



4. RISK ASSESSMENT METHODOLOGY AND TOOLS

A risk assessment is the process of evaluating the potential loss of life, personal injury, and economic and property damage that could result from identified hazards. Identifying potential hazards and vulnerable assets allows planning personnel to address and reduce hazard impacts and allows 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 risk from each hazard. Past, present, and future conditions must be evaluated to assess risk most accurately for the Planning Partners. The process focuses on the following elements:

- **Identify Hazards of Concern**—Use all available information to determine what types of hazards may affect the community.
- **Profile Each Hazard**—Understand each hazard in terms of:
 - Extent—The potential severity of each hazard
 - Location—Geographic area most likely to be affected by the hazard
 - Previous occurrences and losses
 - Impacts of Climate Change
 - Probability of future hazard events
- **Assess Risk**—Use all available information to estimate to what extent populations and assets may be adversely affected by a hazard:
 - Determine vulnerability—Estimate the total number of assets in the planning area that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
 - Estimate potential impacts—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.
 - Evaluate future changes that may affect vulnerability and impacts—Analyze how demographic changes, projected development and climate change impacts can alter current vulnerability and potential impacts.

The Cape May County risk assessment was updated using the following best-available information:

- An updated building stock inventory was generated using 2024 building footprints, tax assessor and parcel data provided by Cape May County; and 2024 RSMeans cost adjustment values.
- 2020 Decennial Census Population data and 2018-2022 American Community Survey (ACS) 5-year Population Estimates were utilized.
- Critical facilities were updated and reviewed by the Planning Partners.
- Lifelines were identified in the critical facility inventory to align with FEMA's community lifeline definition.
- FEMA's Hazus program was used to estimate potential impacts from the flood, wind, and seismic hazards.
- Best-available hazard data were used, as described in this section.

4.1 ASSET INVENTORIES

Cape May County assets were identified to assess potential vulnerability and impacts associated with the hazards of concern. The HMP update assesses vulnerability and potential hazard impacts for the following types of assets:



population, buildings, critical facilities, community lifelines, the environment, and new development. Each asset type is described below. 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.

Quantitative analyses were conducted for all participating jurisdictions where possible. Cape May County Municipal Utility Authority (CMC MUA), assets include critical facilities and are located across the several municipalities which the CMC MUA serves. Those assets are included in the relevant municipalities in which they are located, rather than the CMC MUA being evaluated individually in quantitative analyses.

4.1.1 Population

Statistics from the 2020 Decennial Census and 2018-2022 ACS 5-year estimate were used to estimate the vulnerability of and potential impacts on the County's population. The Hazus model, which was used to estimate sheltering and injuries as part of the hazard analysis, contains 2020 U.S. Census data.

The risk assessment included the collection and use of an expanded and enhanced asset inventory to estimate hazard vulnerability and impacts.

Vulnerable populations in Cape May County included in the risk assessment are people under 5 or over 65 years old, population below the poverty level, non-English speaking individuals, and persons with a disability.

4.1.2 Buildings

The building stock Tetra Tech created for the 2020 HMP was used as the foundation for this update. The building stock inventory was updated with additional centroids using building footprints and parcel data from the County, which was supplemented with 2024 MOD-IV tax assessor data and 2024 RSMeans replacement cost value for building and content replacement costs. Attributes provided in the spatial files were used to further define each structure in terms of occupancy class, construction type, year built, foundation type, etc. Default information was used to fill in the gaps for buildings that could not be assigned attributes from the assessor's data or from the data provided by the County and participating municipalities. The centroid of each building footprint was used to estimate the building location. If a building footprint was not located due to limited spatial data, parcels that had assessor's information supporting the presence of a building were given a centroid to represent the location of a structure.

Structural and content replacement cost values (RCV) were calculated for each building utilizing available assessor data and RSMeans 2024 values. RCV is the cost of returning a destroyed 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 estimated value of contents of the building. A regional location factor for Cape May County was applied (1.11 for non-residential structures and 1.17 for residential structures).

The occupancy classes available in Hazus were condensed into the categories of residential, commercial, industrial, and other (agricultural, religious, governmental, and educational) to facilitate analysis and presentation of results. Residential loss estimates addressed both multi-family and single-family dwellings.



4.1.3 Critical Facilities and Community Lifelines

A critical facility inventory, which includes essential facilities, utilities, transportation features and user-defined facilities, was created by the Planning Partners. The development involved a review for accuracy, additions, or deletions of new or 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. Existing County data on evacuation routes through the planning was used to evaluate hazard exposure for these routes.

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).

4.1.4 Environment and Land Use

New Jersey Department of Environmental Protection (NJDEP) Division of Information Technology and the Bureau of Geographic Information Systems updated their 2015 Land-Use/Land Cover data in 2020 to delineate the land-use and land cover areas in the County. The 2020 update is the seventh in a series of land use mapping efforts. It was created by comparing the 2015 LU/LC layer from NJDEP's Geographic Information Systems (GIS) database to 2020 color infrared (CIR) imagery and delineating and coding areas of change. This dataset helped to inform spatial analysis of three broad categories of land use types:

- The **residential** land use category includes the following land use types: mixed residential; residential, high density or multiple dwelling; residential, rural, single unit; residential, single unit, low density; and residential, single unit, medium density.
- The **non-residential** land use category included all other land use types.
- The **natural** land use land use category was analyzed as a single subcategory of non-residential land uses, consisting of the following land use types:
 - Artificial lakes
 - Atlantic ocean
 - Atlantic white cedar wetlands
 - Bare exposed rock, rock slides, etc.
 - Beaches
 - Coniferous brush/shrubland
 - Coniferous forest
 - Coniferous scrub/shrub wetlands
 - Coniferous wooded wetlands
 - Deciduous brush/shrubland
 - Deciduous forest
 - Deciduous scrub/shrub wetlands
 - Deciduous wooded wetlands (modified)
 - Disturbed tidal wetlands
 - Disturbed wetlands (modified)
 - Freshwater tidal marshes
 - Herbaceous wetlands
 - Managed wetland
 - Mixed deciduous/coniferous brush/shrubland
 - Mixed forest
 - Mixed scrub/shrub wetlands
 - Mixed wooded wetlands
 - Natural lakes
 - Old field (< 25% brush covered)
 - Open tidal bays
 - Phragmites dominate wetlands
 - Phragmites dominate old field
 - Saline marsh
 - Streams and canals
 - Tidal mud flat
 - Tidal rivers, inland bays, and other tidal waters
 - Undifferentiated barren lands
 - Upland rights-of-way undeveloped
 - Wetland rights-of-way

The area within the three general categories of land use was identified as shown in Table 4-1.



Table 4-1. County Area by General Land Use Categories

Land Use Type	Area (acres)
Residential Land Uses	22,646
Non-Residential Land Uses	
Natural Land Uses	142,219
All Other	18,239
Total	160,458
Cape May County (Total)**	183,126

4.2 METHODOLOGY

Cape May County used standardized tools, combined with local, state, and federal data and expertise to assess potential vulnerability and losses associated with hazards of concern. Three levels of analysis were used, depending upon the data available for each hazard:

- **Historical Occurrences and Qualitative Analysis**—This analysis includes an examination of historical impacts to understand potential impacts of future events of similar size. Potential impacts and losses are discussed qualitatively using best-available data and professional judgment.
- **Vulnerability Analysis**—This analysis involves overlaying available spatial hazard layers, for hazards with defined extent and locations, on asset mapping in GIS to determine which assets are located in the impact area of the hazard.
- **Loss Estimation**—The FEMA Hazus modeling software was used to estimate potential losses for the following hazards: flood, earthquake, and hurricane.

Table 4-2 summarizes the type of analysis conducted by hazard of concern.

Table 4-2. Summary of Risk Assessment Analyses

Hazard	Population	General Building Stock	Critical Facilities
Dam Failure	Q	Q	Q
Drought	Q	Q	Q
Earthquake	V	V	V
Flood	V, L	V, L	V, L
Severe Weather	L, Q	L, Q	L, Q
Severe Winter Weather	Q	Q	Q
Wildfire	V	V	V

Notes: V = Vulnerability analysis; L = Loss estimation; Q = Qualitative analysis

4.2.1 Hazus

Hazus is a GIS-based software tool developed by FEMA that uses engineering and scientific risk calculations to estimate damage and loss. Its use is accepted by FEMA and provides a consistent framework for assessing risk across a variety of hazards. Hazus uses GIS technology to produce detailed maps and analytical reports that estimate 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. Table 4-3 lists the levels of analysis that can be conducted using the Hazus software depending on the hazard and inventory data provided.

Table 4-3. Summary of Hazus Analysis Levels

Level 1	Hazus provides hazard and inventory data with minimal outside data collection or mapping.
Level 2	Hazus-provided hazard and inventory data are augmented with more recent or detailed data for the study region, referred to as “local data”
Level 3	The built-in Hazus loss estimation models are adjusted for the hazard loss analyses, usually in conjunction with the use of local data.

Hazus 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.

For this HMP, losses were estimated in Hazus using depth grids for the flood analysis and probabilistic (mean return period) analyses for hurricane wind and seismic hazards. The probabilistic model generates estimated damage and losses for specified return periods (e.g., 100- and 500-year).

4.2.2 Hazard-Specific Methodologies

Dam Failure

To assess the vulnerability of the county to dam failure and its associated impacts, a qualitative review was conducted.

Drought

All of Cape May County is at risk from the impacts of drought events. A qualitative review was conducted to assess the county’s vulnerability to this hazard of concern

Earthquake

The National Earthquake Hazard Reductions Program (NEHRP) has developed soil classifications defined by their ability to amplify ground shaking during a seismic event. The soil classification system ranges from Type A to Type E, where Type A represents hard rock that reduces ground motions from an earthquake and Type E represents soft soils that amplify ground shaking and increase building damage (an additional classification).

A vulnerability analysis was conducted for the county’s assets using NEHRP soil data sourced from NJDOT 2012. The vulnerability analysis defined the hazard area as all areas with Type D and E soil types (the two most vulnerable soil types present in Cape May County). Assets with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to these soil types.

Flood

The 1 percent and 0.2 percent chance flood events were examined to evaluate Cape May County’s risk and vulnerability to the coastal and riverine flood hazard. These flood events are generally those considered by planners and evaluated under federal programs such as the NFIP.



The effective Cape May County FEMA Digital Flood Insurance Rate Map (DFIRM) published in 2017 and the preliminary DFIRM published in 2014 was used to evaluate exposure and determine potential future losses. A depth grid for the 1 percent annual chance flood event was generated using the effective and preliminary DFIRMs and the 2014 post Sandy 1-meter resolution. Holes in the digital elevation model where existing water surfaces occur were filled in using a value of zero. The depth grid was separated by the coastal hazard area and the riverine hazard area, which were defined by 1986 NJDEP head of tide points. All A zones depicted in the preliminary and effective DFIRMs are characterized as riverine hazard areas. Additionally, VE and AO zones are characterized as coastal hazard areas. The final depth grid was integrated into the Hazus coastal 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 DFIRM flood boundaries were overlaid on centroids of updated assets (population, building stock, and critical facilities). 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 coastal and 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. Once updated with the inventories, the Hazus coastal and riverine flood models were run to estimate potential losses in Cape May 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), potential damages to the general building stock, and potential damages to critical facility inventories based on the coastal and riverine depth grids generated and the default Hazus damage functions in the flood model.

Coastal Erosion

Best available data was used to assess Cape May County's vulnerability to coastal erosion. To help understand the geographic distribution of coastal risk, the Limit of Moderate Wave Action (LiMWA) boundary was referenced from FEMA's 2014 Preliminary DFIRM and 2017 Effective DFIRM flood data. The LiMWA boundary was selected to assess coastal erosion because it represents land area that is susceptible to wave action. Wave action can be a driver for coastal erosion in Cape May County.

Asset data (population, building stock, critical facilities) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are exposed to coastal erosion, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number and values exposed to coastal erosion.

Sea Level Rise

Projected sea level rise 2022 data (in one-foot increments) available from the NOAA Office of Coastal Management (<https://coast.noaa.gov/slrdata/>) was used to understand the assets at risk of future sea level rise per each jurisdiction. Please note these sea level rise projections do not include additional storm surge due to a hurricane or Nor'easter. Sea level rise 1-foot through 4-foot hazard area extents were referenced in the exposure analysis. Asset data (population, building stock, critical facilities) were used to support an evaluation of assets exposed and potential impacts and losses. To determine what assets are exposed to sea level rise, the County's assets were overlaid with the hazard area. Assets with their centroid located in the hazard area were totaled to estimate the number and values exposed to sea level rise.



Severe Weather

All of Cape May County is exposed and vulnerable to the severe weather 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 qualitative review was conducted to assess the county's vulnerability to this hazard of concern.

Hurricane and Tropical Storm

A Hazus probabilistic analysis was performed to analyze the wind hazard losses for Cape May County for the 100- and 500-year mean return period 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 Cape May 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, a density analysis was used to extract the percent 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.

In addition to estimating potential losses due to wind, an exposure analysis was conducted using the 2022 Sea – Lake Overland Surge from Hurricanes – SLOSH Model, which represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. Please note these inundation zones do not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the NOAA Office for Coastal Management, forecasts surges that occur from wind and pressure forces of hurricanes, considers only storm surge height, and does not consider the effects of waves. The SLOSH spatial data includes boundaries for Category 1 through Category 4 hurricane events. Asset data (population, building stock, critical facilities) were used to support an evaluation of assets exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to storm surge, the County's assets were overlaid with the SLOSH hazard area. Assets with their centroid located in the hazard area were totaled to estimate the replacement cost value (structure and content) and population exposed to the hazard.

Severe Winter Weather

All of Cape May County is exposed and vulnerable to the severe winter weather 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 qualitative review was conducted to assess the county's vulnerability to this hazard of concern.

Wildfire

The 2023 Wildland-Urban Interface/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 2020 Census and 2021 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, GIS data for the asset inventories were overlaid with the hazard area. Assets with their centroid in the hazard area were totaled to estimate the numbers and values exposed to a wildfire event.

4.3 RATING PROBABILITY OF OCCURRENCE

Based on records of previous hazard events and consideration of potential future changes that could affect the frequency of future events, the risk assessment for each hazard assigns a rating for the probability of occurrence of that hazard in the future. These ratings were assigned as follows:

- Unlikely—not likely to occur or less than 1% annual chance of occurring
- Rare—between 1 and 10% annual chance of occurring
- Occasional—between 10 and 100% annual chance of occurring
- Frequent—100% chance occurring; occurs multiple times a year

4.4 DATA SOURCE SUMMARY

Table 4-4 summarizes the data sources used for the risk assessment for this plan.

4.5 LIMITATIONS

Loss estimates, vulnerability analyses, and hazard-specific impact 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:

- 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 jurisdictions
- 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 vulnerability and loss estimates are approximate. These results do not predict precise results and should be used to understand relative risk. Over the long term, Cape May County will collect additional data and update and refine existing inventories to assist in estimating potential losses.



Table 4-4. Risk Assessment Data Documentation

Data	Source	Date	Format
Population data	U.S. Census Bureau; ACS 5-Year Estimates	2020; 2018-2022	CSV converted to Digital (GIS) format
Building Inventory	Cape May County; RSMeans 2024	2024	Digital (GIS) Format
Tax Assessor	Cape May County; MOD-IV	2024	Digital (GIS) Format
Critical Facilities and Lifelines	Cape May County 2022, 2024; HIFLD 2024; USACE 2024	2022 & 2024	Digital (GIS) Format
1-Meter Digital Elevation Model; Post Sandy	NOAA	2014	TIFF
Land Use	NJDEP	2020	Digital (GIS) Format
1 percent and 0.2 percent Annual Chance Flood Events	FEMA Preliminary/Effective DFIRMS	2014/2017	Digital (GIS) Format
Coastal Hazard Area	FEMA Preliminary/Effective DFIRM LiMWA Lines	2014/2017	Digital (GIS) Format
NEHRP Soils	NJDOT	2012	Digital (GIS) Format
Wildland-Urban Interface/Intermix	University of Wisconsin-Madison, MRLC Consortium, U.S. Census Bureau	2023, 2021, 2020	Digital (GIS) Format
Sea Level Rise	NOAA	2022	Digital (GIS) Format
Sea-Lake Overland Surge from Hurricanes (SLOSH) Model	NOAA	2022	Digital (GIS) Format

Notes: FEMA = Federal Emergency Management Agency; HIFLD = Homeland Infrastructure Foundation-Level Data; NOAA = National Oceanic and Atmospheric Administration; NEHRP = National Earthquake Hazards Reduction Program; NJDEP = New Jersey Department of Environmental Protection; MOD-IV = New Jersey Property Tax System; DFIRM = Digital Flood Insurance Rate Map; LiMWA = Limit of Moderate Wave Action; MRLC = Multi-Resolution Land Characteristics; USGS = U.S. Geological Survey

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 not analyzed.

4.6 CONSIDERATIONS FOR MITIGATION AND NEXT STEPS

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

- All Hazards
 - Utilize updated and current demographic data.
 - Create an updated user-defined general building stock dataset using up-to-date parcels, footprints, and RSMeans values.
- 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).



- Use FEMA's Flood Assessment Structure Tool (FAST) tool for a quicker, simpler flood analysis at the structure level.
- Further refine the repetitive loss area analysis.
- Continue to expand and update urban flood areas to further inform mitigation.
- If available during the next plan update, update the risk assessment using a comprehensive coastal erosion hazard area map
- Collect data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts.
- Implement updated sea level rise data to assess the future flood hazard risk for structures along the coast.
- Severe Weather (Hurricane and Tropical 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.
 - Estimate storm surge related losses using the Hazus flood model if the data is available.
 - If available during the next plan update, update the risk assessment using a comprehensive coastal erosion hazard area map and updated sea level rise inundation areas
 - Collect data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts.
 - Integrate evacuation route data that is currently being developed.
- 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.