SECTION 4. RISK ASSESSMENT

4.2 METHODOLOGY AND TOOLS

A risk assessment is the process of measuring the potential loss of life, personal injury, economic injury, and property damage resulting from identified hazards of concern. It allows emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. The process focuses on the following elements:

- **Hazard identification** uses all available information to determine what types of hazards may affect a jurisdiction, how often they can occur, and their potential severity.
- **Profile each hazard** aims to understand each hazard in terms of the following components:
    o Extent (i.e., severity of each hazard)
    o Location (i.e., geographic area most affected by the hazard)
    o Previous occurrences and losses
    o Impacts of climate change
    o Probability of future hazard events
- **Assess vulnerability** by identifying exposure, estimate losses, and assessing future changes that may affect vulnerability.
    o *Exposure identification* estimates the total number of assets in the jurisdiction that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
    o *Vulnerability identification and loss estimation* assesses the impact of hazard events on the people, property, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.
    o *Future changes that may impact vulnerability* analyzes how demographic changes, projected development and climate change impacts can alter current exposure and vulnerability.

This section presents the Rockland County risk assessment and is outlined as follows:

- Methodology and tools used to conduct the risk assessment
- Identification of hazards of concern that impact Rockland County
- Hazards of concern profiles and vulnerability assessment
- Hazard ranking

4.2.1 Risk Assessment Tools

The following section describes the various tools used to complete the risk assessment for the Rockland County HMP update.

Mapping

National, state, and county databases were reviewed to locate available spatially based data relevant to this planning effort. Maps were produced using geographic information system (GIS) software to show the spatial

extent and location of hazards when such datasets were available. These maps are included in the hazard profile chapters of this document.

Hazus

In 1997, FEMA developed the standardized Hazards U.S. (Hazus) model to estimate losses caused by earthquakes and identify areas that face the highest risk and potential for loss. Hazus was later expanded into a multi-hazard methodology (Hazus-MH) with new models for estimating potential losses from hurricanes and floods.

Hazus is a GIS-based software program used to support risk assessments, mitigation planning, and emergency planning and response. It provides a wide range of inventory data, such as demographics, building stock, critical facility, transportation and utility lifeline, and multiple models to estimate potential losses from natural disasters. The program maps and displays hazard data and the results of damage and economic loss estimates for buildings and infrastructure. Its advantages include the following:

- Provides a consistent methodology for assessing risk across geographic and political entities.
- Provides a way to save data so that they can readily be updated as population, inventory, and other factors change and as mitigation planning efforts evolve.
- Facilitates review of mitigation plans because it helps to ensure that FEMA methodologies are incorporated.
- Supports grant applications by calculating benefits using FEMA definitions and terminology.
- Produces hazard data and loss estimates that can be used in communication with local stakeholders.
- Is administered by the local government and can be used to manage and update a hazard mitigation plan throughout its implementation.

Level of Detail for Evaluation

Hazus provides default data for inventory, vulnerability, and hazards; these default data can be supplemented with local data to provide a more refined analysis. The model can carry out three levels of analysis, depending on the format and level of detail of information about the planning area:

- **Level 1**—All of the information needed to produce an estimate of losses is included in the software's default data. These data are derived from national databases and describe in general terms the characteristic parameters of the planning area.
- **Level 2**—More accurate estimates of losses require more detailed information about the planning area. To produce Level 2 estimates of losses, detailed information is required about local geology, hydrology, hydraulics, and building inventory, as well as data about utilities and critical facilities. This information is needed in a GIS format.
- **Level 3**—This level of analysis generates the most accurate estimate of losses. It requires detailed engineering and geotechnical information to customize it for the planning area.

4.2.2 Risk Assessment Approach

To address the requirements of the Disaster Mitigation Act (DMA) of 2000 and to better understand potential vulnerability and losses associated with hazards of concern, Rockland County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three different levels of analysis

were used depending upon the data available for each hazard, which can be summarized as the following (also see Table 4.2-1):

1. **Historic Occurrences and Qualitative Analysis** includes an examination of historic impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best-available data and professional judgement.
2. **Exposure Assessment** involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are in the impact area of the hazard. The analysis highlights which assets are in the hazard area and may incur future impacts.
3. **Loss Estimation** is produced by the FEMA Hazus modeling software to estimate potential losses for the following hazards: flood, earthquake, and hurricane. In addition, examinations of historical impacts and an exposure assessment are conducted for these spatially delineated hazards.

Table 4.2-1. Summary of Risk Assessment Analyses

Hazard	Population	General Building Stock	Critical Facilities	New Development
Dam/Levee Failure	E	E	E	E
Drought	Q	Q	Q	Q
Earthquake	E	E	E	E
Extreme Temperature	Q	Q	Q	Q
Flood	E, H	E, H	E, H	E
Landslide	E	E	E	E
Severe Storm	H	H	H	Q
Severe Winter Storm	Q	Q	Q	Q
Wildfire	E	E	E	E

Notes: E – Exposure analysis; H – Hazus analysis; Q – Qualitative analysis

Dam/Levee Failure

An exposure analysis was conducted for the County's assets (population, building stock, critical facilities, historic assets, and new development) using the Dam Inundation Areas provided by Rockland County. While there are 32 dams in the County, not all had mapped inundation areas available during the HMP update. Table 4.2-2 lists the dams and shows which dam inundation areas were included in the risk assessment. In order to conduct analysis, a composite dam failure inundation area was developed for all accessible dams. Consequently, if an asset is identified as being exposed, it is located at minimum within one dam failure inundation area.

Table 4.2-2. Dams in Rockland County

Dam Name	Hazard Classification	Inundation Area Included in HMP
Breakneck Pond Dam	Low	No
Central Nyack Dam	High	Yes
Christie Brook Dam #1	Significant	Yes
Christie Brook Dike	Low	No
Congers Lake Dam	High	Yes
Doodletown Dam	Significant	Yes

Dam Name	Hazard Classification	Inundation Area Included in HMP
First Reservoir Dam	High	Yes
Garnerville Dam	High	No
Henrich Pond Dam	Significant	No
Ibm Edcenter Dam A	Significant	No
John Patrick Pond Dam	Significant	No
Lake Boyce Dam	Significant	Yes
Lake Deforest Dam	High	Yes
Lake Kanawauke Dam	High	Yes
Lake Lucille Dam	High	Yes
Lake Sebago Dam	High	Yes
Lake Suzanne Dam	High	Yes
Lake Welch Dam	High	Yes
Pine Grove Lake Dam	High	Yes
Pine Meadow Brook Dam	Low	No
Pine Meadow Lake Dam	Significant	No
Potake Lake Dam	High	No
Rockland Print CO Dam #2	Significant	No
Schwartz Estate Pond Dam 6	Significant	Yes
Second Reservoir Dam	Significant	Yes
Stony Point Dam	Significant	No
Third Reservoir Spillway and Dam	Significant	Yes
Tivoli Lake Dam	High	Yes
Tivoli Lake Spillway	Significant	No
Tomkins Cove Dam	Significant	No
Wesley Chapel Dam #1	Significant	Yes
Wesley Chapel Dam #2	Significant	Yes

Disease Outbreak

To assess the vulnerability of the County to disease outbreak and its associated impacts, a qualitative assessment was conducted. This includes historical impacts, information provided by the Steering Committee and Planning Partnership, and publicly available hazard history information.

Drought

To assess the vulnerability of the County to drought and its associated impacts, a qualitative assessment was conducted.

Earthquake

An exposure analysis was conducted for the County's assets (population, building stock, critical facilities, historic assets, and new development) using the National Earthquake Hazards Reduction Program (NEHRP) soil data. Due to their known susceptible to ground shaking from earthquakes, NEHRP Soil Classes Type D and Type E were used to determine what assets are exposed to the soils most susceptible to seismic activity. Assets with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to these soil types.

Extreme Temperature

To assess the vulnerability of the County to extreme temperatures and its associated impacts, a qualitative assessment was conducted. This includes historical impacts, information provided by the Steering Committee and Planning Partnership, and publicly available hazard history information.

Flood

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

The following data were used to evaluate exposure and determine potential future losses for this plan update:

- The Rockland County FEMA Effective Digital Flood Insurance Rate Map (DFIRM) dated March 3, 2014 with the latest Letter of Map Amendment (LOMR) date of May 23, 2023.
- A depth grid was created using base-flood elevation and cross-section data from FEMA and a one-third Arc-second digital elevation models (DEM) model (highest resolution seamless DEM dataset for the U.S. with full coverage of the 48 conterminous states, Hawaii, and U.S. territories) provided by the U.S. Geological Survey (USGS); areas without flood elevation data from FEMA were generated using the FEMA flood boundaries and USGS DEM.

The effective Rockland County DFIRM effective in 2014 was used to evaluate exposure for both the 1- and 0.2-percent annual chance flood events; and determine potential future losses for the 0.2-percent annual chance flood event. The depth grid generated using the DFIRM and one-third Arc-second DEM was integrated into the Hazus riverine flood model and used to estimate potential losses for the 1-percent annual chance flood event.

To estimate exposure to the 1- and 0.2-percent annual chance flood events, the DFIRM flood boundaries were overlaid on the centroids of updated assets (population, building stock, historic assets, and critical facilities); as well as the DFIRM flood boundaries being overlaid on the polygons provided for anticipated new development. Centroids or polygons that intersected the flood boundaries were totaled to estimate the building replacement cost value (RCV) and population vulnerable to the flood inundation areas. A Level 2 Hazus riverine flood analysis was performed. Both the critical facility and building inventories were formatted to be compatible with Hazus and its Comprehensive Data Management System (CDMS). Once updated with the inventories, the Hazus riverine flood model was run to estimate potential losses in Rockland County for the 1-percent annual chance flood event. A user-defined analysis was also performed for the building stock. Buildings located within the floodplain were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. Hazus calculated the estimated potential losses to the population (default 2020 U.S. Census data across dasymetric blocks), potential damages to the general building stock, and potential damages to critical facility inventories based on the depth grids generated and the default Hazus damage functions in the flood model.

Landslide

An exposure analysis was conducted for the County's assets (population, building stock, critical facilities, historic assets, and new development). Landslide susceptibility maps were used to complete the analysis. These maps describe the relative likelihood of future landsliding based solely on the intrinsic properties of a locale or site. Prior

failure (from a landslide inventory), rock or soil strength, and steepness of slope are three of the more important site factors that determine susceptibility (USGS 2023).

Severe Weather

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Rockland County for the 100- and 500-year MRP events. The probabilistic Hazus hurricane model activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with Rockland County. Hazus contains data on historical hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Default demographic and updated building and critical facility inventories in Hazus were used for the analysis. Although damages are estimated at the census tract level, results were presented at the municipal level. Because there are multiple census tracts that contain more than one jurisdiction, a density analysis was used to extract the percentage of building structures that fall within each tract and jurisdiction. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Severe Winter Weather

All of Rockland County is exposed and vulnerable to severe winter weather events. Therefore, the entire general building stock inventory in Rockland County is exposed and vulnerable to the severe winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses for the severe winter storm hazard.

Historical data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, a percentage of the custom-building stock RCV was used to estimate damages that could result from winter storm conditions. This methodology is based on FEMA's How-to Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA 2001) and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA 2004).

Based on professional expertise and the information currently at hand, the projected losses for this hazard are believed to be overstated, thereby offering a cautious estimate for losses related to winter storm occurrences.

Wildfire

The wildfire urban interface, known as WUI, obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison was used to define the wildfire hazard areas. The wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For the purposes of this risk assessment, the high-, medium- and low-density interface areas aggregated into a single interface hazard area and the high-, medium- and low-density intermix areas aggregated into a single intermix hazard area.

The defined hazard area was overlaid upon the asset data (population, building stock, critical facilities) to estimate the exposure to each hazard. To determine what assets are exposed to wildfire, available and appropriate GIS data were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number of assets and their replacement cost value exposed to a wildfire event.

4.2.3 Sources of Data Used in Hazus Modeling and Exposure Analysis

Rockland County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Rockland County assessed exposure and vulnerability of the following types of assets: population, buildings, critical facilities, lifelines, infrastructure, new development, historic and cultural, and the environment. Some assets may be more vulnerable because of their physical characteristics or socio-economic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties. The following section defines each asset type and identifies the data sourced used in this risk assessment.

Building and Cost Data

A custom building stock inventory was generated using 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 parcel data; 2022 U.S. Army Corps of Engineers, National Structure Inventory to identify occupancy class, and 2022 Center for International Earth Science Information Network (CIESIN), New York State Energy Research and Development Authority for building footprints. Attributes provided in the associated files were used to further define each structure, such as year built, number of stories, occupancy class, and square footage. The centroid of each building footprint was used to estimate the building location. Structural and content RCV were calculated for each building using the available assessor data, the building footprint, and RSMeans 2022 values.

A regional location factor for Rockland County was applied based on the individual building stock's zip code location - 109: Residential – 1.08/Non-Residential – 1.05

RCV is the current cost of returning an asset to its pre-damaged condition using present-day cost of labor and materials. Total RCV consists of both the structural cost to replace a building and the estimate value of contents of a building. The occupancy classes available in Hazus were condensed into the categories of residential, commercial, industrial, agricultural, religious, governmental, and educational to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.

Critical Facilities and Lifelines

The individual datasets used to create the critical facility inventory, which includes essential facilities, utilities, transportation features and user-defined facilities, were provided by Rockland County GIS. The development aligned with Hazus attribute standards and included determining whether the critical facility is considered a lifeline in accordance with FEMA's definition (refer to Appendix F, Critical Facilities). To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

Critical facilities were provided by Rockland County and updated based on review by officials from each participating jurisdiction. Lifelines were identified in the critical facility inventory to align with FEMA's lifeline definition.

Population

Total population statistics from the 2021 American Community Survey (ACS) Five-Year Estimate were used to estimate the exposure and potential impacts to the County's population in place of the 2020 U.S. Census block estimates. The 2021 ACS was used because it provides information about communities every year and is considered best available data. To determine population statistics for villages and towns, village population totals were subtracted from the total town population. Population counts at the jurisdictional level were averaged among the residential structures in the county to estimate the population at the structure level. This estimate provides a more precise distribution of population across the county compared to only using the Census block or Census tract boundaries. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate for planning purposes.

Socially Vulnerable Populations

As discussed in Section 3, County Profile, research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. Vulnerable populations in Rockland County included in the risk assessment are children, elderly, population below the poverty level, non-English speaking individuals, and persons institutionalized with a disability. The 2021 ACS was used to determine the number of each at the county and municipal level.

However, the United Way of New York State's Asset Limited, Income Constrained, Employed (ALICE) report was used to determine the number of households and individuals earning above the federal poverty level but struggle to afford basic expenses. 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, child care, food, transportation, health care, and utilities) where they live. To determine this threshold, the ALICE measures use household costs and income. The Household Survival Budget calculates the cost of household essentials for each county in New York and relies on a wide range of sources for the budget items of housing, child care, food, transportation, health care, and a smartphone plan, plus taxes. For household income, the ALICE measures rely on the U.S. Census Bureau's ACS.

Household costs are compared to household income to determine if households are below the ALICE threshold. This includes both households in Poverty, with income below the FPL, and those that are ALICE, with income above the FPL but below the cost of basics. The average percent of ALICE households was calculated to determine the number of households in Rockland County that are below the ALICE threshold. It should be noted that this is a calculated average and may not fully represent the number of ALICE households in Rockland County.

FEMA's Hazus program was used to model estimated potential losses to flood and wind hazards as discussed further later in this section. Hazus contains 2020 U.S. Census block data and was used to estimate sheltering and injuries as part of the hazard analysis.

Environmental and Land Use Area

The National Land Use and Land Cover data was derived from the Multi-Resolution Land Characteristics (MRLC) Consortium. The MRLC is a consortium of federal agencies that coordinates and generates consistent and relevant land cover information at the national scale for a wide variety of environmental, land management, and modeling applications. Additionally, Rockland County provided 2022 land use information that includes more detailed categories, such as agricultural, general business/community commercial, heavy industrial, institutional/quasi-public, light industrial/warehouse, local neighborhood, local park/open space, mixed use (residential/commercial), multi-family residential, multi-family residential - senior housing, not yet classified, office, one family residential, private recreation/private open space, public park/open space, railroad, regional commercial, road/commuter parking, three family residential, two family residential, under water, utilities, and vacant.

New Development

In addition to assessing the vulnerability of the built environment, Rockland County examined anticipated new development in the next five years. New development was identified by Rockland County as anticipated in the next five years and recently developed since the last plan update in 2018. An exposure analysis was conducted in GIS to determine hazard exposure to the anticipated development sites.

Identifying these changes and integrating new development into the risk assessment provides communities information to consider when developing the mitigation strategy to reduce these vulnerabilities in the future (one tool in the Mitigation Toolbox discussed in Section 6, Mitigation Strategy). The new development is listed in Section 4, County Profile, and hazard exposure analysis results are presented in Section 9, Jurisdictional Annexes, as a table in each annex.

Data Source Summary

Table 4.2-3 summarizes the data sources used for the risk assessment for this plan.

Table 4.2-3. Risk Assessment Data Documentation

Data	Source	Date	Format
Population Data	U.S. Census Bureau, American Community Survey 5-Year Estimates	2017- 2021	Digital (GIS) format
New Development	Participating Rockland County Municipalities	2023	Digital Format
Building Inventory	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); Center for International Earth Science Information Network, New York State Energy Research and Development Authority; U.S. Army Corps of Engineers, National Structure Inventory; RS Means 2022	2022	Digital Format
Critical Facilities and Lifelines	Rockland County	2023	Digital Format
Land Use	National Land Use Cover Database; Rockland County	2019; 2022	Digital Format
Natural/Historical/Cultural Resources	U.S. National Park Service	N/A	Digital Format
NEHRP Soils	NYS DHSES	N/A	Digital Format

Data	Source	Date	Format
Dam Failure	Rockland County	2023	Digital Format
Landslide	USGS, Godt	2011	Digital Format
Wildfire Hazard Data	Radeloff et al.	2012	Digital Format
Social Vulnerability Index	Center for Disease Control	2020	Digital Format

Notes:
FEMA – Federal Emergency Management Agency
NEHRP – National Earthquake Hazard Reductions Program
NYS DHSES – New York State, Division of Homeland Security and Emergency Services

4.2.4 Limitations

Loss estimates, exposure assessments, and hazard-specific vulnerability evaluations rely on the best-available data and methodologies. Uncertainties are inherent in any loss estimation methodology and arise in part from incomplete scientific knowledge concerning natural hazards and their effects on the built environment. Uncertainties also result from the following phenomenon:

- Approximations and simplifications necessary to conduct such a study
- Incomplete or dated inventory, demographic, or economic parameter data
- The unique nature, geographic extent, and severity of each hazard
- Mitigation measures already employed by the participating municipalities
- The amount of advance notice residents have to prepare for a specific hazard event
- Uncertainty of climate change projections

These factors can result in a range of uncertainty in loss estimates, possibly by a factor of two or more. Therefore, potential exposure and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, Rockland County will collect additional data and update and refine existing inventories to assist in estimating potential losses.

Potential economic loss is based on the present value of the general building stock using best-available data. The County acknowledges significant impacts may occur to critical facilities and infrastructure as a result of these hazard events causing great economic loss. However, monetized damage estimates to critical facilities and infrastructure, and economic impacts were not quantified and require more detailed loss analyses. In addition, economic impacts to industry such as tourism and the real-estate market were qualitatively analyzed.

4.2.5 Considerations for Mitigation and Next Steps

The following section discusses for considerations for the next plan update to enhance the vulnerability assessment.

All Hazards

- Create an updated user-defined general building stock dataset using up-to-date parcels, footprints, and RSMeans values.
- Utilize updated and current demographic data.
- Utilizing assessor data, include updated occupancy class attributes in general building stock.

Extreme Temperatures

- Track extreme temperature data for injuries, deaths, shelter needs, pipe freezing, agricultural losses, and other impacts to determine distributions of most at-risk areas.

Flood

- The general building stock inventory can be updated to include attributes regarding first floor elevation and foundation type (basement, slab on grade, etc.) to enhance loss estimates.
- As more current FEMA floodplain data become available (i.e., DFIRMs), update the exposure analysis and generate a more detailed flood depth grid that can be integrated into the current Hazus version.
- Conduct a Hazus loss analysis for more frequent flood events (e.g., 10- and 50-year flood events).
- Conduct a repetitive loss area analysis.
- Continue to expand and update urban flood areas to further inform mitigation.

Severe Storm

- The general building stock inventory can be updated to include attributes regarding protection against strong winds, such as hurricane straps, to enhance loss estimates.
- Integrate evacuation route data that are currently being developed.

Severe Winter Storm

- If available for the region, obtain average snowfall distributions to determine if various areas in the county have historically received higher snowfalls and might continue to be more susceptible to higher snowfalls and snow loads on the building stock and critical facilities and infrastructure.

Wildfire

- General building stock inventory can be updated to include attributes such as roofing material or fire detection equipment or integrate distance to fuels as another measure of vulnerability.