450	Mahwah River at Suffern	4.5	5	7	10.5	N/A
01376800	Hackensack River at West Nyack	N/A	6	8	10	N/A
01376269	Hudson River at Piermont	6.3	6.4	7.4	8.4	N/A

Source: USGS 2023; NWS 2023
N/A Not available/not recorded

Figure 4.3.6-9. Stream Gages in Rockland County



Source: *NWS 2023*
Note: *Rockland County is outlined with a black border*

Previous Occurrences

FEMA Major Disaster and Emergency Declarations

Between 1954 and 2023, Rockland County was included in eight major disaster (DR) or emergency (EM) declarations for flood-related events (FEMA 2023). For declarations that occurred between 2017 and 2023, Rockland County has not been included in any flood-related declarations. Detailed information about the declared disasters since 1954 is provided in Section 3 (County Profile).

USDA Declarations

The Secretary of Agriculture from the U.S. Department of Agriculture (USDA) is authorized to designate counties as disaster areas to make emergency loans to producers suffering losses in those counties and in counties that are contiguous to a designated county. Between 2014 and 2023, Rockland County was included in one flood-related agricultural disaster declarations. For declarations that occurred between 2014 and 2023, refer to Table 4.3.6-3. For declarations that occurred between 2017 and 2023, refer to Table 4.3.6-3.

Table 4.3.6-3. USDA Declarations for Flood Events in Rockland County (2014 to 2023)

Event Date	Event Type	USDA Declaration Number	Description
April 1 – July 8, 2014	Flood	S3747	Excessive Rain, Flash Flooding, Flooding, High Winds, and Hail

Sources: USDA 2023

Previous Events

For this 2024 HMP update, known hazard events that impacted Rockland County between January 2017 and December 2023 are discussed in Table 4.3.6-4. For events prior to 2017, refer to the 2018 Rockland County HMP.

Table 4.3.6-4. Hazard Events in Rockland County (2017 to 2023)

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Rockland County included in declaration?	Location Impacted	Description
January 12, 2018	Flood	N/A	N/A	Tallman	Rain and continued snow melt resulted in river flooding along the Mahwah River near Suffern. After an average of 5 to 9 inches of snow the week before, rainfall totals across the region ranged from 1 to 3 inches. The Mahwah River near Suffern New York exceeded its flood stage of 4 feet and crested at a height of 4.42 feet.
April 16-17, 2018	Flood, Flash Flood	N/A	N/A	Spring Valley, Tallman	Heavy rainfall resulted in flash flooding across the region. Rainfall totals ranged from 1.5 to 3.5 inches across much the Lower Hudson Valley, with much of the rain falling in a 3 to 4-hour period. South Pascack Road was closed in Nanuet due to flooding of the Pascack Brook. A vehicle was partially submerged at the intersection of South Pascack Road and Forman Drive in Spring Valley due to flooding. The Mahwah River at Suffern rose above its flood stage of 4 feet, cresting at a height of 5.51 feet.
October 2, 2018	Flash Flood	N/A	N/A	Grassy Point	Multiple rounds of showers and thunderstorms developed and moved through the region. With wet conditions from recent rainfall, these showers and storms resulted in isolated flash flooding. Rainfall totals ranged from 1 to 3 inches. Heavy rain caused a small mudslide that blocked the intersection of East Main Street and Ba Mar Drive in Stony Point. The road had to be repaired by highway crews.
July 11, 2019	Flash Flood	N/A	N/A	Viola	Showers and thunderstorms developed, resulting in a several hour period of heavy rain. Rainfall totals ranged from 0.75 to 1.5 inches. College Road was impassable due to flooding in front of Rockland Community College in Viola.
June 8, 2021	Flash Flood	N/A	N/A	Piermont	Thunderstorms and showers developed, resulting in several reports of flash flooding. Rainfall amounts varied across the area, ranging from 1 to almost 3 inches. Widespread flooding was reported on Route 303 in Orangeburg with multiple occupied vehicles under water and fire department rescue units on scene performing water rescues.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Rockland County included in declaration?	Location Impacted	Description
July 2, 2021	Flash Flood	N/A	N/A	Piermont	Showers and thunderstorms slowly moved through the County, resulting in flash flooding. Rainfall amounts ranged from around 1 to 1.5 inches. NY 303 was closed due to flooding between Spruce Street and Orangeburg Road in Orangeburg.
August 22, 2021	Flash Flood	N/A	N/A	Germonds, Spring Valley, Central Nyack	Rainfall from Tropical Storm Henri resulted in widespread flash flooding across the Lower Hudson Valley. Rainfall totals ranged from 2 to 5 inches. North Main Street in Hillcrest and West Clarkstown Road in New City were closed due to flooding. The ramp from Route 303 to westbound Route 59 in Central Nyack was closed due to flooding with a car stranded.
September 1, 2021	Flash Flood	N/A	N/A	Monsey, Tallman Bear Mountain, Bardonia	Extremely heavy rainfall associated with the remnants of Hurricane Ida produced rainfall totals ranging from 5 to 8 inches across much of the region. Ultimately 17 people died because of the flash flooding, including 13 in New York City and four in the Lower Hudson Valley. Elaine Place in Monsey was closed due to flooding. Flash flooding resulted in an estimated $3,126,485 in damages across Rockland County. This estimate is based on FEMA grant money awarded under the Individuals and Household Program, which includes funds for both housing assistance and other needs. Severe flooding was occurring on the Palisades Parkway between North Middletown Road (Exit 10) and New Hempstead Road (Exit 11) in New City. The Mahwah River near Suffern rose above its minor flood stage of 5.0 feet, then surpassed its moderate flood stage (7 feet) and crested at a height of 7.06 feet.
October 25, 2021	Flash Flood	N/A	N/A	Monsey Heights	Thunderstorms dropped 1 to 3 of rain over a several hour period. Total rainfall amounts of 2-4 were observed. All lanes were closed on Chestnut Ridge Road due to flooding caused by heavy rain.
April 7, 2022	Flood	N/A	N/A	Spring Valley, Suffern, Germonds, Pearl River, Central Nyack	Moderate to heavy rain produced 2 to 3 inches of rain over the Lower Hudson Valley. This resulted in river and poor drainage flooding. A car was submerged in floodwater on South Pascack Road. A residence filled with water on Route 59. Nine feet of water was reported in a basement on Hickory Street. There was a water rescue of an occupant from a vehicle stuck in floodwaters on Grotke Rd. Route 59 east and westbound had all lanes closed due to flooding between Rt 303 and Palisades Center Drive. Flooding conditions were reported at Pearl River High School.
December 23, 2022	Flash Flood	N/A	N/A	Viola	Heavy rainfall resulted in a widespread 1.5 to 3 inches of rainfall with localized areas of flash flooding and river flooding. Two lanes blocked on NY 306 due to flooding.

Date(s) of Event	Event Type	FEMA and/or USDA Declaration Number (if applicable)	Rockland County included in declaration?	Location Impacted	Description
July 9, 2023	Flash Flood	FEMA-DR-4723	Yes	Tallman, Bear Mountain, Cedar Flats, Stony Point	A storm stalled overtop Rockland County, producing multiple rounds of torrential rainfall and heavy thunderstorms; rainfall rates reached 2-3 inches per hour at times. There were parts of the area that receive anywhere from 3-5 inches of rain in a several hour period with some spots seeing upwards of 8 inches. This allowed for the issuance of a localized Flash Flood Emergency for portion of the Lower Hudson Valley. Water rescues took place on Spook Rock Road and Joy Road. Flooding and a debris spill has closed 9W on Seven Lakes Drive. Flooding closed Palisades Interstate parkway at Gate Hill Road in both directions. Several roads were washed out near Cedar Brook.
September 29, 2023	Flash Flood	N/A	N/A	Viola	Persistent heavy rain developed, falling over the same areas for more than 12-18 hours. While the rainfall rates were generally 1 inch per hour or less, the persistence in the heavier rainfall resulted in a widespread total of 4-6 inches of rain. There were some brief periods of time where rainfall rates peaked at near 2 inches per hour. This resulted in widespread flash flooding. DOT reports flooding and road closure on NY 306 both directions at Edison Court.
December 18, 2023	Flash Flood, Flood	N/A	N/A	Countywide	An overnight storm caused significant damage in Rockland County. The Fire & Emergency Services Department reported flooding and trees down on several roadways including the Palisades Interstate Parkway (PIP), near the Palisades Mall, along Route 59 by Pascack Road near the Nanuet/Spring Valley border, and Long Mountain Circle which had reports of multiple vehicles stuck in water.

Sources: NOAA 2023

Probability of Future Occurrences

For the 2024 HMP update, best available data was used to collect hazard event details. These details were used to calculate the probability of future occurrence of hazard events in the County. Information from USACE, NOAA, and FEMA were used to identify the number of events that occurred between 1961 and 2023. Table 4.3.6-5 provides the calculated probability of future flood events in Rockland County.

Table 4.3.6-5. Probability of Future Flood Events in Rockland County

Hazard Type	Number of Occurrences Between 1961 and 2023	Percent Chance of Occurring in Any Given Year
Flash Flood	52	79.02%
Flood	35	54.84%
Ice Jam	2	0.03%
Stormwater/Urban Flood	N/A	N/A
Total	**89**	**100%**

Sources: USACE 2022; NOAA 2023; FEMA 2023

Notes: Disaster occurrences include federally declared disasters since the 1950 Federal Disaster Relief Act, and selected flood events since 1968. Due to limitations in data, not all flood events occurring between 1954 and 1996 are accounted for in the tally of occurrences. As a result, the number of hazard occurrences is underestimated.

In Section 4.4, the identified hazards of concern for Rockland County were ranted. 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 Partnership, the probability of occurrence for flood in the County is considered 'frequent'.

Climate Change Projections

Climate change affects the State of New York's residents and resources. As the effects of climate change worsen, flooding impacts are expected to worsen as well.

The region encompassing Rockland County, which includes the Catskill Mountains and the West Hudson River Valley is expected to experience temperatures increases of 3.0 °F to 5.0 °F by the 2050s and 4.0 °F to 8.0 °F by the 2080s. Precipitation totals will increase up to 10 percent by the 2050s and 5 to 10 percent by the 2080s. Table 4.3.6-6 displays the projected seasonal precipitation change (NYSERDA 2014).

The projected increase in precipitation is expected to fall as heavy downpours. Downpours are very likely to increase in frequency and intensity, a change which has the potential to 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 (NYSERDA 2014). Less frequent rainfall during the summer months may impact the potable water availability. A secondary impact of flooding which could occur due to climate change includes impacts from increasing water temperatures in rivers and streams which will affect aquatic health and reduce the capacity of streams to assimilate effluent wastewater treatment plants (NYSERDA 2014).

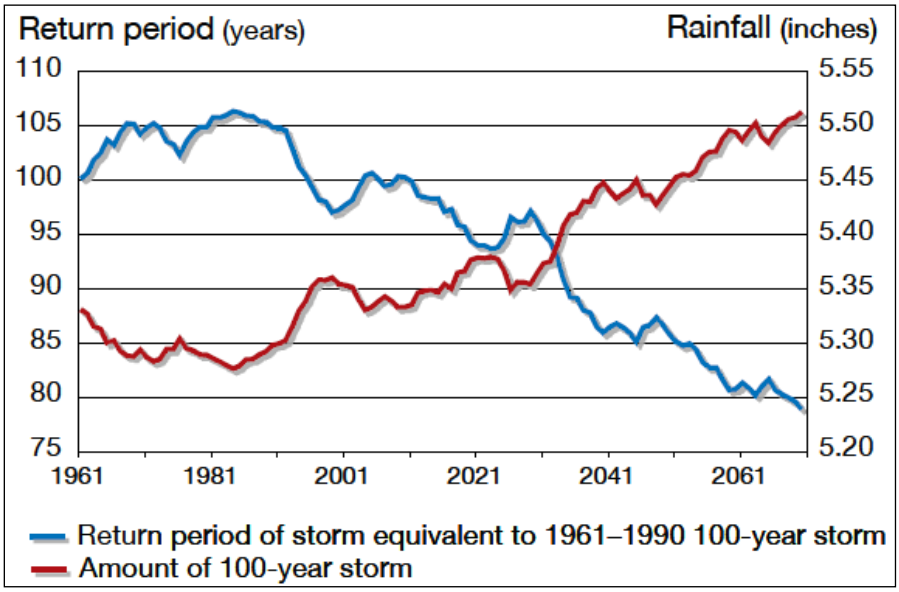
Table 4.3.6-6. Projected Seasonal Precipitation Change in the Catskill Mountains and West Hudson River Valley, 2050s (% change)

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

Source: NYSERDA 2014

Figure 4.3.6-10 displays the projected rainfall and frequency of extreme storms in the State of New York. 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, meaning extreme storms will become more severe and more frequent in Rockland County (NYSERDA 2014).

Figure 4.3.6-10. Projected Rainfall and Frequency of Extreme Storms



Source: NYSERDA 2014

Warming atmospheric temperatures influence ocean temperatures. With the projected increase in temperature, it is anticipated that ocean waters will increase as well, causing ice sheets and glaciers to melt, increasing the level of the ocean's waters. Sea level rise will lead to more frequent and extensive flooding from severe storms, particularly heavy rains in Rockland County. Rising sea levels can impact the severity of coastal and tidal flooding, such as that of the Hudson River, as floodwaters will reach farther in land then previously seen. This will not only raise impacts seen in communities along the tidal Hudson River, but also result in impacts to inland communities as well. These inland communities who rarely experience flooding in the tributaries of the Hudson River may not be equipped to mitigate and respond to such hazards.

In 2024, the New York State Department of Environmental Conservation (NYSDEC) proposed an amendment to new Part 490 of Title 6 of New York Codes, Rules, and Regulations (6 NYCRR), "Projected Sea-level Rise" (Part 490). The amendment does not impose any compliance obligations or mandates on local governments or other entities. However, the proposed amendment establishes up-to-date science-based projections for future sea level rise for multiple scenarios modeled for the New York State Climate Imsipacts Assessment. The proposed projections for the region encompassing Rockland County are shown in **TABLE REFERENCE.**

TABLE REFERENCE: 6 NYCRR Part 490 Sea Level Rise Projections for the Lower Hudson-New York City Region

Time Interval	Low Projection	Low-Medium Projection	Medium Projection	High-Medium Projection	High Projection	Rapid Ice Melt Scenario
2030s	6 inches	7 inches	9 inches	11 inches	13 inches	N/A
2050s	12 inches	14 inches	16 inches	19 inches	23 inches	N/A
2080s	21 inches	25 inches	30 inches	39 inches	45 inches	83 inches
2100	25 inches	30 inches	36 inches	50 inches	65 inches	114 inches
2150	38 inches	47 inches	59 inches	89 inches	177 inches	N/A

Source: NYSDEC 2024

Vulnerability Assessment

To assess Rockland County's risk to the flood hazard, a spatial analysis was conducted using the FEMA Risk Map effective 2023. The 1-percent annual chance flood event was further examined to estimate potential loss using the FEMA Hazus model. These results are summarized below. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess flood risk.

Impact on Life, Health, and Safety

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

To estimate population exposure to the 1-percent and 0.2-percent annual chance flood events, the DFIRM flood boundaries were used. Based on the spatial analysis, there are an estimated 3,567 residents living in the 1-percent annual chance floodplain, or 1.1 percent of the County's total population. The Village of Suffern has the greatest number of residents living in the floodplain, with approximately 602 residents living in the 1-percent annual chance floodplain. Based on the same analysis, there are an estimated 8,401 residents living in the 0.2-percent annual chance floodplain, or 2.5 percent of the County's total population. The Town of Clarkstown has the greatest number of residents living in the floodplain, with approximately 1,218 residents living in the 0.2-percent annual chance floodplain. Table 4.3.6-7 summarizes the population exposed to the flood hazard by jurisdiction.

Table 4.3.6-7. Estimated Population Exposed to the 1-percent and 0.2-percent Annual Chance Flood Event Hazard Area

Jurisdiction	Total Population (Decennial Population 2020)	Estimated Population Located in the Flood Hazard Area			
		Number of Persons Located in the 1-percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2-percent Annual Chance Flood Event Hazard Area	Percent of Total
Airmont, Village of	9,964	48	0.5%	61	0.6%
Chestnut Ridge, Village of	10,211	46	0.5%	67	0.7%
Clarkstown, Town of	81,385	547	0.7%	1,218	1.5%
Grand View on Hudson, Village of	241	6	2.5%	240	99.6%
Haverstraw, Town of	14,028	18	0.1%	46	0.3%
Haverstraw, Village of	12,292	6	0.0%	64	0.5%
Hillburn, Village of	1,110	15	1.4%	17	1.5%
Kaser, Village of	5,433	33	0.6%	99	1.8%
Montebello, Village of	4,665	212	4.5%	325	7.0%
New Hempstead, Village of	5,440	28	0.5%	42	0.8%
New Square, Village of	9,433	94	1.0%	141	1.5%
Nyack, Village of	7,303	8	0.1%	327	4.5%
Orangetown, Town of	36,127	197	0.5%	818	2.3%
Piermont, Village of	2,525	278	11.0%	977	38.7%

Jurisdiction	Total Population (Decennial Population 2020)	Estimated Population Located in the Flood Hazard Area			
		Number of Persons Located in the 1-percent Annual Chance Flood Event Hazard Area	Percent of Total	Number of Persons Located in the 0.2-percent Annual Chance Flood Event Hazard Area	Percent of Total
Pomona, Village of	3,306	39	1.2%	39	1.2%
Ramapo, Town of	48,846	298	0.6%	532	1.1%
Sloatsburg, Village of	3,043	84	2.8%	199	6.5%
South Nyack, Village of	2,803	5	0.2%	1,137	40.6%
Spring Valley, Village of	32,953	588	1.8%	708	2.1%
Stony Point, Town of	14,876	378	2.5%	468	3.1%
Suffern, Village of	11,376	602	5.3%	792	7.0%
Upper Nyack, Village of	2,355	2	0.1%	2	0.1%
Wesley Hills, Village of	6,105	7	0.1%	18	0.3%
West Haverstraw, Village of	10,665	28	0.3%	64	0.6%
Rockland County (Total)	**336,485**	**3,567**	**1.1%**	**8,401**	**2.5%**

Source: U.S. Census Bureau, American Community Survey 5-Year Estimates 2017-2021; FEMA 2023

In addition, displaced populations were estimated for the 1-percent annual chance flood event. It is important to note that the impacts to the households in the FEMA flood hazard area are assessed using the riverine flood model in Hazus. Using 2021 ACS data, Hazus estimates 5,570 would be displaced as a result of a 1-percent annual chance flood event and 2,048 people may seek short-term sheltering. These statistics, by jurisdiction, are presented in Table 4.3.6-8.

Table 4.3.6-8. Estimated Population Seeking Short-Term Shelter from the 1-percent Annual Chance Flood Event

Jurisdiction	Total Population (American Community Survey 2021)	1-Percent Annual Chance Flood Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Airmont, Village of	9,964	75	42
Chestnut Ridge, Village of	10,211	74	38
Clarkstown, Town of	81,385	1,054	339
Grand View on Hudson, Village of	241	5	0
Haverstraw, Town of	14,028	47	23
Haverstraw, Village of	12,292	145	60
Hillburn, Village of	1,110	11	7
Kaser, Village of	5,433	72	72
Montebello, Village of	4,665	182	20
New Hempstead, Village of	5,440	40	3
New Square, Village of	9,433	74	73
Nyack, Village of	7,303	29	17
Orangetown, Town of	36,127	324	62
Piermont, Village of	2,525	225	10
Pomona, Village of	3,306	29	10
Ramapo, Town of	48,846	579	292
Sloatsburg, Village of	3,043	160	44
South Nyack, Village of	2,803	3	3
Spring Valley, Village of	32,953	1,535	713
Stony Point, Town of	14,876	221	53

Jurisdiction	Total Population (American Community Survey 2021)	1-Percent Annual Chance Flood Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Suffern, Village of	11,376	497	76
Upper Nyack, Village of	2,355	3	3
Wesley Hills, Village of	6,105	14	7
West Haverstraw, Village of	10,665	172	81
Rockland County (Total)	**336,485**	**5,570**	**2,048**

Source: U.S. Census Bureau, American Community Survey 5-Year Estimates 2017-2021; FEMA 2023

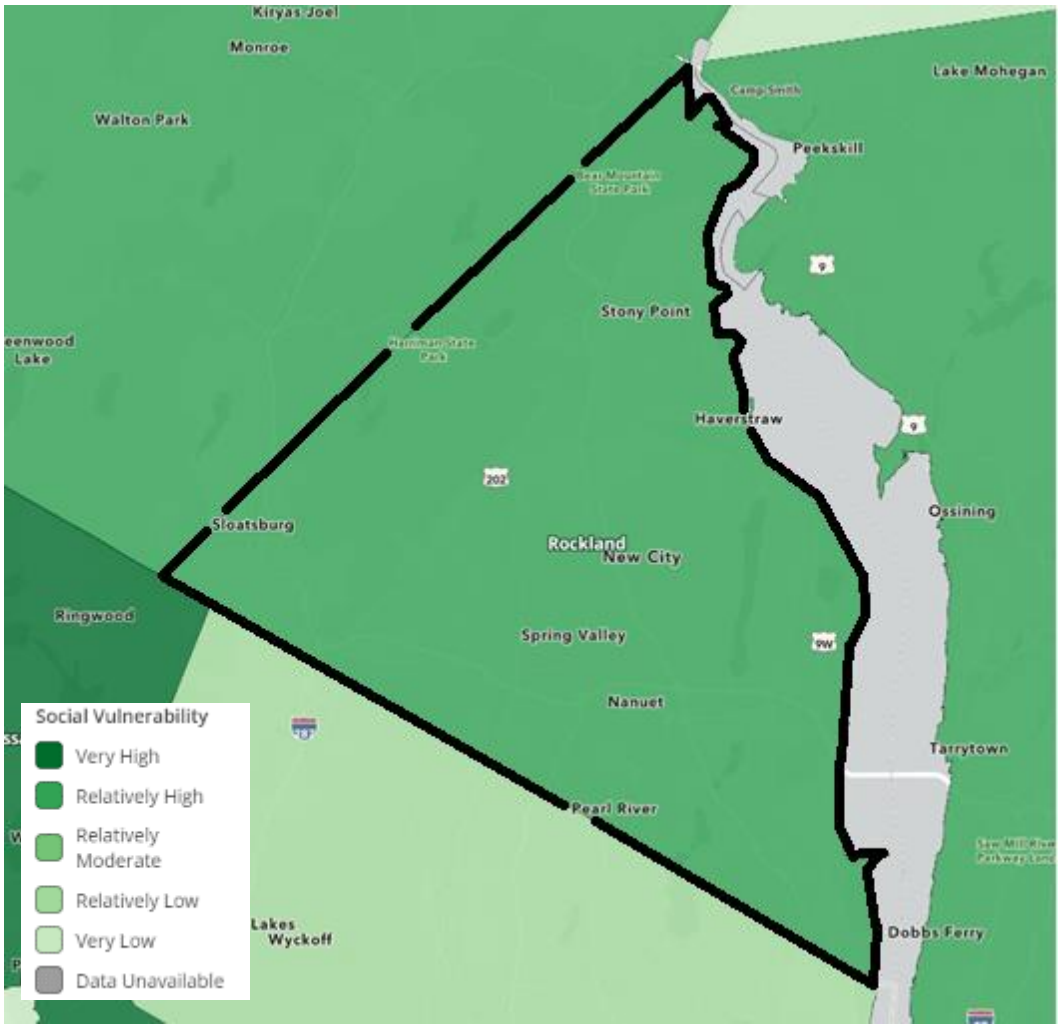
Socially Vulnerable Population

Social vulnerability is defined as the susceptibility of social groups to the adverse impacts of natural hazards, including disproportionate death, injury, loss, or disruption of livelihood. Social vulnerability considers the social, economic, demographic, and housing characteristics of a community that influence its ability to prepare for, respond to, cope with, recover from, and adapt to environmental hazards.

Socially vulnerable populations are most susceptible to flood events based on several factors, including their physical and financial ability to react or respond during a flood. Vulnerable populations include homeless persons, elderly (over 65 years old), low income or linguistically isolated populations, people with life-threatening illnesses, and residents that may struggle to evacuate. The population over the age of 65 is also more vulnerable. They may require extra time to evacuate or need assistance to evacuate and are more likely to seek or need medical attention.

Table 4.3.6-9 presents the estimated socially vulnerable populations located in the 1-percent annual chance flood hazard area. Of the 3,567 persons located in the 1-percent annual chance flood hazard area, there are 560 persons over the age of 65 years, 250 persons under the age of five years, 321 non-English speakers, 297 persons with a disability, and 454 living in poverty. For the purpose of this HMP and as determined by the Steering Committee, ALICE data for Rockland County was used to determine the number of households and individuals that earn more than the federal poverty level but not enough to afford the basics (e.g., housing, childcare, food, transportation, health care, and utilities) where they live. According to the ALICE data, there are 1,251 persons (1.1 percent of the County's total population) living below the ALICE threshold ($48,048 annually for a single adult) within the 1-percent annual chance flood hazard area. Refer to Figure 4.3.6-11 for a map indicating the social vulnerability index for riverine flooding in Rockland County.

Figure 4.3.6-11. FEMA Social Vulnerability Index for Riverine Flooding



Source: FEMA n.d.

Table 4.3.6-9. Estimated Vulnerable Persons Located Within the 1-Percent Annual Chance Flood Hazard Area

Jurisdiction	Estimated Vulnerable Persons Located Within the 1-Percent Flood Hazard Area											
	Over 65	Percent of Total	Under 5	Percent of Total	Non-English Speaking	Percent of Total	Disability	Percent of Total	Poverty Level	Percent of Total	Living Below ALICE	Percent of Total
Airmont, Village of	7	0.5%	3	0.5%	1	0.3%	3	0.4%	5	0.5%	12	0.5%
Chestnut Ridge, Village of	7	0.4%	6	0.4%	2	0.3%	5	0.4%	8	0.4%	8	0.4%
Clarkstown, Town of	112	0.7%	25	0.7%	28	0.7%	54	0.7%	23	0.6%	152	0.7%
Grand View on Hudson, Village of	1	1.6%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Haverstraw, Town of	3	0.1%	1	0.1%	1	0.1%	1	0.1%	1	0.1%	6	0.1%
Haverstraw, Village of	0	0.0%	0	0.0%	1	0.0%	0	0.0%	0	0.0%	2	0.0%
Hillburn, Village of	2	1.2%	1	0.9%	0	0.0%	1	0.7%	2	1.3%	4	1.1%
Kaser, Village of	1	0.6%	8	0.6%	8	0.6%	0	0.0%	20	0.6%	7	0.6%
Montebello, Village of	25	4.4%	8	4.1%	7	4.2%	13	4.3%	23	4.5%	26	4.4%
New Hempstead, Village of	4	0.5%	1	0.4%	0	0.0%	1	0.3%	0	0.0%	2	0.5%
New Square, Village of	2	1.0%	15	1.0%	16	1.0%	3	0.9%	57	1.0%	15	0.9%
Nyack, Village of	1	0.1%	0	0.0%	0	0.0%	1	0.1%	0	0.0%	4	0.1%
Orangetown, Town of	37	0.5%	9	0.5%	5	0.5%	19	0.5%	8	0.5%	68	0.5%
Piermont, Village of	59	10.9%	15	10.6%	15	10.6%	19	10.5%	5	10.4%	133	11.0%
Pomona, Village of	7	1.1%	2	0.8%	1	0.9%	3	1.0%	1	0.9%	6	1.2%
Ramapo, Town of	28	0.6%	43	0.6%	7	0.6%	14	0.6%	99	0.6%	115	0.6%
Sloatsburg, Village of	14	2.7%	5	2.5%	1	1.5%	10	2.6%	4	2.4%	39	2.7%
South Nyack, Village of	1	0.2%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.1%
Spring Valley, Village of	56	1.8%	66	1.8%	173	1.8%	49	1.8%	142	1.8%	239	1.8%
Stony Point, Town of	67	2.5%	15	2.5%	6	2.3%	41	2.5%	16	2.4%	111	2.5%
Suffern, Village of	122	5.3%	25	5.1%	45	5.2%	58	5.3%	37	5.2%	288	5.3%
Upper Nyack, Village of	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Wesley Hills, Village of	1	0.1%	0	0.0%	0	0.0%	0	0.0%	0	0.0%	1	0.1%
West Haverstraw, Village of	3	0.2%	2	0.2%	4	0.2%	2	0.2%	3	0.2%	12	0.3%
Rockland County (Total)	**560**	**1.1%**	**250**	**0.9%**	**321**	**1.2%**	**297**	**1.0%**	**454**	**0.9%**	**1,251**	**1.1%**

Source: U.S. Census Bureau, American Community Survey 5-Year Estimates 2017-2021; Poverty Populations: ALICE 2021; FEMA 2023

Impact on General Building Stock

After considering the population exposed and potentially vulnerable to the flood hazard, the built environment was evaluated. Exposure includes those buildings located in the flood hazard areas. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content replacement cost values.

Table 4.3.6-10 and Table 4.3.6-11 summarize the number of structures located in the 1-percent and 0.2-percent annual chance flood events by jurisdiction. In summary, there are 1,448 buildings (1.3 percent of the total building stock) located in the 1-percent annual chance flood hazard area with an estimated $1.3 billion of replacement cost value (e.g., building and content replacement costs). There are 3,409 buildings (3 percent of the total building stock) located in the 0.2-percent annual chance flood hazard area with an estimated $2.7 billion of replacement cost value.

Table 4.3.6-12 provides the estimated building stock potential loss, by occupancy class, to the 1-percent annual chance flood event. Estimated losses for all occupancies is $588 million, of which $227 million is residential properties, $162 million is commercial properties, and $198 million is other occupancies.

Table 4.3.6-10. Estimated Building Stock Located in the 1-Percent Annual Chance Flood Hazard Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located in the Flood Hazard Area			
			Number of Buildings Located in the 1-Percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost of Buildings in the 1-Percent Annual Chance Flood Event Hazard Area	Percent of Total
Airmont, Village of	4,324	$2,712,726,498	25	0.6%	$9,685,487	0.4%
Chestnut Ridge, Village of	3,996	$2,590,102,202	20	0.5%	$13,263,840	0.5%
Clarkstown, Town of	34,094	$22,578,694,610	270	0.8%	$299,184,405	1.3%
Grand View on Hudson, Village of	219	$123,746,894	7	3.2%	$5,415,049	4.4%
Haverstraw, Town of	5,157	$14,687,792,118	34	0.7%	$79,984,088	0.5%
Haverstraw, Village of	2,232	$1,373,775,543	8	0.4%	$135,998,296	9.9%
Hillburn, Village of	499	$340,797,550	6	1.2%	$1,928,934	0.6%
Kaser, Village of	197	$434,976,786	1	0.5%	$826,942	0.2%
Montebello, Village of	2,002	$1,957,771,278	97	4.8%	$47,927,094	2.4%
New Hempstead, Village of	2,074	$1,416,579,766	22	1.1%	$14,953,982	1.1%
New Square, Village of	455	$640,979,013	4	0.9%	$2,540,868	0.4%
Nyack, Village of	1,830	$1,930,474,072	2	0.1%	$490,461	0.0%
Orangetown, Town of	18,439	$19,240,363,073	156	0.8%	$123,958,932	0.6%
Piermont, Village of	841	$520,681,014	97	11.5%	$36,190,492	7.0%
Pomona, Village of	1,437	$947,429,629	17	1.2%	$7,897,582	0.8%
Ramapo, Town of	9,783	$7,401,302,608	74	0.8%	$174,763,227	2.4%
Sloatsburg, Village of	1,776	$780,218,848	54	3.0%	$20,168,393	2.6%
South Nyack, Village of	1,009	$628,994,780	2	0.2%	$705,215	0.1%
Spring Valley, Village of	3,468	$2,977,580,954	92	2.7%	$94,304,345	3.2%
Stony Point, Town of	8,819	$4,492,546,145	256	2.9%	$95,601,135	2.1%
Suffern, Village of	3,110	$2,011,976,760	184	5.9%	$62,437,520	3.1%
Upper Nyack, Village of	1,121	$714,087,836	1	0.1%	$598,545	0.1%
Wesley Hills, Village of	2,432	$1,597,464,375	3	0.1%	$1,412,252	0.1%
West Haverstraw, Village of	3,171	$1,575,031,545	16	0.5%	$76,676,435	4.9%
Rockland County (Total)	**112,485**	**$93,676,093,896**	**1,448**	**1.3%**	**$1,306,913,522**	**1.4%**

Source: Rockland County, NYS Office of Information Technology Services Geospatial Services and NYS Department of Taxation and Finance's Office of Real Property Tax Services (ORPTS) 2022; Center for International Earth Science Information Network, New York State Energy Research and Development Authority 2022; U.S. Army Corps of Engineers, National Structure Inventory 2022; RS Means 2022; FEMA 2023

Table 4.3.6-11. Estimated Building Stock Located in the 0.2-Percent Annual Chance Flood Hazard Area

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Located in the Flood Hazard Area			
			Number of Buildings Located in the 0.2-Percent Annual Chance Flood Event Hazard Area	Percent of Total	Total Replacement Cost of Buildings in the 0.2-Percent Annual Chance Flood Event Hazard Area	Percent of Total
Airmont, Village of	4,324	$2,712,726,498	31	0.7%	$16,812,928	0.6%
Chestnut Ridge, Village of	3,996	$2,590,102,202	28	0.7%	$17,297,182	0.7%
Clarkstown, Town of	34,094	$22,578,694,610	577	1.7%	$497,689,163	2.2%
Grand View on Hudson, Village of	219	$123,746,894	219	100.0%	$123,746,894	100.0%
Haverstraw, Town of	5,157	$14,687,792,118	49	1.0%	$109,132,872	0.7%
Haverstraw, Village of	2,232	$1,373,775,543	20	0.9%	$142,011,756	10.3%
Hillburn, Village of	499	$340,797,550	15	3.0%	$37,790,358	11.1%
Kaser, Village of	197	$434,976,786	3	1.5%	$1,371,444	0.3%
Montebello, Village of	2,002	$1,957,771,278	144	7.2%	$81,510,816	4.2%
New Hempstead, Village of	2,074	$1,416,579,766	27	1.3%	$17,417,053	1.2%
New Square, Village of	455	$640,979,013	6	1.3%	$4,220,601	0.7%
Nyack, Village of	1,830	$1,930,474,072	75	4.1%	$24,650,111	1.3%
Orangetown, Town of	18,439	$19,240,363,073	479	2.6%	$443,858,952	2.3%
Piermont, Village of	841	$520,681,014	327	38.9%	$150,356,167	28.9%
Pomona, Village of	1,437	$947,429,629	17	1.2%	$7,897,582	0.8%
Ramapo, Town of	9,783	$7,401,302,608	119	1.2%	$195,841,233	2.6%
Sloatsburg, Village of	1,776	$780,218,848	129	7.3%	$54,375,688	7.0%
South Nyack, Village of	1,009	$628,994,780	421	41.7%	$363,140,571	57.7%
Spring Valley, Village of	3,468	$2,977,580,954	112	3.2%	$127,304,257	4.3%
Stony Point, Town of	8,819	$4,492,546,145	322	3.7%	$122,246,188	2.7%
Suffern, Village of	3,110	$2,011,976,760	248	8.0%	$96,988,984	4.8%
Upper Nyack, Village of	1,121	$714,087,836	2	0.2%	$9,586,136	1.3%
Wesley Hills, Village of	2,432	$1,597,464,375	7	0.3%	$3,746,093	0.2%
West Haverstraw, Village of	3,171	$1,575,031,545	32	1.0%	$93,886,277	6.0%
Rockland County (Total)	**112,485**	**$93,676,093,896**	**3,409**	**3.0%**	**$2,742,879,304**	**2.9%**

Source: Rockland County, NYS Office of Information Technology Services Geospatial Services and NYS Department of Taxation and Finance's Office of Real Property Tax Services (ORPTS) 2022; Center for International Earth Science Information Network, New York State Energy Research and Development Authority 2022; U.S. Army Corps of Engineers, National Structure Inventory 2022; RS Means 2022; FEMA 2023

Table 4.3.6-12. Estimated Building Stock Potential Loss by Occupancy to the 1-Percent Annual Chance Flood Event

Jurisdiction	Estimated Loss for All Occupancies	Estimated Loss for Residential Properties	Estimated Loss for Commercial Properties	Estimated Loss for All Other Occupancies
Airmont, Village of	$6,784,907	$4,963,412	$127,848	$1,693,647
Chestnut Ridge, Village of	$4,607,962	$4,124,964	$0	$482,998
Clarkstown, Town of	$187,797,524	$55,646,740	$107,408,782	$24,742,002
Grand View on Hudson, Village of	$1,436,434	$511,303	$0	$925,131
Haverstraw, Town of	$25,327,966	$1,928,281	$2,617,980	$20,781,705
Haverstraw, Village of	$46,288,163	$9,270	$0	$46,278,893
Hillburn, Village of	$967,273	$967,273	$0	$0
Kaser, Village of	$534,756	$534,756	$0	$0
Montebello, Village of	$32,560,791	$28,337,700	$99,520	$4,123,571
New Hempstead, Village of	$2,095,430	$1,659,506	$0	$435,925
New Square, Village of	$2,328,357	$2,328,357	$0	$0
Nyack, Village of	$200,505	$200,505	$0	$0
Orangetown, Town of	$55,127,155	$13,378,141	$18,370,317	$23,378,697
Piermont, Village of	$5,708,587	$5,045,283	$663,304	$0
Pomona, Village of	$388,495	$388,495	$0	$0
Ramapo, Town of	$20,347,226	$17,683,113	$2,464,570	$199,544
Sloatsburg, Village of	$14,464,415	$10,377,627	$3,673,818	$412,969
South Nyack, Village of	$104,607	$104,607	$0	$0
Spring Valley, Village of	$44,434,225	$23,690,842	$13,094,767	$7,648,617
Stony Point, Town of	$41,300,866	$24,029,536	$5,541,257	$11,730,072
Suffern, Village of	$44,639,151	$28,921,630	$7,496,155	$8,221,365
Upper Nyack, Village of	$261,365	$261,365	$0	$0
Wesley Hills, Village of	$1,689,861	$1,689,861	$0	$0
West Haverstraw, Village of	$49,537,328	$1,207,697	$965,101	$47,364,529
Rockland County (Total)	**$588,933,347**	**$227,990,261**	**$162,523,421**	**$198,419,666**

Source: Hazus v6.0
Note: These values are rounded to the nearest dollar/whole value.

NFIP Statistics

Participating in the NFIP is voluntary and to join, a community must complete an application; adopt a resolution of intent to participate and cooperate with FEMA; and adopt and submit a floodplain management ordinance that meets or exceeds the minimum NFIP criteria, and the ordinance must also adopt any FIRM or FHBM for the community. By participating, communities agree to adopt and implement local floodplain management regulations that protect lives and reduce risk from future flooding. In return, the federal government makes flood insurance available to property owners throughout the community (FEMA 2020) (FEMA 2022). Table 4.3.6-13 summarizes the NFIP community statistics for Rockland County. All 24 municipalities participate in the NFIP.

Table 4.3.6-13. NFIP Community Statistics for Rockland County

Community Name	Community Identification Number	Participates in the NFIP?
Airmont, Village of	360140	Yes
Chestnut Ridge, Village of	361615	Yes
Clarkstown, Town of	360679	Yes
Grand View on Hudson, Village of	360680	Yes
Haverstraw, Town of	360681	Yes
Haverstraw, Village of	360682	Yes
Hillburn, Village of	360683	Yes
Kaser, Village of	365376	Yes
Montebello, Village of	361617	Yes
New Hempstead, Village of	361618	Yes
New Square, Village of	360684	Yes
Nyack, Village of	360685	Yes
Orangetown, Town of	360686	Yes
Piermont, Village of	360687	Yes
Pomona, Village of	360688	Yes
Ramapo, Town of	365340	Yes
Sloatsburg, Village of	360690	Yes
South Nyack, Village of	360691	Yes
Spring Valley, Village of	365344	Yes
Stony Point, Town of	360693	Yes
Suffern, Village of	360694	Yes
Upper Nyack, Village of	360695	Yes
Wesley Hills, Village of	361616	Yes
West Haverstraw, Village of	360696	Yes

Source: FEMA 2022

Table 4.3.6-14 summarizes NFIP policies, claims, and repetitive loss statistics for Rockland County. 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 4.3.6-14. NFIP Policies, Claims, and Repetitive Loss Statistics

Jurisdiction	Number of Policies	Total Paid Policies	Number of Claims	Total Paid Claims	NFIP		FMA	
					RL Properties	SRL Properties	RL Properties	SRL Properties
Airmont, Village of	2	$1,131	2	$17,742	0	0	0	0
Chestnut Ridge, Village of	17	$10,226	13	$184,281	1	0	0	0
Clarkstown, Town of	322	$245,945	941	$9,346,749	99	16	1	18
Grand View on Hudson, Village of	20	$17,296	46	$1,296,282	4	1	0	0
Haverstraw, Town of	17	$13,136	55	$390,221	4	0	0	0
Haverstraw, Village of	13	$80,105	7	$7,768	0	0	0	0
Hillburn, Village of	3	$4,425	33	$1,222,574	2	1	0	1
Kaser, Village of	2	$1,076	0	$0	0	0	0	0

Jurisdiction	Number of Policies	Total Paid Policies	Number of Claims	Total Paid Claims	NFIP		FMA	
					RL Properties	SRL Properties	RL Properties	SRL Properties
Montebello, Village of	35	$46,521	55	$1,404,227	6	0	1	0
New Hempstead, Village of	9	$7,860	6	$44,138	1	0	0	0
New Square, Village of	0	$0	9	$27,452	1	0	0	0
Nyack, Village of	22	$34,915	85	$2,497,954	9	2	0	2
Orangetown, Town of	115	$123,854	362	$5,668,545	33	5	3	5
Piermont, Village of	97	$118,937	131	$4,725,881	15	3	2	3
Pomona, Village of	14	$10,950	29	$97,455	3	0	0	0
Ramapo, Town of	44	$60,266	422	$1,972,984	40	0	0	0
Sloatsburg, Village of	25	$36,980	58	$595,914	8	1	1	1
South Nyack, Village of	10	$10,094	27	$559,165	3	1	0	1
Spring Valley, Village of	29	$43,417	254	$1,469,991	29	4	0	4
Stony Point, Town of	56	$62,159	97	$3,170,230	4	0	2	0
Suffern, Village of	62	$118,237	432	$4,914,588	29	3	0	4
Upper Nyack, Village of	13	$12,887	13	$227,317	1	1	1	1
Wesley Hills, Village of	12	$6,938	7	$90,283	0	0	0	0
West Haverstraw, Village of	23	$57,780	29	$3,917,935	0	0	0	0
Rockland County (Total)	**962**	**$1,125,135**	**3,113**	**$43,849,675**	**292**	**38**	**11**	**40**

Source: FEMA 2023
Notes: Data current as of December 2023
RL count may include properties also identified as SRL

Table 4.3.6-15. Occupancy Class of Repetitive Loss (NFIP) Structures in Rockland County

Jurisdiction	NFIP										FMA									
	RL					SRL					RL					SRL				
	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential
Airmont, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Chestnut Ridge, Village of	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clarkstown, Town of	2	1	90	5	1	14	0	0	1	1	0	0	1	0	0	0	0	14	3	1
Grand View on Hudson, Village of	0	0	4	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Haverstraw, Town of	1	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Haverstraw, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hillburn, Village of	0	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0
Kaser, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montebello, Village of	0	0	6	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
New Hempstead, Village of	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
New Square, Village of	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nyack, Village of	1	3	3	1	1	1	0	0	0	1	0	0	0	0	0	0	0	1	0	1

Jurisdiction	NFIP										FMA									
	RL					SRL					RL					SRL				
	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential	2-4 Family	Other Residential	Single Family	Other Non-Residential	Business Non-Residential
Orangetown, Town of	1	0	31	1	0	4	0	0	1	0	0	0	3	0	0	0	0	4	1	0
Piermont, Village of	4	0	11	0	0	3	0	0	0	0	1	0	1	0	0	0	0	3	0	0
Pomona, Village of	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ramapo, Town of	1	1	35	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sloatsburg, Village of	0	0	7	1	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0
South Nyack, Village of	0	0	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Spring Valley, Village of	0	3	26	0	0	4	0	0	0	0	0	0	0	0	0	0	0	4	0	0
Stony Point, Town of	0	0	4	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0
Suffern, Village of	0	0	27	2	0	3	0	0	0	0	0	0	0	0	0	0	0	4	0	0
Upper Nyack, Village of	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	1	0	0
Wesley Hills, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
West Haverstraw, Village of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rockland County (Total)	**11**	**8**	**257**	**14**	**2**	**33**	**0**	**0**	**3**	**2**	**1**	**0**	**10**	**0**	**0**	**0**	**0**	**34**	**5**	**2**

Source: NFIP 2023
Note: RL count may include properties also identified as SRL

Impact on Critical Facilities and Community Lifelines

Critical services during and after a flood event may not be available if critical facilities are directly damaged or transportation routes to access these critical facilities are impacted. Roads that are blocked or damaged can isolate residents and can prevent access throughout the planning area to many service providers needing to get to vulnerable populations or to make repairs. Utilities such as overhead power, cable, and phone lines could also be vulnerable due to utility poles damaged by standing water or the surge of water from a dam failure event. Loss of these utilities could create additional isolation issues for the inundation zones (refer to Section 4.3.1 Dam Failure).

Major roadways that may be impacted by the 1- and 0.2-percent annual chance flood events include Route 202, Route 17, portions of Route 303 and Route 340, and other various state and county roads. There are several issues associated with transportation routes flooding, including isolation caused by bridges being washed out or blocked by floods or debris, health problems caused by water and sewer systems that are flooded or backed up, drinking water contamination caused by floodwaters carrying pollutants in water supplies, and localized urban flooding caused by culverts blocked with debris.

Community lifeline exposure to the 1-percent and 0.2-percent annual chance flood hazard event boundary was examined. In addition, Hazus was used to estimate the flood loss potential to community lifelines located in the FEMA mapped floodplains. Table 4.3.6-16 summarizes the number of community lifelines exposed to the 1-percent and 0.2-percent flood inundation areas by jurisdiction. Of the 82 community lifelines located in the 1-percent annual chance flood event boundary, Safety and Security has the majority of facilities (59). Out of the 98 community lifelines located in the 0.2-percent annual chance flood event boundary, Safety and Security has the

majority of facilities (67). Refer to Section 3 (County Profile) for more information about the critical facilities and lifelines in Rockland County.

In cases where short-term functionality is impacted by flooding, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce flood impacts to critical facilities and ensure sufficient emergency and school services remain when a significant event occurs.

Table 4.3.6-16. Number of Lifeline Critical Facilities Located in the Annual Chance Flood Hazard Area

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Located in the 1-Percent Annual Chance Flood Event Hazard Area	Number of Lifelines Located in the 0.2-Percent Annual Chance Flood Event Hazard Area
Communications	154	6	8
Energy	0	0	0
Food, Water, Shelter	71	0	0
Hazardous Materials	56	1	1
Health and Medical	195	2	6
Safety and Security	349	59	67
Transportation	8	0	0
Water Systems	148	14	16
Rockland County (Total)	**981**	**82**	**98**

Table 4.3.6-17. Critical Facilities and Lifeline Facilities Located in the 1-Percent Annual Chance Flood Event Hazard Area by Jurisdiction

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 1-Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Airmont, Village of	61	40	8	13.1%	8	20.0%
Chestnut Ridge, Village of	46	30	1	2.2%	1	3.3%
Clarkstown, Town of	406	230	17	4.2%	14	6.1%
Grand View on Hudson, Village of	1	1	0	0.0%	0	0.0%
Haverstraw, Town of	96	68	4	4.2%	4	5.9%
Haverstraw, Village of	65	30	0	0.0%	0	0.0%
Hillburn, Village of	20	12	2	10.0%	2	16.7%
Kaser, Village of	18	1	0	0.0%	0	0.0%
Montebello, Village of	47	37	11	23.4%	11	29.7%
New Hempstead, Village of	30	12	0	0.0%	0	0.0%
New Square, Village of	19	4	0	0.0%	0	0.0%
Nyack, Village of	64	35	1	1.6%	0	0.0%
Orangetown, Town of	243	129	3	1.2%	3	2.3%
Piermont, Village of	23	10	5	21.7%	3	30.0%
Pomona, Village of	8	5	0	0.0%	0	0.0%
Ramapo, Town of	219	109	10	4.6%	10	9.2%

Jurisdiction	Total Critical Facilities Located in Jurisdiction	Total Lifelines Located in Jurisdiction	Number of Critical Facilities and Lifeline Facilities Located in the 1-Percent Annual Chance Flood Event Hazard Area			
			Critical Facilities	Percent of Total Critical Facilities	Lifelines	Percent of Total Lifelines
Sloatsburg, Village of	32	22	6	18.8%	5	22.7%
South Nyack, Village of	13	7	0	0.0%	0	0.0%
Spring Valley, Village of	119	58	6	5.0%	3	5.2%
Stony Point, Town of	108	75	9	8.3%	6	8.0%
Suffern, Village of	42	28	6	14.3%	6	21.4%
Upper Nyack, Village of	11	5	0	0.0%	0	0.0%
Wesley Hills, Village of	22	12	3	13.6%	3	25.0%
West Haverstraw, Village of	40	21	3	7.5%	3	14.3%
Rockland County (Total)	1,753	981	95	5.4%	82	8.4%

Source: Rockland County 2023; FEMA 2023; NYSDHSES; USGS, Godt; Radeloff et all

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, business interruption, impacts on tourism, and impacts on the tax base to Rockland County. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the 'Impact on General Building Stock' subsection earlier which discusses direct impacts to buildings in Rockland County. Other economic components such as loss of facility use, functional downtime and socio-economic factors are less measurable with a high degree of certainty.

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. Table 4.3.6-18 discusses building-related economic losses due to the 1-percent annual chance flood event. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. The Impact on General Building Stock subsection above discusses replacement cost value for buildings located in flood zones.

Table 4.3.6-18. Building-Related Economic Loss Estimates from the 1-Percent Annual Chance Flood Event

	Total Business Interruption Loss				
Flood Hazard	Inventory Loss	Relocation Loss	Wage Loss	Rental Loss	Income Loss
1-Percent Annual Chance Flood Event	$37,760,000	$63,140,000	$150,180,000	$32,400,000	$80,210,000

Source: Hazus v6.0

Debris management may also be a large expense after a flood event. Hazus estimates the amount of debris generated from the 1-percent annual chance 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.). The distinction is made because of the different types of equipment needed to handle the debris. Table 4.3.6-19 summarizes the Hazus v6 countywide debris estimates for the 1-percent annual chance flood event. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or

storm that causes flooding. Overall, Hazus estimates that there will be 67,320 tons of debris generated during the 1-percent annual chance flood event in Rockland County.

Table 4.3.6-19. Estimated Debris Generated from the 1-Percent Annual Chance Flood Event

Jurisdiction	1-Percent Annual Chance Flood Event			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Airmont, Village of	3,938	668	1,949	1,321
Chestnut Ridge, Village of	1,763	305	800	659
Clarkstown, Town of	14,069	2,824	6,382	4,863
Grand View on Hudson, Village of	312	87	138	87
Haverstraw, Town of	1,021	226	456	339
Haverstraw, Village of	182	104	48	30
Hillburn, Village of	431	68	194	169
Kaser, Village of	349	108	88	153
Montebello, Village of	6,095	1,188	2,685	2,222
New Hempstead, Village of	225	67	83	74
New Square, Village of	92	28	25	39
Nyack, Village of	174	68	65	41
Orangetown, Town of	5,107	1,214	2,437	1,456
Piermont, Village of	1,455	673	479	303
Pomona, Village of	82	19	35	29
Ramapo, Town of	4,357	867	1,828	1,662
Sloatsburg, Village of	4,634	867	2,037	1,730
South Nyack, Village of	106	30	47	29
Spring Valley, Village of	6,347	1,426	2,442	2,478
Stony Point, Town of	3,306	1,086	1,165	1,054
Suffern, Village of	10,868	2,071	4,689	4,108
Upper Nyack, Village of	182	57	77	49
Wesley Hills, Village of	694	121	323	250
West Haverstraw, Village of	1,532	212	745	576
Rockland County (Total)	**67,320**	**14,383**	**29,216**	**23,721**

Source: Hazus v6.0
Note: These values are rounded to the nearest whole value.

Impact on the Environment

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

The environmental impacts of a flood can include significant water quality and debris-disposal issues. Floodwaters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals get added to floodwaters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could

be offline for weeks. After the floodwaters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties. In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

Flood events will inevitably impact Rockland County's natural and local environment. Severe flooding not only influences the habitat of these natural land areas, but it can also be disruptive to species that reside in these natural habitats. Table 4.3.6-20 lists the number of acres exposed to the 1- and 0.2-percent annual chance flood hazard areas.

Table 4.3.6-20. Land Acreage in Rockland County Located in the 1% and 0.2% Flood Extents

Jurisdiction	Total Acres of Land Area	Total Acres of Land Area (Excluding Waterbodies) Located in the Flood Hazard Areas			
		Total Acres Located in the 1-Percent Annual Chance Flood Event	Percent of Total	Total Acres Located in the 0.2-Percent Annual Chance Flood Event	Percent of Total
Airmont, Village of	2,844	60	2.1%	73	2.6%
Chestnut Ridge, Village of	3,109	93	3.0%	114	3.7%
Clarkstown, Town of	23,295	1,023	4.4%	1,261	5.4%
Grand View on Hudson, Village of	106	2	1.9%	106	100.0%
Haverstraw, Town of	11,066	210	1.9%	319	2.9%
Haverstraw, Village of	1,254	43	3.4%	58	4.6%
Hillburn, Village of	1,364	65	4.8%	92	6.7%
Kaser, Village of	103	2	1.9%	3	2.9%
Montebello, Village of	2,704	259	9.6%	314	11.6%
New Hempstead, Village of	1,747	65	3.7%	68	3.9%
New Square, Village of	220	2	0.9%	3	1.4%
Nyack, Village of	492	3	0.6%	22	4.5%
Orangetown, Town of	13,958	894	6.4%	1,169	8.4%
Piermont, Village of	411	83	20.2%	169	41.1%
Pomona, Village of	1,488	61	4.1%	62	4.2%
Ramapo, Town of	19,415	569	2.9%	623	3.2%
Sloatsburg, Village of	1,564	166	10.6%	196	12.5%
South Nyack, Village of	389	1	0.3%	197	50.6%
Spring Valley, Village of	1,285	76	5.9%	88	6.8%
Stony Point, Town of	17,910	592	3.3%	621	3.5%
Suffern, Village of	1,317	106	8.0%	144	10.9%
Upper Nyack, Village of	738	2	0.3%	4	0.5%
Wesley Hills, Village of	2,102	40	1.9%	52	2.5%
West Haverstraw, Village of	988	39	3.9%	55	5.6%
Rockland County (Total)	**109,869**	**4,456**	**4.1%**	**5,813**	**5.3%**

Source: Rockland County 2020; USGS, NHD 2023; FEMA
Notes:
1) Excludes areas designated as water
2) Values are rounded to the nearest whole value

Cascading Impacts on Other Hazards

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. Mold spores can grow in as short a period as 24 to 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 2020).

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 (FEMA 2022):

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

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

Floods of any type have the potential to impact water and power utilities which may impact public and private use, as well as cause disruption to critical infrastructure. Flooding's harmful effects on the water supply include any of the following (Andrew 2021):

- *Water Supply Contamination*: Excess floodwater can contaminate private drinking water sources, such as wells and springs. Floodwater picks up debris, increasing the number of bacteria, sewage, and other industrial waste and chemicals into the water source or leaky pipes. Excess water also makes it more difficult for water treatment plants to treat the water efficiently and effectively. If there is a contamination at any step of the water flow process, this puts consumers at risk of exposure to dangerous toxins that could result in serious harm, such as wound infections, skin rashes, gastrointestinal illnesses, and tetanus; in extreme cases, death may occur.
- *Disruption to Clean Drinking and Cooking Water*: In the event of only having access to contaminated water, consumers are unable to cook or clean in their home the water is certified as safe. Depending on the severity of the flood and the storm, this could take days, weeks, months and in some cases even years. Without access to clean drinking and cooking water, consumers ultimately become reliant on bottled water. In impoverished communities, this reality is even more detrimental because those affected may not have the economic means to stock up on bottled water. Moreover, in a flood, retail locations are often inaccessible and/or low on water supply.

Floodwaters can also cause damage to power utilities. Flooded buildings may have the utilities disrupted if the service panel, generator, meter, or other equipment are not elevated above the flood protection level. Oversaturated soils from periods of heavy rain and flooding may cause utility poles to tip over or fall completely, interrupting the power grid for a potentially large area, especially if the transformer is impacted.

Future Changes That May Impact Vulnerability

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

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

Potential or Projected Development

Section 3 (County Profile) identifies areas targeted for future growth and development across the County. Any areas of growth located in the special flood hazard area could be potentially impacted by flooding. Areas outside of the special flood hazard can also be impacted by urban flooding and less frequent and more severe flooding events. Specific areas of recent and new development are indicated in tabular form and/or on the hazard maps included in Volume II, Section 9 (Jurisdictional Annexes) of this plan.

Projected Changes in Population

Rockland County has experienced an increase in its population since 2010. According to the U.S. Census Bureau, the County's population increased by approximately 8.5 percent between 2010 and 2020 (County of Rockland 2021). Cornell University's Program on Applied projects Rockland County will have a population of 356,758 by 2030 and 372,432 by 2040 (Cornell University 2018). Changes in the density of population can increase the number of persons exposed to flooding. As areas continue to be cleared for new development and run-off persists, the population in the County will remain exposed to this hazard. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.

Other Identified Conditions

As discussed above, most studies project that the County will see an increase in average annual temperatures and precipitation. Increased severe storm and heavy rainfall events are likely to increase the occurrence and severity of flooding in Rockland County. It is anticipated that the County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

Change of Vulnerability Since 2018 HMP

Rockland County remains vulnerable to the flood hazard. However, there are several differences between the exposure estimates of this plan update and the results reported in the 2018 HMP. Updated population statistics and building stock was used in the current risk assessment. Further, exposure for both the population and critical facilities was analyzed. These updated datasets provide a more accurate exposure analysis to the flood hazard.