5.1 Methodology and Tools

A risk assessment is the process of measuring the potential loss of life, personal injury, and economic and property damage resulting from identified hazards. Identifying potential hazards and vulnerable assets allows planning personnel to address and reduce hazard impacts and emergency management personnel to establish early response priorities. Results of the risk assessment are used in subsequent mitigation planning processes, including determining and prioritizing mitigation actions that reduce each jurisdiction's risk to a specified hazard. Past, present, and future conditions must be evaluated to most accurately assess risk for the county and each jurisdiction. The process focuses on the following elements:

- **Hazard identification**—Use all available information to determine what types of hazards may affect a jurisdiction.
- **Profile each hazard**—Understand each hazard in terms of:
  - Extent—Severity of each hazard.
  - Location—Geographic area most affected by the hazard.
  - Previous occurrences and losses
- **Assess Vulnerability –**
  - Exposure identification—Estimate 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.
  - Vulnerability identification and loss estimation—Assess 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.
  - Future changes that may impact vulnerability—Analyze how demographic changes, projected development and climate change impacts can alter current exposure and vulnerability.

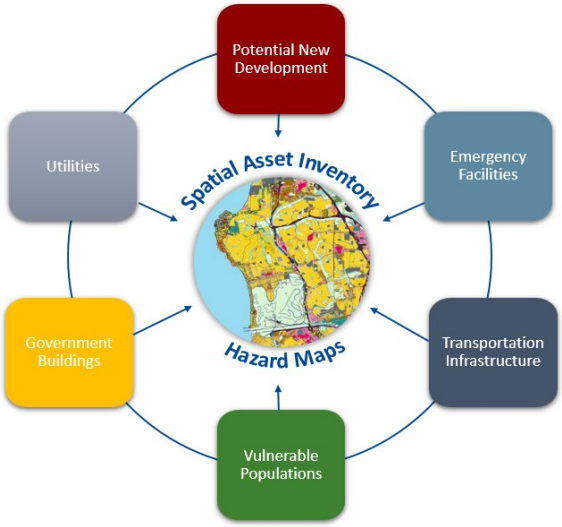
The Livingston County risk assessment was updated using best available information.

- An updated building stock inventory was created using Livingston County's 2020 tax assessor and parcel data, 2018 Microsoft Bing building footprints, and 2021 RS Means values.
- 2015-2019 American Community Survey 5-year Population Estimates were utilized.
- A critical facility was generated and reviewed by the Planning Partnership and County jurisdictions.
- Lifelines were identified in the critical facility inventory to align with FEMA's lifeline definition.
- Hazus was used to estimate potential impacts to the flood, wind, and seismic hazards.
- Best available hazard data was used as described in this section.

The following summarizes the asset inventories, methodology and tools used to support the risk assessment process.

5.1.1 Asset Inventories

Livingston County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Livingston County assessed exposure and vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure, new development, and the environment. Some assets may be more vulnerable because of their physical characteristics or socioeconomic 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 risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate hazard exposure and vulnerability.

Population

Total population statistics from the 2015-2019 American Community Survey (ACS) 5-year estimate were used to estimate the exposure and potential impacts to the County's population in place of the 2010 U.S. Census block estimates. To determine population statistics for village and towns, the population of villages was 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 is 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.

As discussed in Section 4 (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 Livingston County included in the risk assessment are children, elderly, population below the poverty level, limited English speaking individuals, and persons non-institutionalized with a disability.

Buildings

The building stock inventory was updated using Livingston County's 2020 tax assessor and parcel data, 2018 Microsoft Bing building footprint, and supplemental NYS tax assessor data. The occupancy classes available in Hazus were condensed into the following categories (residential, commercial, industrial, agricultural, religious, governmental, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single-family dwellings. Replacement cost value (RCV) is the current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials. Total replacement cost value consists of both the structural cost to replace a building and the estimate value of contents of a building. Structural and content RCV were calculated for each building utilizing RS Means 2021 values. A regional location factor for Livingston County was applied (1.01 for residential buildings and 1.01 for all other building types).

Critical Facilities and Lifelines

The 2015 HMP critical facility inventory, which includes essential facilities, utilities, transportation features and user-defined facilities was updated by the Planning Partnership and County jurisdictions. The update involved a review for accuracy, additions or deletions of new/moved critical assets, identification of backup power for each asset (if known) and whether the critical facility is considered a lifeline in accordance with FEMA's definition; refer to Appendix E (Risk Assessment Supplementary Data). To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

*A **lifeline** provides indispensable service that enables the continuous operation of critical business and government functions, and is critical to human health and safety, or economic security (FEMA).*

Environment and Land Use Area

National land use land cover data created by the U.S. Geological Survey (USGS) in 2016 was used to assess land use characteristics of the County. This dataset was converted from a raster to a vector polygon, which informed spatial areas of agriculture, barren land, forested land, urban areas, water, and wetlands.

New Development

In addition to assessing the vulnerability of the built environment, Livingston County examined recent development over the last 5 years and anticipated new development in the next 5 years. Each jurisdiction was asked to provide a list by parcel ID or address of major development that has taken place within these timeframes.

New development was identified as 1) anticipated in the next five years and 2) recently developed over the last five years. An exposure analysis was conducted in Geographic Information System (GIS) to determine hazard exposure to these 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.

5.1.2 Methodology

To address the requirements of the DMA 2000 and to better understand potential vulnerability and losses associated with hazards of concern, Livingston 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 as described below. Table 5.1-1 summarizes the type of analysis conducted by hazard of concern.

1. **Historic Occurrences and Qualitative Analysis** – This 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** – This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets are located in the hazard area and may incur future impacts.

3. **Loss estimation** — The FEMA Hazus modeling software was used to estimate potential losses for the following hazards: flood, earthquake, hurricane. In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards.

Table 5.1-1. Summary of Risk Assessment Analyses

Hazard	Population	General Building Stock	Critical Facilities	New Development
Drought	Q	Q	Q	Q
Earthquake	E, H	E, H	E, H	E
Flood	E, H	E, H	E, H	E
Hazardous Materials	E	E	E	E
Invasive Species	Q	Q	Q	Q
Landslide	E	E	E	E
Mine Subsidence	E	E	E	E
Pandemic	Q	Q	Q	Q
Severe Storm	Q	Q	Q	Q
Severe Winter Storm	Q	Q	Q	Q
Terrorism	Q	Q	Q	Q
Utility Failure	Q	Q	Q	Q
Wildfire	E	E	E	E

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

Hazards U.S. – Multi-Hazard (Hazus)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or Hazus. Hazus was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. Hazus was expanded into a multi-hazard methodology, Hazus with new models for estimating potential losses from wind (hurricanes) and flood (riverine) hazards. Hazus is a GIS-based software tool that applies engineering and scientific risk calculations, which have been developed by hazard and information technology experts, to provide defensible damage and loss estimates. These methodologies are accepted by FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

Hazus uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems and utility systems. To generate this information, Hazus uses default data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic impact) depending on the hazard and available local data. Hazus' open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of data output now and in the future and standardization of data collection and storage. More information on Hazus is available at http://www.fema.gov/hazus.

In general, modeled losses were estimated in the program using depth grids for the flood analysis and probabilistic analyses were performed to develop expected/estimated distribution of losses (mean return period losses) for hurricane wind and seismic hazards. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). Table 5.1-2 displays the various levels of analyses that can be conducted using the Hazus software.

Table 5.1-2. Summary of Hazus Analysis Levels

Hazus Analysis Levels	
Level 1	Hazus provides hazard and inventory data with minimal outside data collection or mapping.
Level 2	Analysis involves augmenting the Hazus provided hazard and inventory data with more recent or detailed data for the study region, referred to as "local data"
Level 3	Analysis involves adjusting the built-in loss estimation models used for the hazard loss analyses. This Level is typical done in conjunction with the use of local data.

Drought

All of Livingston County is at risk to drought events. To assess the vulnerability of Livingston County to drought and its associated impacts, a qualitative assessment was conducted. The United States Department of Agriculture (USDA) Census of Agriculture 2017 was used to estimate economic impacts. Information regarding the number of farms and farmland area was extracted from the report and summarized in the vulnerability assessment. Additional resources from New York State Energy Research and Development Authority, New York State's 2019 Hazard Mitigation Plan, New York State Division of Homeland Security & Emergency Services, and the U.S. Environmental Protection Agency were used to assess the potential impacts to the population from a drought event.

Earthquake

A probabilistic assessment was conducted for Livingston County for the 500-year mean return period (MRPs) through a Level 2 analysis in Hazus v5.0 to analyze the earthquake hazard and provide a range of loss estimates. The probabilistic method uses information from historic earthquakes and inferred faults, locations and magnitudes, and computes the probable ground shaking levels that may be experienced during a recurrence period by Census tract.

As noted in the Hazus Earthquake User Manual, "*Although the software offers users the opportunity to prepare comprehensive loss estimates, it should be recognized that uncertainties are inherent in any estimation methodology, even with state-of-the-art techniques. Any region or city studied will have an enormous variety of buildings and facilities of different sizes, shapes, and structural systems that have been constructed over a range of years under diverse seismic design codes. There are a variety of components that contribute to transportation and utility system damage estimations. These components can have differing seismic resistance.*" (FEMA 2020). However, Hazus' potential loss estimates are acceptable for the purposes of this HMP.

Ground shaking is the primary cause of earthquake damage to man-made structures and soft soils amplify ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The National Earthquake Hazard Reductions Program (NEHRP) has developed five soil classifications defined by their shear-wave velocity that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. Class D and E NEHRP soils are the two classes most susceptible to amplified ground motion during an earthquake.

An exposure analysis was conducted for the County's assets (population, building stock, critical facilities, and new development) using NEHRP soil data provided by New York State and the national landslide susceptibility data where landslide susceptibility was listed as high susceptibility. The exposure analysis focused on soil types that would experience amplified ground motion during an earthquake (i.e., Class D and E). Assets with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to these soil types.

Data from New York State was used in Hazus to replace default NEHRP soils. Groundwater was set at a depth of five (5) feet (default setting). The default assumption is a magnitude 7.0 earthquake for all return periods. Although damages are estimated at the census tract level, results were presented at the municipal level. Since there are multiple census tracts that contain more than one jurisdiction, an area analysis was used to extract the percent of each tract that falls within individual jurisdictions. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Damage estimates are calculated for losses to buildings (structural and non-structural) and contents; structural losses include load carrying components of the structure, and non-structural losses include those to architectural, mechanical, and electrical components of the structure, such as nonbearing walls, veneer and finishes, HVAC systems, boils, etc.

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 NFIP.

The depth grid generated for the 2015 HMP and flood data provided by the County was used to evaluate exposure and determine potential future losses for this plan update. The depth grid generated in the 2015 HMP was created using the following data:

- The FEMA digital Quality 3 (Q3) flood data
- A 10-meter elevation dataset was used in the Enhanced Quick Look tool in Hazus to generate the 1-percent annual chance flood depth grid

The depth grid generated for the 2015 HMP was integrated into the Hazus riverine flood model used to estimate potential losses for the 1-percent annual chance flood event.

To estimate exposure to the 1-percent- and 0.2-percent annual chance flood events, the flood boundaries provided by Livingston County ere overlaid on the centroids of updated assets (population, building stock, critical facilities, lifelines, and new development). Centroids that intersected the flood boundaries were totaled to estimate the building replacement cost value and population vulnerable to the flood inundation areas. A Level 2 Hazus riverine flood analysis was performed in Hazus v5.0. 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 Livingston County for the 1-percent annual chance flood events. 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 2010 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.

Hazardous Materials

The specific substances transported or at fixed facilities is unknown and can vary. Overall, potential losses from HazMat incidents are difficult to quantify due to the many variables and human elements. Data regarding this hazard were obtained from Livingston County and the Planning Partnership as well as appropriate state and federal resources.

An exposure analysis was conducted for the County's assets (population, building stock, critical facilities, lifelines and new development) using selected radius boundaries around Tier II facilities, and half mile buffers around pipelines, railways, and the following roadways: Interstate I-390 and Routes 20, 20A, 36, 63, 15, and 15A.

Assets with their centroid located in the hazard area were totaled to estimate the totals and values potentially vulnerable if a hazardous materials release should occur.

Invasive Species

All of Livingston County is exposed to infestation and invasive species. Resources from the New York State Department of Environmental Conservation, Livingston County Soil and Water Conservation District, United States Department of Agriculture, and the Livingston County Environmental Management Council were referenced to assess the potential impacts to the County's assets.

Landslide

An exposure assessment was conducted using steep slope to determine the County's risk to the landslide. Steep slopes are an indication of where landslides may occur, and carbonate soils may be prone to subsidence. Based on the Highlands NJ Council's Steep Slope Protection Area classifications, steep slopes are considered to be greater than 15-percent. Local ordinances often impose more stringent regulations on land development that occurs on slopes of 15% or greater. A steep slope layer was created using the 2014 USGS 1-meter resolution Digital Elevation Model (DEM). The DEM was converted to percent slope and slopes greater than 15-percent were selected.

To determine what assets are exposed to steep slopes, the County's assets were overlaid with these hazard areas. Assets with their centroid located in the hazard area were totaled to estimate the number (or count) and replacement cost values exposed to a hazard event.

Mine Subsidence

Mine subsidence is a new hazard of concern for Livingston County. "Mine Subsidence" means lateral or vertical ground movement caused by a failure initiated at the mine level, of manmade underground mines, including, but not limited to coal mines, clay mines, limestone mines, and fluorspar mines that directly damages residences or commercial buildings. The AkzoNobel Salt Incorporated Retsof salt mine boundary was provided by Livingston County and used to assess areas at risk to subsidence based on the historical collapse of 1994. To determine what assets are exposed to mine subsidence, the County's assets were overlaid with the Retsof salt mine boundary. Assets with their centroid located in the hazard area were totaled to estimate the number (or count) and replacement cost values exposed to a hazard event.

Pandemic

Pandemics are a new hazard of concern for Livingston County. A qualitative assessment was conducted for this hazard. Information from the World Health Organization, Centers for Disease Control and Prevent, New York State Department of Health, Natural Resources Defense Council, and New York State ClimAID was used to assess the County's overall risk.

Severe Storm

All of Livingston County is exposed to severe storm events. A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Livingston County for the 500-year mean return period event. 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 Livingston County. Hazus contains data on historic 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. Since there are multiple census tracts that contain more than one jurisdiction, the general building stock inventory was leveraged to extract the percent of each tract that falls within individual jurisdictions. The percentage was multiplied against the results calculated for each tract and summed for each jurisdiction.

Severe Winter Storm

All of Livingston County is exposed and vulnerable to the 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 this hazard. A percentage of the custom-building stock structural replacement cost value was utilized to estimate damages that could result from winter storm conditions (i.e., 1-percent, 5-percent, and 10-percent of total replacement cost value). Given professional knowledge and currently available information, the potential losses for this hazard are considered to be overestimated; hence, providing a conservative estimate for losses associated with winter storm events.

Terrorism

All of Livingston County is at risk to terrorism events, including cyber attacks. A qualitative assessment was conducted for the terrorism hazard. Information from the U.S. Department of Homeland Security, FEMA, Centers for Disease Control and Prevent, and the US Department of Justice was referenced to review the County's overall risk.

Utility Failure

All of Livingston County is at risk to utility failure. A qualitative assessment was conducted for the terrorism hazard. Information from the Environmental Protection Agency, FEMA, and the New York State Energy Research and Development Authority was referenced to review the County's overall risk.

Wildfire

The Wildland-Urban Interface (Interface and Intermix) obtained through the SILVIS Laboratory, Department of Forest Ecology and Management, University of Wisconsin – Madison, was referenced to delineate wildfire hazard areas. The University of Wisconsin – Madison wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For this risk assessment, the high-, medium-, and low-density interface areas were combined and used as the "Interface" hazard area, and the high-, medium-, and low-density intermix areas were combined and used as the "Intermix" hazard areas.

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 totals and values exposed to a wildfire event.

Considerations for Mitigation and Next Steps

The following items are to be discussed for considerations for the next plan update to enhance the vulnerability assessment:

- All Hazards
  - Utilize updated and current demographic data. If 2020 U.S. Census demographic data is available at the U.S. Census block level during the next plan update, use the census block estimates and residential structures for a more precise distribution of population, or the current American Community Survey 5-Year Estimate populations counts at the Census tract level.
- 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.
  - 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.
  - 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.
- Earthquake
  - Identify unreinforced masonry in critical facilities and privately-owned buildings (i.e., residences) by accessing local knowledge, tax assessor information, and/or pictometry/orthophotos. These buildings may not withstand earthquakes of certain magnitudes and plans to provide emergency response/recovery efforts at these properties can be developed.
- Landslide
  - Use higher resolution Digital Elevation Model (DEM) provided from the County to create an updated steep slopes hazard area.
- Mine Subsidence
  - As models evolve for subsidence, use updated modeling to assess estimated impacts caused by subsidence that is driven by other hazards of concern such as flooding and earthquakes.
- Pandemic
  - Utilize data collection that summarizes the outcome from Covid-19 to assess areas where the County is most vulnerable.
- 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 is currently being developed.
- Severe Winter Storm
  - Assess damages using winter storm modeling as these climate models become available.
- Utility Failure
  - Once Hazus has progressed its utility failure models, use Hazus to assess estimated downtime for utilities of concern during specified hazard events such as flood, earthquake, and wind events.
- 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.

5.1.3 Data Source Summary

Table 5.1-3 summarizes the data sources used for the risk assessment for this plan.

Table 5.1-3. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	U.S. Census Bureau; American Community Survey 5-Year Estimates	2010; 2019	Digital (GIS) format
Parcel Inventory	Livingston Parcel Data, Real Property Tax Data	2020	Digital (GIS) format
Building Footprints	Microsoft Bing	2018	Digital (GIS) format
Wildland-Urban Intermix/Interface Wildfire Hazard	University of Wisconsin - Madison	2010	Digital (GIS) format
Critical facilities	Livingston Planning Partnership and County Jurisdictions	2014/2021	Digital (GIS) format
NEHRP Soil	NYS	n.d.	Digital (GIS) format
Tier II Facilities	Livingston County OEM	2021	Digital (GIS) format
HazMat Roadways/Railways/Pipelines	Livingston County GIS	2021	Digital (GIS) format
New Development Data	Livingston County Planning Partnership and County Jurisdictions	2021	Digital (GIS) Format
Flood Depth Grids	FEMA/2014 HMP	n.d.	FEMA Q3
Mine Subsidence	Livingston County GIS	2021	Digital (GIS) Format

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:

1) Approximations and simplifications necessary to conduct such a study
2) Incomplete or dated inventory, demographic, or economic parameter data
3) The unique nature, geographic extent, and severity of each hazard
4) Mitigation measures already employed by the participating municipalities
5) The amount of advance notice residents have to prepare for a specific hazard event
6) 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, Livingston County will collect additional data to collect additional data, 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 utilizing 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 not analyzed.