SUSSEX COUNTY MULTI-JURISDICTIONAL HAZARD MITIGATION ACTION PLAN 2021 UPDATE

Volume I

Prepared for:

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Division of Emergency Management
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MAY 2021

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TETRA TECH

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SECTION 1. INTRODUCTION

> ***Hazard Mitigation*** *is any sustained action taken to reduce or eliminate the long-term risk and effects that can result from specific hazards.*
>
> *FEMA defines a* ***Hazard Mitigation Plan*** *as the documentation of a state or local government evaluation of natural hazards and the strategies to mitigate such hazards.*

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), Sussex County and the municipalities located therein have developed this Hazard Mitigation Plan (HMP), which represents a regulatory update to the *2016 Sussex County Multi-Jurisdictional Hazard Mitigation Plan* (HMP). The DMA 2000 amends the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act) and is designed to improve planning for, response to, and recovery from disasters by requiring state and local entities to implement pre-disaster mitigation planning and develop HMPs. The Federal Emergency Management Agency (FEMA) has issued guidelines for HMPs. The New Jersey Office of Emergency Management (NJOEM), supports plan development for jurisdictions in New Jersey.

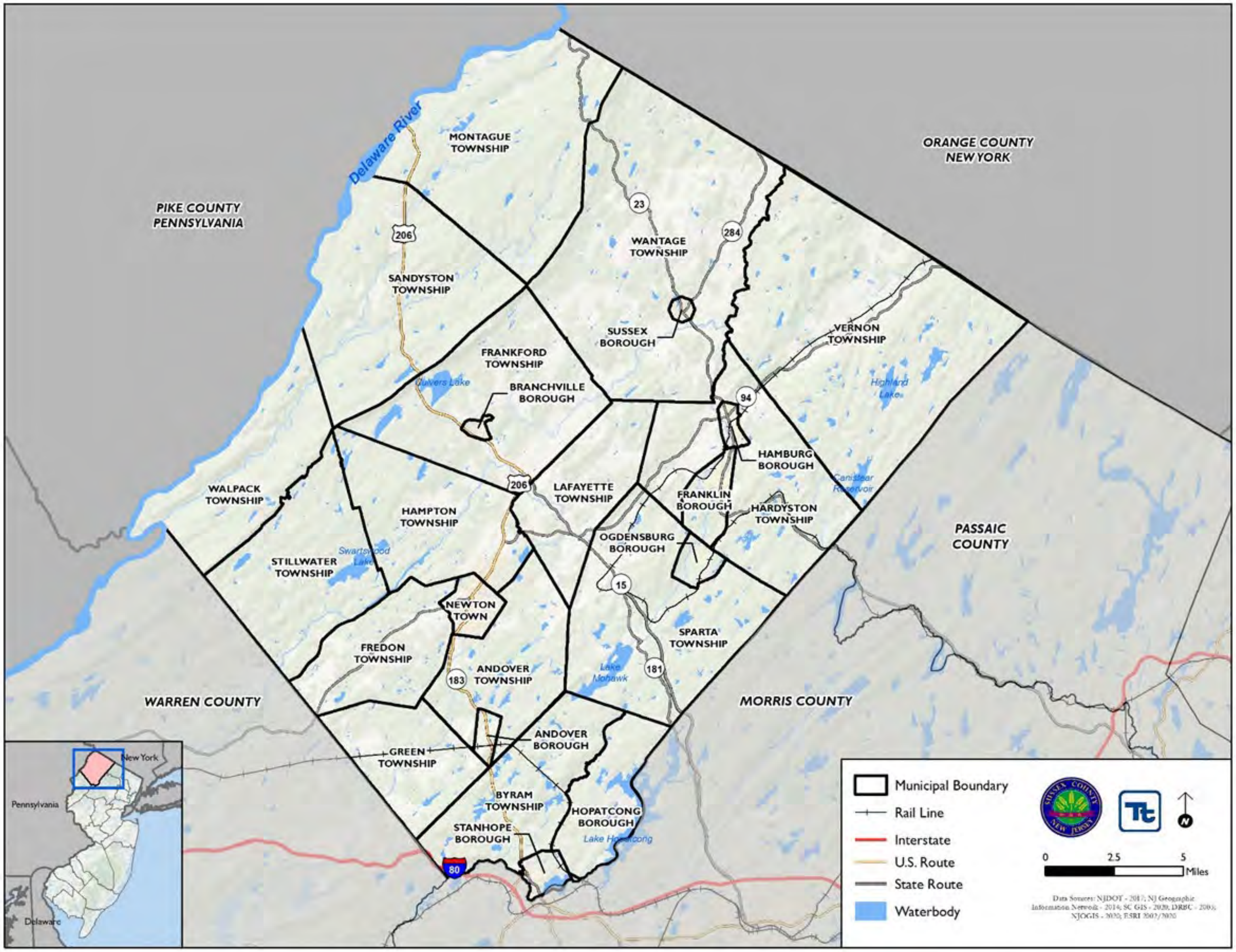
Specifically, the DMA 2000 requires that states, with support from local governmental agencies, develop and update HMPs on a five-year basis to prepare for and reduce the potential impacts of natural hazards. The DMA 2000 is intended to facilitate cooperation between state and local authorities, prompting them to work together. This enhanced planning better enables local and state governments to articulate accurate needs for mitigation, resulting in faster allocation of funding and more effective risk reduction projects.

Sussex County and all municipalities are participating in the plan update; refer to Table 1-1 and Figure 1-1.

Table 1-1. Participating Jurisdictions

Jurisdictions		
Andover Borough	Hamburg Borough	Sandyston Township
Andover Township	Hampton Township	Sparta Township
Branchville Borough	Hardyston Township	Stanhope Borough
Byram Township	Hopatcong Borough	Stillwater Township
Frankford Township	Lafayette Township	Sussex Borough
Franklin Borough	Montague Township	Vernon Township
Fredon Township	Town of Newton	Walpack Township
Green Township	Ogdensburg Borough	Wantage Township
Sussex County		

Figure 1-1. Sussex County New Jersey



1.1 DMA 2000 ORIGINS -THE STAFFORD ACT

In the early 1990s, a new federal policy regarding disasters began to evolve. Rather than reacting whenever disasters strike communities, the federal government began encouraging communities to first assess their vulnerability to various disasters and proceed to take actions to reduce or eliminate potential risks. The logic is that a disaster-resistant community can rebound from a natural disaster with less loss of property or human injury, at much lower cost, and, consequently, more quickly. Moreover, these communities minimize other costs associated with disasters, such as the time lost from productive activity by business and industries.

The DMA 2000 provides an opportunity for states, tribes, and local governments to take a new and revitalized approach to mitigation planning. The DMA 2000 amended the Stafford Act by repealing the previous mitigation planning provisions (Section 409) and replacing them with a new set of requirements (Section 322). Section 322 sets forth the requirements that communities evaluate natural hazards within their respective jurisdictions and develop an appropriate plan of action to mitigate those hazards, while emphasizing the need for state, tribal and local governments to closely coordinate mitigation planning and implementation efforts.

The amended Stafford Act requires that each local jurisdiction identify potential natural hazards to the health, safety, and well-being of its residents and identify and prioritize actions that the community can take to mitigate those hazards—before disaster strikes. To remain eligible for hazard mitigation assistance from the federal government, communities must first prepare and then maintain and update an HMP (this plan).

Responsibility for fulfilling the requirements of Section 322 of the Stafford Act and administering the FEMA Hazard Mitigation Program has been delegated to the State of New Jersey, specifically to NJOEM. FEMA also provides support through guidance, resources, and plan reviews.

1.2 BENEFITS OF MITIGATION PLANNING

Mitigation planning forms the foundation for Sussex County's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. Mitigation planning also allows Sussex County, as a whole, and participating jurisdictions to remain eligible for mitigation grant funding for mitigation projects that will reduce the impact of future disaster events. The long-term benefits of mitigation planning include the following:

National Benefit-Cost Ratio (BCR) Per Peril *BCR numbers in this study have been rounded*	Beyond Code Requirements	Federally Funded
Overall Hazard Benefit-Cost Ratio	$4:1	$6:1
Riverine Flood	$5:1	$7:1
Hurricane Surge	$7:1	Too few grants
Wind	$5:1	$5:1
Earthquake	$4:1	$3:1
Wildland-Urban Interface Fire	$4:1	$3:1

Source: FEMA 2018; Federal Insurance Mitigation Administration 2018
Note: Natural hazard mitigation saves $6 on average for every $1 spent on federal mitigation grants.

- An increased understanding of hazards faced by Sussex County and their inclusive jurisdictions.
- Building more sustainable and disaster-resistant communities.
- Increasing education and awareness of hazards and their threats, as well as their risks.
- Developing implementable and achievable actions for risk reduction in the county and its jurisdictions.
- Building relationships by involving residents, organizations, and businesses.
- Identify implementation approaches that focus resources on the greatest risks and vulnerabilities.
- Financial savings through partnerships that support planning and mitigation efforts.
- Focused use of limited resources on hazards that have the biggest impact on the community.
- Reduced long-term impacts and damages to human health and structures.
- Reduced repair costs.

1.3 HAZARD MITIGATION PLAN OVERVIEW

The structure of this HMP follows the four-phase planning process recommended by FEMA and summarized in Figure 1-2. Table 1-2 summarizes the requirements outlined in the DMA 2000 Interim Final Rule and provides the section where each is addressed in this HMP. This HMP is organized in accordance with FEMA and NJOEM guidance. This plan was prepared in accordance with the following:

- FEMA Local Mitigation Planning Handbook, March 2013.
- FEMA Integrating Hazard Mitigation into Local Planning, March 1, 2013.
- FEMA Plan Integration: Linking Local Planning Efforts, July 2015.
- Local Mitigation Plan Review Guide, October 1, 2011.
- DMA 2000 (Public Law 106-390, October 30, 2000).
- 44 Code of Federal Regulations (CFR) Parts 201 and 206 (including: Feb. 26, 2002, Oct. 1, 2002, Oct. 28, 2003, and Sept. 13, 2004 Interim Final Rules).
- FEMA How-To Guide for Using HAZUS-MH-MH for Risk Assessment FEMA Document No. 433, February 2004.
- FEMA Mitigation Planning How-to Series (FEMA 386-1 through 4), 2002, available at: http://www.fema.gov/fima/planhowto.shtm.
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards, January 2013

Figure 1-2. Sussex County Hazard Mitigation Planning Process

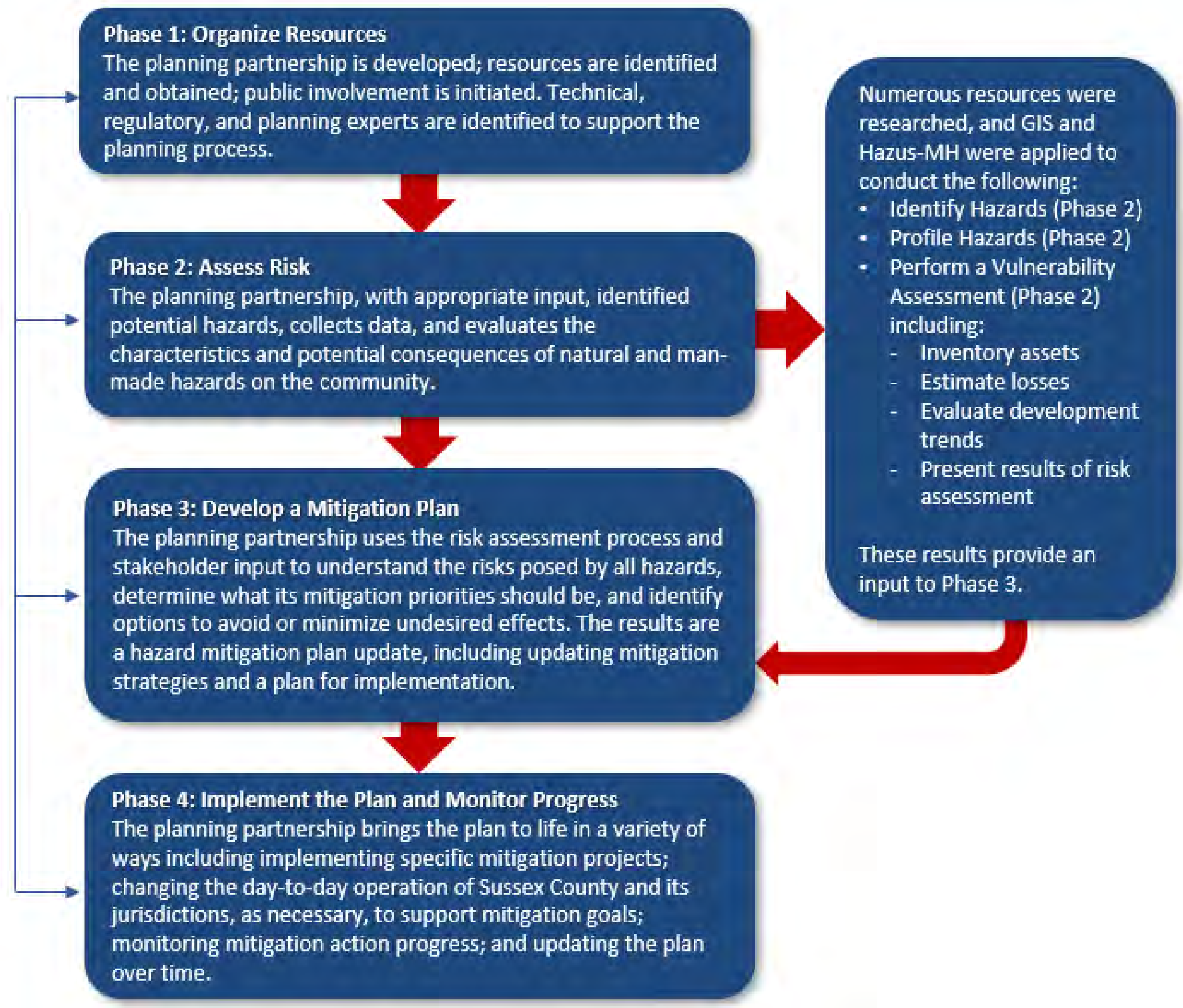


Table 1-2. FEMA Local Mitigation Plan Review Crosswalk

HMP Criteria	Primary Location in the HMP
Prerequisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Section 1; Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Section 2; Section 8
Risk Assessment	
Identifying Hazards: §201.6(c)(2)(i)	Sections 4.1
Profiling Hazards: §201.6(c)(2)(i)	Section 4.3
Assessing Vulnerability: Overview: §201.6(c)(2)(ii)	Section 4.3
Assessing Vulnerability: Identifying Structures: §201.6(c)(2)(ii)(A)	Section 3; Section 4.2; Section 4.3; Section 9
Assessing Vulnerability: Estimating Potential Losses: §201.6(c)(2)(ii)(B)	Section 4.3; Section 9
Assessing Vulnerability: Analyzing Development Trends: §201.6(c)(2)(ii)(C)	Section 3; Section 4.3; Section 9
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Section 6; Section 9
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Section 6; Section 9
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Section 6; Section 9
Multi-Jurisdictional Mitigation Actions: §201.6(c)(3)(iv)	Section 6; Section 9
Plan Maintenance Process	
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Section 7
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Section 6; Section 7; Section 9
Continued Public Involvement: §201.6(c)(4)(iii)	Section 7

1.4 PLANNING PROCESS OVERVIEW

Sussex County and all participating municipalities intend to implement this HMP with full coordination and participation of County and local departments, organizations and groups, and relevant state and federal entities. Coordination helps to ensure that stakeholders have established communication channels and relationships necessary to support mitigation planning and mitigation actions included in Section 6 (Mitigation Strategy) and Section 9 (Jurisdictional Annexes).

During the Sussex County HMP planning process, the State of New Jersey and Sussex County were facing the COVID-19 pandemic. The COVID-19 pandemic was declared a major disaster on March 25, 2020 (DR-4488). Sussex County has been greatly impacted by the COVID-19 pandemic with 7,973 positive cases and over 250 confirmed deaths as of February 4, 2021.

The Sussex County Division of Emergency Management (DEM), Steering Committee members and the planning partners (County departments, municipalities, and stakeholders) were facing the COVID-19 pandemic concurrent with completing the update to the HMP. Sussex County and all planning partners made their best effort to work through this unprecedented time to complete the HMP update and meet FEMA and State requirements. Due to social distancing measures to reduce the spread of COVID-19, remote meetings were utilized instead of in-person meetings. This included planned public meetings throughout the planning process.

The Sussex County DEM website was updated, and social media was utilized to advertise the draft plan posting. All planning partners were notified that the draft plan was posted for public and stakeholder review, were provided social media posts/images, and were asked to distribute these notifications in their jurisdictions. Last, stakeholders that were distributed the stakeholder surveys were notified via email that the draft plan was posted for public review and comment. Refer to Section 2 (Planning Process) and Appendix D (Public and Stakeholder Engagement) for additional details on public and stakeholder outreach. Public and stakeholder comments received on the draft plan were shared with the planning partners via email and discussed with the Steering Committee. To complete the update to the draft plan prior to submission to NJOEM, teleconference meetings were held in a best effort to complete jurisdictional annexes given staffing constraints during the active pandemic.

1.5 MULTIPLE AGENCY SUPPORT FOR HAZARD MITIGATION

Primary responsibility for the development and implementation of mitigation strategies and policies lies with local governments. However, local governments are not alone; various partners and resources at the regional, state, and federal levels are available to assist communities in the development and implementation of mitigation strategies. Within New Jersey, NJOEM is the lead agency providing hazard mitigation planning assistance to local jurisdictions. NJOEM provides guidance to support mitigation planning. In addition, FEMA provides grants, tools, guidance, and training to support mitigation planning.

__Steering Committee (SC)__ is comprised of County and municipal representatives that guide and lead the HMP update process on behalf of the Planning Partnership.

__Planning Committee (PC)__ is comprised of representatives from each participating jurisdiction (County and municipalities).

Planning Partnership = SC + PC

The Sussex County Division of Emergency Management, and the Steering Committee provided project management and oversight of the planning process. Participating jurisdictions were asked to identify a primary and alternate local point of contact (POC) to be members of the Planning Committee and lead the planning process update on behalf of the jurisdiction. At the start of the planning process, each municipality identified their National Flood Insurance Program (NFIP) Floodplain Administrator (FPA) and requested their involvement. Further, each jurisdiction was encouraged to form a ‘mitigation team’ comprised of representatives across departments to ensure broad participation, share the work of the update process and ensure accurate information was captured in their chapter, or annex.

The municipal mitigation teams worked directly with the primary and alternate POCs, and the NFIP FPA and contributed to the jurisdictional annexes presented in Section 9. Together, the Steering Committee and Planning Committee are referred to as the Planning Partnership for the Sussex County HMP update. A list of Steering Committee and jurisdiction POCs is provided in Section 2 (Planning Process), while Appendices B (Meeting Documentation) and Appendix C (Participation Documentation) provide further documentation of the broader level of municipal involvement. Additional input and support for this planning effort was obtained from a range of agencies and through public and stakeholder involvement (as discussed in Section 2 and presented in Appendix D – Public and Stakeholder Outreach).

1.6 GOALS AND OBJECTIVES

The planning process included a review and update of the prior mitigation goals and objectives as a basis for the planning process and selection of appropriate mitigation actions addressing all hazards of concern. Further, the goal development process considered the mitigation goals expressed in the 2019 State of New Jersey HMP, as well as other relevant county and local planning documents, as discussed in Section 6 (Mitigation Strategy).

1.7 HAZARDS OF CONCERN

Sussex County and participating jurisdictions reviewed the hazards that caused measurable impacts based on events, losses, and information available since the development of the 2016 Sussex County HMP and the 2019 State of New Jersey HMP. A list of potential hazards of concern was reviewed by the Planning Partnership, and each was evaluated to identify the hazards of concern for the 2021 update planning process. The list was presented to each of the participating jurisdictions where they evaluated their risk and vulnerability from each hazard of concern. While the overall hazard rankings were calculated for the County and each participating jurisdiction, the specific hazard rankings displayed in each annex reflect jurisdictional input. The hazard risk rankings were used to focus and prioritize individual jurisdictional mitigation strategies.

1.8 PLAN INTEGRATION INTO OTHER PLANNING MECHANISMS

Plan integration is the process by which jurisdictions look at their existing planning framework and align efforts with the goal of building a safer, smarter, and more resilient community. It is specific to each community and depends on the vulnerability of the built environment. Community-wide plan integration supports risk reduction through various planning and development measures, both before and after a disaster. Plan integration involves a community's plans, policies, codes, and programs that guide development and the roles of people and government in implementing these capabilities. Successful integration occurs through collaboration among a diverse set of stakeholders in the community.

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies are integrated into local planning mechanisms and become an integral part of public activities and decision making. Within Sussex County, there are numerous existing plans and programs that support hazard risk management and reduction, and thus, it is critical that the 2021 HMP update integrates, coordinates with, and complements those mechanisms.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the County. Within each jurisdictional annex in Section 9 (Jurisdictional Annexes), the County and each participating jurisdiction identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework ("existing integration"), and how they intend to promote this integration ("opportunities for future integration").

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 9 (Jurisdictional Annexes).

1.9 IMPLEMENTATION OF PRIOR AND EXISTING LOCAL HAZARD MITIGATION PLANS

Section 9 (Jurisdictional Annexes) of the plan present the status of the mitigation projects identified in the 2016 Sussex County HMP. Numerous projects and programs have been implemented that have reduced hazard vulnerability to assets in the planning area. The County and jurisdictional annexes, as well as plan maintenance procedures in Section 7 (Plan Maintenance), were developed to encourage specific activities. Future actions include integrating hazard mitigation goals into Master Plan updates; reviewing the HMP during updates of codes, ordinances, zoning, and development; and ensuring a more thorough integration of hazard mitigation, with its related benefits into municipal operations, will be completed within the upcoming five-year planning period.

1.10 IMPLEMENTATION OF THE PLANNING PROCESS

The planning process and findings are required to be documented in local HMPs. To support the planning process in developing this HMP, Sussex County and the participating jurisdictions have accomplished the following:

- Developed a Steering Committee and countywide planning partnership with jurisdictions and stakeholders.
- Reviewed the 2016 Sussex County Hazard Mitigation Plan.
- Identified and reviewed those hazards that are of greatest concern to Sussex County and its jurisdictions (hazards of concern) to be included in the plan.
- Profiled the relevant hazards.
- Estimated the inventory at risk and potential losses associated with the relevant hazards.
- Reviewed and updated the hazard mitigation goals and objectives.
- Reviewed mitigation strategies identified in the 2016 Sussex County HMP.
- Developed new mitigation actions to address reduction of vulnerability of hazards of concern.
- Involved a wide range of stakeholders and the public in the plan process.
- Developed mitigation plan maintenance procedures to be executed after obtaining approval of the plan from NJOEM and FEMA.

As required by the DMA 2000, Sussex County and its participating jurisdictions have informed the public and provided opportunities for public comment and input. Numerous agencies and stakeholders were invited to participate in the planning process by providing input and expertise. Refer to Appendix D (Public and Stakeholder Outreach) for copies of public announcements, social media posts and other forms of public and stakeholder outreach conducted.

1.11 ADOPTION

Upon FEMA Approval Pending Adoption (APA) status of the 2021 HMP update, Sussex County and each municipality will adopt the plan by resolution of local governing body. An example resolution authorizing adoption of the 2021 Sussex County HMP may found in Appendix A. Upon receipt of the FEMA APA status, participants will adopt the plan and the resolutions saved in Appendix A. Please refer to Section 8 (Planning Partnership) for additional information on plan adoption procedures.

1.12 ORGANIZATION OF THE HAZARD MITIGATION PLAN

The Sussex County HMP update is organized as a two-volume plan. Volume I provides information on the overall planning process and hazard profiling and vulnerability assessments, which serves as a basis for understanding risk and identifying mitigation actions. As such, Volume I is intended for use as a resource for on-going mitigation analysis. Volume II provides an annex dedicated to each participating jurisdiction. Each annex summarizes the jurisdiction's legal, regulatory, and fiscal capabilities; identifies vulnerabilities to hazards; documents mitigation plan integration with other planning efforts; records status of past mitigation actions; and presents an individualized mitigation strategy. The annexes are intended to provide a useful resource for each jurisdiction for implementation of mitigation projects and future grant opportunities, as well as place for each jurisdiction to record and maintain their local aspect of the countywide plan.

Volume I of this HMP includes the following sections:

Section 1: Introduction: Overview of participants, planning process and information regarding adoption of the HMP by Sussex County and each participating jurisdiction.

Section 2: Planning Process: Description of the HMP methodology and development process; Steering Committee, Planning Committee, Planning Partnership, and stakeholder involvement efforts; and a description of how this HMP will be incorporated into existing programs.

Section 3: County Profile: Overview of Sussex County, including: (1) physical setting, (2) land use, (3) land use trends, (4) population and demographics, (5) general building stock and (6) critical facilities and lifelines.

Section 4: Risk Assessment: Documentation of the hazard identification and hazard risk ranking process, hazard profiles, and findings of the vulnerability assessment (estimates of the impact of hazard events on life, safety, health, general building stock, critical facilities, the economy).

Section 5: Capability Assessment: A summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the County.

Section 6: Mitigation Strategy: Information regarding the mitigation goals and objectives in response to priority hazards of concern and the process by which Sussex County and local mitigation strategies have been developed or updated.

Section 7: Plan Maintenance Procedures: System established to continue to monitor, evaluate, maintain, and update the HMP.

Volume II of this plan includes the following sections:

Section 8: Planning Partnership: Description of the planning partnership, their responsibilities, and description of jurisdictional annexes.

Section 9: Jurisdictional Annexes: Jurisdiction-specific annex for Sussex County and each participating jurisdiction containing their hazards of concern, hazard ranking, capability assessment, mitigation actions, action prioritization specific only to Sussex County or that jurisdiction, progress on prior mitigation activities (as applicable), and a discussion of prior local hazard mitigation plan integration into local planning processes.

Appendices include the following:

Appendix A: Plan Adoption: Resolutions from the County and each jurisdiction included as each formally adopts the HMP update.

Appendix B: Participation Documentation: Matrix to give a broad overview of who attended meetings and when input was provided to the HMP update, as well as Letters of Intent to Participate described in Section 2 (Planning Process), and additional worksheets submitted during workshops conducted throughout the planning process.

Appendix C: Meeting Documentation: Agendas, attendance sheets, meeting notes, and other documentation (as available and applicable) of planning meetings convened during the development of the plan.

Appendix D: Public and Stakeholder Outreach: Documentation of the public and stakeholder outreach effort including webpages, informational materials, public and stakeholder meetings and presentations, surveys, interactive StoryMap and other methods used to receive and incorporate public and stakeholder comment and input to the plan process.

Appendix E: Risk Assessment Supplementary Data: Expanded explanation of community lifelines and the previous hazard events from the 2016 HMP.

Appendix F: Mitigation Strategy Supplementary Data: Documentation of the broad range of actions identified during the mitigation process; types of mitigation actions; the mitigation catalog developed using jurisdiction input and potential mitigation funding sources.

Appendix G: Plan Maintenance Tools: Examples of plan review tools and templates available to support annual plan review.

Appendix H: Linkage Procedures: Procedures for non-participating local governments to "link" to the plan within the period of performance to gain eligibility for programs under the DMA 2000.

1.13 THE UPDATED PLAN – WHAT IS DIFFERENT?

Both the planning process and the 2021 HMP have been enhanced for this update. An increased effort to actively engage stakeholders and the public was a focus of the update; as well as the continued education of the Planning Partnership of mitigation and available grant funding opportunities. The mitigation strategy was updated to only contain detailed actions that are considered priority to each jurisdiction (i.e., quality not quantity). Further, the sections in the 2021 HMP have been realigned to increase the readability of the plan. The following summarizes process and plan changes that differ from the 2016 process and HMP:

- Section 2 (Planning Process) was formerly Section 3 in the 2016 HMP and now comprises the Planning Process section of the plan. Adoption information has been re-located to Section 8 (Planning Partnership) and Appendix A.
- Section 2 (Planning Process) has been updated in its entirety to summarize the planning process followed for the 2021 HMP update. In summary, the Steering Committee was expanded to include additional County Departments, two municipal representatives (Andover Township and Wantage Township), two major employers in the County (Newton Medical Center and Sussex County Community College), as well as a representative from the Upper Delaware Conservation District (former Sussex County Soil and Water Conservation District) and the Rutgers Cooperative Extension of Sussex County.
- Section 4 (Risk Assessment) has been streamlined and updated as summarized below.
    - A new hazard of concern, Infestation and Invasive Species, was added to the plan and the flood hazard was expanded to collect additional details on urban flooding (i.e., flooding outside of the floodplain).
    - The updated plan is based on new inventory data (i.e., building footprints, updated replacement cost values, critical facilities and community lifelines) and updated spatial hazard data.
    - The topic of FEMA community lifelines is included. All jurisdictions identified critical facilities considered lifelines in accordance with FEMA's community lifeline definition. In addition, the inventory expanded to include lifeline types not considered in the 2016 HMP.
    - The flood hazard was expanded to include urban flooding or flooding outside of the floodplain. The Planning Partnership identified locations of urban flooding utilizing a spatial identification tool which was developed into a spatial layer to inform the mitigation strategy.
    - The hazard ranking methodology was expanded to include adaptive capacity and climate change.
- Section 5 (Capability Assessment) and Section 9 (Jurisdictional Annexes) were subject to several changes in the capability assessment, both in Volumes I and II of the plan.
    - Section 5 (Capability Assessment) is now a stand-alone section for the capability assessment summarizing existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county, local) that support hazard mitigation within the County. This information was formerly part of Section 6 (Mitigation Strategy) in the 2016 HMP.

  - Section 9 (Jurisdictional Annexes) has an expanded capability assessment to include additional planning mechanisms in New Jersey as well as information regarding plan integration in the Planning, Legal and Regulatory table.
- Section 6 (Mitigation Strategy) - A mitigation strategy workshop was conducted in November 2020 and supported by NJOEM and FEMA to focus on the development of specific problem statements based on the impacts of natural hazards in the County and communities. These problem statements provided a detailed description of the problem area, including its impacts to the municipality/jurisdiction; past damages; loss of service; etc. An effort was made to include the property/project location, adjacent streets, water bodies, and well-known structures as well as a brief description of existing conditions (topography, terrain, hydrology) of the site. These problem statements form a bridge between the hazard risk assessment which quantifies impacts to each community with the development of actionable mitigation strategies.
- The jurisdictional annexes in Section 9 have been enhanced to include the following:
  - Identification of the NFIP Floodplain Administrator as part of the hazard mitigation planning team.
  - Expanded capability assessment including the identification of additional administrative and technical capabilities and catalog of adaptive capacity for each hazard of concern for each jurisdiction.
  - Expansion of the critical facility and lifeline flood hazard exposure table to include a mitigation action, if appropriate.
  - A user-friendly presentation of the hazard ranking results.
  - A revised 2016 previous mitigation strategy status table to more clearly identify if the action is to be included in the 2021 HMP update.
  - An increased focus on actionable projects has been applied; removing actions that are capabilities and focusing on high-ranked hazards.
  - A more detailed proposed mitigation action table that now specifies the problem statement and the proposed solution (mitigation action). The more detailed mitigation strategy is also reflected in the mitigation action worksheets that also include additional details.
  - A table that summarizes the actions across the ranked hazards and their mitigation action types.
  - Individuals that contributed to the annex are specifically listed at the end of the section.
  - Mitigation action worksheets have only been developed for FEMA-eligible projects, per NJOEM guidance.
- To increase public engagement, the following efforts were made:
  - All Planning Partnership meetings were made open to the public.
  - Social media (Facebook and Twitter) was used to inform the public of meetings and to take the citizen survey.
  - An interactive StoryMap was developed to engage residents and stakeholders. The StoryMap has interactive web maps to pan around the County and view the hazard areas. It also links directly to the public and stakeholder surveys distributed.
- A user-friendly tone was used to cater to the strong desire for this plan to be understandable to the general public and not overly technical. This includes limiting the hazard profile section to brief summaries and providing an increased number of graphical summaries throughout the risk assessment.
- An enhanced mitigation strategy process was utilized to develop a robust and actional action plan.
  - A mitigation toolbox was built to assist with mitigation action identification.
  - A Strengths, Weaknesses, Obstacles and Opportunities exercise was conducted to gain a better understanding of areas of improvement and challenges faced with risk reduction.
  - Utilizing the risk assessment and capability assessment results, problem statements were drafted by each municipality and used to inform the mitigation action development.

  - Actions are identified, rather than strategies. Strategies provide direction, but actions are fundable under grant programs. The identified actions are designed to meet multiple measurable objectives, so that each planning partner can measure the effectiveness of their mitigation actions.
- The plan maintenance strategy is more clearly defined to provide a roadmap for the annual monitoring of the plan.

Table 1-3 summarizes the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 1-3. HMP Changes Crosswalk

44 CFR Requirement	2016 HMP	2021 Updated HMP
Requirement §201.6(b): In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include: (1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval; (2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia and other private and non-profit interests to be involved in the planning process; and (3) Review and incorporation, if appropriate, of existing plans, studies, reports and technical information.	The 2016 plan followed an outreach strategy utilizing multiple media developed and approved by the Steering Committee. This strategy involved the following: • Establishment of a plan informational website. • Press release • Use of public and stakeholder information surveys. Stakeholders were identified and coordinated with throughout the process. A comprehensive review of relevant plans and programs was performed by the planning team.	Building upon the success of the 2016 plan, the 2021 planning effort deployed an enhanced public engagement methodology: • Use of social media (Facebook and Twitter). • Web-deployed surveys to residents and targeted stakeholders • All meetings open to the public • Development of an interactive StoryMap to provide risk communication to residents and direct access to the citizen and stakeholder surveys. As with the 2016 plan, the 2021 planning process identified key stakeholders and coordinated with them throughout the process. The Steering Committee was expanded to include a representative of two major employers in the County, Newton Medical Center and Sussex County Community College, as well as the Upper Delaware Conservation District. A comprehensive review of relevant plans and programs was performed by the planning team.
§201.6(c)(2): The plan shall include a risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.	The 2016 plan included a comprehensive risk assessment of hazards of concern. Risk was defined as (probability x impact), where impact is the impact on people, property, and economy of the planning area. All planning partners ranked hazard risk as it pertains to their jurisdiction. The potential impacts of climate change are discussed for each hazard.	New and updated data hazard and inventory data was utilized for the 2021 plan's risk assessment update. The flood hazard was expanded to include urban flooding (or flooding outside of the floodplain). A new hazard of concern, infestation and invasive species was included. The hazard ranking methodology was expanded to include adaptive capacity and climate change. Jurisdiction-specific risk assessment results are summarized in Section 4 (Risk Assessment) and in each jurisdictional annex (Section 9).
§201.6(c)(2)(i): [The risk assessment] shall include a] description of the … location and extent of all-natural hazards	The 2016 plan presented a risk assessment of each hazard of concern. Each section included the following:	A similar format, using new and updated data, was used for the 2021 plan update. Each section of the risk

44 CFR Requirement	2016 HMP	2021 Updated HMP
that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	• Hazard profile, including maps of extent and location, previous occurrences, and probability of future events. • Climate change impacts on future probability. • Impact and vulnerability on life, health, safety, general building stock, critical facilities, and economy. • Future growth and development.	assessment includes the following along with an expanded section to discuss future changes that may impact vulnerability: • Hazard profile, including maps of extent and location, previous occurrences, and probability of future events. • Climate change impacts on future probability using the best available data for New Jersey. • Vulnerability assessment includes impact on life, safety, and health, general building stock, critical facilities/lifelines, and the economy, as well as future changes that could impact vulnerability (population, development, and climate). • The vulnerability assessment also includes changes in vulnerability since the 2016 plan.
§201.6(c)(2)(ii): [The risk assessment] shall include a] description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i). This description shall include an overall summary of each hazard and its impact on the community.	Vulnerability was assessed for all hazards of concern. The HAZUS-MH-MH computer model was used for the wind, earthquake, and flood hazards. These were Level 2 analyses using County data. Site-specific data on County-identified critical facilities were entered into the HAZUS-MH model. HAZUS-MH outputs were generated for other hazards by applying an estimated damage function to an asset inventory extracted from HAZUS-MH-MH.	A robust vulnerability assessment was conducted for the 2021 plan update, using new and updated asset and hazard data. Volume 1, Section 4.3 summarizes countywide and municipal-specific vulnerability for each hazard of concern. The jurisdictional annexes (Section 9) include a summary table of impacts on each community.
§201.6(c)(2)(ii): [The risk assessment] must also address National Flood Insurance Program insured structures that have been repetitively damaged floods.	A summary of NFIP insured properties including an analysis of repetitive loss property locations was included in the plan.	Updated NFIP statistics, as well as Write-Your-Own statistics were presented in the 2021 plan update using best available data.
Requirement §201.6(c)(2)(ii)(A): The plan should describe vulnerability in terms of the types and numbers of existing and future buildings, infrastructure and critical facilities located in the identified hazard area.	A complete inventory of the numbers and types of buildings exposed was generated for each hazard of concern. The Steering Committee defined "critical facilities" for the planning area, and these were inventoried by exposure. Each hazard chapter provides a discussion on future development trends.	Quantitative and qualitative analyses were conducted using the updated hazard and inventory data as presented in Section 4 (Risk Assessment). In addition, critical facilities considered community lifelines in accordance with FEMA's definition were identified.
Requirement §201.6(c)(2)(ii)(B): [The plan should describe vulnerability in terms of an] estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(i)(A) and a description of the methodology used to prepare the estimate.	Loss estimates were generated for all hazards of concern. These were generated by HAZUS-MH-MH for the wind, earthquake, and flood hazards. For the other hazards, loss estimates were generated by applying a regionally relevant damage function to the exposed inventory. In all cases, a damage function was applied to an asset inventory. The asset inventory was the same for all hazards and was generated in HAZUS-MH.	Quantitative and qualitative analyses were conducted using the updated hazard and inventory data as presented in Section 4 (Risk Assessment). Estimated potential losses are reported in both Volume 1, Section 4.3 and Volume II Section 9 for each jurisdiction.

44 CFR Requirement	2016 HMP	2021 Updated HMP
Requirement §201.6(c)(2)(ii)(C): [The plan should describe vulnerability in terms of] providing a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.	There is a summary of anticipated development in the County profile, as well as in each individual annex.	A spatial analysis using Highlands Council identified growth areas (Section 3), and potential new development identified by municipalities was conducted to determine if located in hazard areas (Section 9). These results were reported to all participants and summarized in their annexes to discuss mitigation measures. In Volume I, Section 4.3, projected changes in population and development are discussed in each hazard section and how these projected changes may lead to increased vulnerability, or plans/regulations/ordinances in place to implement mitigation to protect the development. Further, a land use analysis was conducted for the flood hazard to examine residential and non-residential classified land in the floodplain.
§201.6(c)(3):[The plan shall include a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.]	The 2016 plan contained goals, objectives, and actions. Each planning partner identified actions that could be implemented within their capabilities. The actions were jurisdiction-specific and strove to meet multiple objectives. All objectives met multiple goals and stand alone as components of the plan. Each planning partner completed an assessment of its regulatory, technical, and financial capabilities.	The Steering Committee reviewed and updated the goals and objectives and they were approved by the Planning Committee. A mitigation strategy workshop with associated tools and guidance on problem statement development was deployed to inform the identification of mitigation actions. Actions that were completed or no longer considered to be feasible were removed; and actions considered general or capabilities were moved to the capability and integration sections. The balance of the actions was carried over to the 2021 plan, and in some cases, new actions were added to the action plan.
Requirement §201.6(c)(3)(i): [The hazard mitigation strategy shall include a] description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.	The Steering Committee identified goals, and objectives targeted specifically for this hazard mitigation plan. These planning components supported the actions identified in the plan.	The Steering Committee reviewed and updated the goals and objectives and they were approved by the Planning Committee. One new goal and several new objectives were identified to align with updated County and municipal priorities.
Requirement §201.6(c)(3)(ii): [The mitigation strategy shall include a] section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure.	The 2016 plan included mitigation action worksheets that evaluated alternative actions considered for the final mitigation strategy.	For the 2021 update, a mitigation catalog was developed to provide a comprehensive range of specific mitigation actions to be considered. A table with the analysis of mitigation actions by type and hazard was used in jurisdictional annexes to the plan. Mitigation action worksheets with an alternatives evaluation were prepared for FEMA-eligible projects.
Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National	All municipal planning partners that participate in the National Flood Insurance Program indicated their	An analysis of repetitive and severe repetitive loss properties was conducted and is summarized in

44 CFR Requirement	2016 HMP	2021 Updated HMP
Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	commitment to maintain compliance and good standing under the program.	Section 4.3.5 (Flood) and in Section 9 (Jurisdictional Annexes). Municipalities with repetitive and severe repetitive loss properties included an action to mitigate those properties.
Requirement: §201.6(c)(3)(iii): [The mitigation strategy shall describe] how the actions identified in section (c)(3)(ii) will be prioritized, implemented and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.	Each recommended action was prioritized using a revised methodology based on the STAPLEE criteria was used to prioritize projects.	A revised methodology to evaluate mitigation alternatives based on the STAPLEE with expanded criteria and using new and updated data was used for the 2021 plan update. A total of 14 criteria were used to evaluate each potential mitigation action. The evaluation included a qualitative benefits and cost review. The results of the evaluation were used to identify the actions to include in the plan and assist with the prioritization. An emphasis was placed on benefits and costs (quantified where possible and listed in the mitigation action worksheets), as well as timeline for implementation (also documented in the mitigation action worksheets for FEMA-eligible projects).
Requirement §201.6(c)(4)(i): [The plan maintenance process shall include a] section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.	The 2016 plan outlined a detailed maintenance strategy.	The 2021 plan details a maintenance strategy similar to that of the initial plan. It has been enhanced to provide a roadmap for the annual monitoring of the plan and a program to assist with project progress reporting. This includes the inclusion of a summary plan maintenance matrix that provides an overview of the planning partner responsibilities for monitoring, evaluation, and update of the plan.
Requirement §201.6(c)(4)(ii): [The plan shall include a] process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.	The 2016 plan details recommendations for incorporating the plan into other planning mechanisms.	The 2021 plan details recommendations for incorporating the plan into other planning mechanisms such as the following: • Master Plan • Emergency Response Plan • Capital Improvement Programs • Municipal Code
Requirement §201.6(c)(4)(iii): [The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.	The 2016 plan details a strategy for continuing public involvement.	The 2016 plan maintenance strategy was enhanced for the 2021 plan. In addition, the County will use a proprietary online tool to support the annual progress reporting of mitigation actions. Section 7 (Plan Maintenance) also details the continued public participation in the plan maintenance process.
Requirement §201.6(c)(5): [The local hazard mitigation plan shall include] documentation that the plan has been formally adopted by the governing body of the jurisdiction requesting approval of the	Sussex County and all jurisdictions participated in the 2016 HMP.	The 2021 plan achieves DMA compliance for Sussex County and all jurisdictions. Resolutions for each partner adopting the plan can be found in Appendix A of this volume.

44 CFR Requirement	2016 HMP	2021 Updated HMP
plan (e.g., City Council, County Commissioner, Tribal Council).		

SECTION 2. PLANNING PROCESS

2021 HMP CHANGES

- The sections in the 2021 HMP were realigned to increase the readability of the plan. Section 2 (formerly Section 3 in the 2016 HMP) now comprises the Planning Process section of the plan.
- All aspects of the planning process were updated for the 2021 HMP.
- The Steering Committee was expanded to include additional County departments, municipal representatives and stakeholders including major employers.
- Public outreach was enhanced to reach a broader audience by using additional media outlets (Facebook, Twitter) and interactive online tools (StoryMap and web maps).

2.1 INTRODUCTION

This section includes a description of the planning process used to update the 2016 Sussex County HMP, including how it was prepared, who was involved in the process, and how the public was involved. To ensure that the plan meets requirements of the DMA 2000 and that the planning process would have the broad and effective support of the participating jurisdictions, regional and local stakeholders, and the public, an approach to the planning process and plan documentation was developed to achieve the following goals:

- The HMP will be multi-jurisdictional and consider natural and human-caused hazards facing Sussex County, thereby satisfying the natural hazards mitigation planning requirements specified in the DMA 2000.

- Sussex County invited all municipalities in the County to join with them in the preparation of the Sussex County HMP. The County and all municipalities are participating in the HMP as indicated in Table 2-1 below.

- The HMP shall be developed following the process outlined by the DMA 2000, FEMA regulations, and prevailing FEMA and NJOEM guidance. Following this process ensures all the requirements are met and support HMP review.

Table 2-1. Participating Sussex County Jurisdictions

Jurisdictions		
Andover Borough	Hamburg Borough	Sandyston Township
Andover Township	Hampton Township	Sparta Township
Branchville Borough	Hardyston Township	Stanhope Borough
Byram Township	Hopatcong Borough	Stillwater Township
Frankford Township	Lafayette Township	Sussex Borough
Franklin Borough	Montague Township	Vernon Township
Fredon Township	Town of Newton	Walpack Township
Green Township	Ogdensburg Borough	Wantage Township
Sussex County		

The Sussex County HMP update was written using the best available information obtained from a wide variety of sources. Throughout the HMP update process, a concerted effort was made to gather information from local and regional agencies and staff, as well as stakeholders, federal and state agencies, and the residents of the County. The HMP Steering and Planning Committees, together called the Planning Partnership, solicited information from local agencies and individuals with specific knowledge of certain hazards and past historical events, as well as considering planning and zoning codes, ordinances, and other recent planning decisions. The hazard mitigation strategies identified in this HMP have been developed through an extensive planning process involving local, county and regional agencies, County residents and stakeholders.

This section describes the mitigation planning process, including (1) Organization of the Planning Process; (2) Stakeholder Outreach and Involvement; (3) Public Participation; (4) Integration of Existing Data, Plans, and Technical Information; (5) Integration with Existing Planning Mechanisms and Programs; and (6) Continued Public Involvement.

2.2 ORGANIZATION OF THE PLANNING PROCESS

Many parties supported the preparation of this HMP update: County officials, municipal officials, the Steering Committee, Planning Committee, stakeholders and planning consultant. This planning process does not represent the start of hazard risk management in the County; rather it is part of an ongoing process that various State, County and local agencies and individuals have continued to embrace. A summary of the past and ongoing mitigation efforts is provided in Section 6 (Mitigation Strategy), as well as in Volume II Section 9 (Jurisdictional Annexes), to give an historical perspective of the County and local activities implemented to reduce vulnerablity to hazards in the planning area.

This section of the HMP describes how the planning process was organized with the many “planning partners” involved and outlines the major activities that were conducted in the development of this HMP update.

2.2.1 ORGANIZATION OF PLANNING PARTNERSHIP

Recognizing the need to manage risk within the County, and to meet the requirements of the DMA 2000, the Sussex County DEM led the update to the 2016 Sussex County HMP. The State of New Jersey and Sussex County signed a Grantee-Subgrantee Agreement to fund the Sussex County HMP update. The period of performance for this grant is from October 1, 2018 and ending April 1, 2022. The County selected a contract planning consultant (Tetra Tech Inc. – Parsippany, NJ) to guide the County and participating jurisdictions through the HMP update process. A contract between Tetra Tech Inc. (Tetra Tech) and the County was executed in July 2020. Specifically, Tetra Tech, the “contract consultant”, was tasked with:

- Assisting with the organization of a Steering Committee and Planning Committee.
- Assisting with the development and implementation of a public and stakeholder outreach program.
- Data collection.
- Facilitation and attendance at meetings (Steering Committee, Planning Committee, stakeholder, public and other).
- Review and update of the hazards of concern, and hazard profiling and risk assessment.
- Assistance with the review and update of mitigation planning goals and objectives.
- Assistance with the review of progress of past mitigation strategies.
- Assistance with the screening of mitigation actions and the identification of appropriate actions.
- Assistance with the prioritization of mitigation actions.
- Authoring of the draft and final HMP documents.

In July 2020, Sussex County DEM notified all municipalities within the County of the pending planning process and invited them to formally participate. Municipalities were provided with a copy of the Planning Partner Expectations and asked to formally notify the County of their intent to participate [via a Letter of Intent to

Participate (LOIP)] and to identify a primary and secondary planning point of contact to serve on a Planning Committee and represent the interests of their respective community. In addition, each municipal Floodplain Administrator (FPA) was identified in the LOIP and requested to actively participate in the planning process. Section 9 (Jurisdictional Annexes) and Appendix B (Participation Documentation) detail contributions provided by the FPA. All jurisdictions returned their LOIP; refer to Appendix B for copies of the returned letters.

To facilitate HMP development, with support from their contract planning consultant, Sussex County developed a Steering Committee to provide guidance and direction to the planning effort, and to ensure the resulting document will be embraced both politically and by the constituency within the planning area. All municipalities participating in the plan update authorized the Steering Committee to perform certain activities on their behalf, via the LOIP. Specifically, the Steering Committee was charged with:

Steering Committee (SC) *is comprised of County and municipal representatives and stakeholders that guide and lead the HMP update process on behalf of the Planning Partnership.*

Planning Committee (PC) *is comprised of representatives from each participating jurisdiction (County and municipal).*

Planning Partnership = SC + PC

- Providing guidance and overseeing the planning process on behalf of the general planning partnership.
- Attending and participating in Steering Committee meetings.
- Establish a timeline for completion of the plan;
- Assisting with the development and completion of certain planning elements, including:
  - Reviewing and updating the hazards of concern,
  - Developing a public and stakeholder outreach program,
  - Assuring that the data and information used in the plan update process is the best available
  - Reviewing and updating the hazard mitigation goals and objectives,
  - Identification and screening of appropriate mitigation strategies and activities; and
  - Reviewing and commenting on plan documents prior to submission to NJOEM and FEMA.
  - Ensure that the plan meets the requirements of DMA 2000 and FEMA and NJOEM guidance.

The organizational structure was successfully implemented for the 2021 HMP updated consistent with the development of the initial 2016 planning process. The Steering Committee provided guidance and leadership, oversight of the planning process, and acted as the point of contact for all participating jurisdictions and the various interest groups in the planning area. In summary, the Steering Committee was expanded to include additional County Departments, two municipal representatives from Andover Township and Wantage Township, two major employers in the County (Newton Medical Center and Sussex County Community College), as well as a representative from the Upper Delaware Conservation District (former Sussex County Soil and Water Conservation District) and the Rutgers Cooperative Extension of Sussex County.

Table 2-2. Steering and Planning Committee Members

Jurisdiction	Name	Title	Steering Committee	Planning Committee		
				Primary POC	Secondary POC	NFIP FPA
Sussex County HMP Steering Committee	Michael F. Strada	Sheriff/OEM Coordinator	X			
	Robert Haffner	Division of Emergency Management	X	X		
	Jen Van Der Wende	Division of Emergency Management	X		X	
	Scott House	Sussex County Division of Public Works	X			
	Gregory V. Poff	Sussex County Administrator, Sussex	X			

Table 2-2. Steering and Planning Committee Members

Jurisdiction	Name	Title	Steering Committee	Planning Committee Primary POC	Planning Committee Secondary POC	Planning Committee NFIP FPA
		County Department of Central and Shared Services				
	William J. Koppenaal	Sussex County Engineering Department	X			
	Tom Drabic	Sussex County Division of Planning	X			
	Carol Novrit	Sussex County Health and Human Services – Division of Health	X			
	Keith Nelson	Sussex County Facilities Management	X			
	Stepher Komar	Rutgers Cooperative Extension of Sussex County	X			
	Manny Ayers	Newton Medical Center	X			
	Fred Mamay	Sussex County Community College	X			
	Sandra Meyers	Upper Delaware Conservation District (former Sussex County Soil and Water Conservation District)	X			
	George Loudis	Andover Township	X			
	Joe Konopinski	Wantage Township	X			
Planning Committee						
Sussex County	Robert Haffner	Division of Emergency Management		X		
	Jen Van Der Wende	Division of Emergency Management			X	
Andover Borough	John Hoag	Emergency Management Coordinator		X		
	Jessica Casella	Deputy Emergency Management Coordinator			X	
	Harold Pellow	Engineer				X
Andover Township	Chief Eric Danielson	Emergency Management Coordinator		X		
	Ptl. Georgios Laoudis	Deputy Coordinator			X	
	Corey Stoney	Township Engineer				X
Branchville Borough	Jeff Lewis	OEM Coordinator		X		
	Kate Leissler	Borough Clerk			X	
	Dave Simmons	Engineer				X
Byram Township	Thomas Koundry	Emergency Management Coordinator		X		X
	Ken Burke	Deputy Emergency Management Coordinator			X	
Frankford Township	Jeff Lewis	OEM Coordinator		X		
	Scott Klosterhoff	Deputy OEM Coordinator			X	
	Harold E. Pellow	Engineer				X

Table 2-2. Steering and Planning Committee Members

Jurisdiction	Name	Title	Steering Committee	Planning Committee Primary POC	Planning Committee Secondary POC	Planning Committee NFIP FPA
Franklin Borough	Jim Williams	OEM Coordinator		X		
	Brian VanDenBroek	DPW Supervisor			X	
	Deborah Bonanno	Administrator				X
Fredon Township	Keith Festa	OEM Coordinator		X		X
	Glenn Deitz	Third OEM Coordinator			X	
Green Township	Mark Zschack	Municipal Clerk/Administrator		X		
	Margaret “Peg” Phillips	Mayor			X	
	Cory Stoner	Township Engineer				X
Hamburg Borough	Keith Sukennikoff	OEM Coordinator		X		
	Michael Postorino	Public Safety/Police Director			X	
	John Ruschke	Borough Engineer				X
Hampton Township	Edward Hayes	Township Emergency Management Coordinator		X		
	Jessica M. Caruso	Administrator			X	
	Harold E. Pellow	Engineer				X
Hardyston Township	William Hickerson	OEM Coordinator		X		
	Carrine Piccolo-Kaufer	Township Manager/Planner			X	
	Joseph Butto	Construction				X
Hopatcong Borough	Wade Crowley	OEM Coordinator		X		
	Ron Tappan	Administrator			X	
	William O'Connor	Construction Official				X
Lafayette Township	Richard Hughes	Committeeman/Emergency Management Coordinator		X		
	Bill Macko	Road Foreman/Roads			X	
	Debra Card	Zoning Officer/Zoning				X
Montague Township	David Coss	OEM Coordinator				
	Eileen DeFabiis	Clerk		X		
	Robert Huber	Construction Official/Plumbing Sub-Code Official			X	
Town of Newton	Dan Finkle	Deputy OEM Coordinator		X		X
	Ken Teets	OEM Coordinator			X	
	Cory Stoner	Town Engineer				X
Ogdensburg Borough	Richard Keslo	Emergency Management		X		
	George P. Hutnick	Mayor			X	
	Mike Vreeland	Borough Engineer				X
Sandyston Township	Shane Houghtaling	Emergency Management		X		
	Amanda F. Lobban	Municipal Clerk			X	
	Robert W. Huber	Construction Official				X
Sparta Township	Neil Spidaletto	OEM Coordinator		X		
	William Close	Deputy OEM Coordinator			X	

Table 2-2. Steering and Planning Committee Members

Jurisdiction	Name	Title	Steering Committee	Planning Committee Primary POC	Planning Committee Secondary POC	Planning Committee NFIP FPA
	Stan Puszcz, P.E.	Township Engineer				X
Stanhope Borough	Brian McNeilly	Borough Administrator		X		
	Eric Keller	Borough Engineer			X	
	Thomas Pershouse	Construction Official				X
Stillwater Township	Lisa Chammings	Mayor/OEM		X		
	Robert Wolfe	Deputy OEM			X	
	Arlene Fisher	Zoning Officer				X
Sussex Borough	Floyd Southard	OEM Coordinator		X		
	Robert Regavich	Deputy OEM			X	
	Kevin Kervatt	Zoning Officer				X
Vernon Township	Ken Clark	OEM Coordinator		X		
	Dan Young	Deputy OEM Coordinator/Police Chief			X	
	Robert Westenberger	Construction Official				X
Walpack Township	Victor Maglio, Mayor	Victor Maglio, Mayor		X		
	Michael Vreeland	Township Engineer, Van Cleef Engineering			X	X
Wantage Township	Joseph Konopinski	OEM Coordinator		X		
	Michael Restel	Administrator			X	
	Harold E. Pellow	Engineer				X

Notes: POC = Point of Contact; NFIP FPA=National Flood Insurance Program Floodplain Administrator

Each municipality received a copy of the “Planning Partner Expectations” which outlined the responsibilities of the participants and the agreement of the partners to authorize the Steering Committee to represent the jurisdiction in the completion of certain planning elements. Please note that while Steering Committee members are also part of the overall project Planning Partnership fulfilling these responsibilities on behalf of Sussex County. The Planning Partnership was collectively charged with the following:

- Identify municipal representatives to serve as the planning points of contact.
- Support the Steering Committee selected to oversee the development of the plan.
- Provide representation at municipal planning committee meetings.
- Provide data and information about their community as requested to update their jurisdictional annex.
- Support public outreach efforts in their community.
- Assist with the identification of stakeholders within their community that should be informed and potentially involved with the planning process.
- Review draft sections when requested and provide common and input as appropriate.
- Prepare and submit a jurisdictional annex to the Steering Committee/contract consultant.
- Identify specific mitigation actions to address each of the natural hazards posing high or medium risk to their community.
- Involve the local NFIP floodplain administrator in the planning process.
- Adopt the HMP by resolution of the governing body after FEMA conditional approval.
- Provide the Steering Committee with summary or municipal staff and volunteer labor spent on the planning process on a monthly basis.

The jurisdictional LOIP identifies the above "Planning Partner Expectations" as serving to identify those activities comprising overall participation by jurisdictions throughout the planning process. The jurisdictions in Sussex County have differing levels of capabilities and resources available to apply to the plan update process, and further have differing exposure and vulnerability to the hazard risks being considered in this plan. Sussex County's intent was to encourage participation by all-inclusive jurisdictions, and to accommodate their specific needs and limitations while still meeting the intents and purpose of plan participation. Such accommodations have included the establishment of a Steering Committee and engaging a contract consultant to assume certain elements of the planning process on behalf of the jurisdictions, and to provide additional and alternative mechanisms to meet the purposes and intent of mitigation planning.

Ultimately, jurisdictional participation is evidenced by a completed annex (chapter) of the HMP (Section 9) wherein the jurisdictions have identified their planning points of contact, evaluated their risk to the hazards of concern, identified their capabilities to effect mitigation in their community, and identified and prioritized an appropriate suite of mitigation initiatives, actions, and projects to mitigate their natural hazard risk; and eventually by the adoption of the updated plan via resolution.

Appendix B (Participation Documentation) identifies those individuals who represented their jurisdictions during this planning effort and indicates how they contributed to the planning process. This matrix is intended to give a broad overview of who attended meetings and when input was provided. All participants were encouraged to attend the Kick-off Meeting, Risk Assessment and Mitigation Action Workshop. During the planning process the planning consultant contacted each participant to offer support, explain the process, meet individually to collect updated information and to facilitate the submittal and review of critical documents.

All municipalities actively participate in the National Flood Insurance Program (NFIP) and have designated NFIP Floodplain Administrators (FPA). The FPAs were informed of the planning process, were provided the opportunity to review the plan including the jurisdictional annex and provide direct input to the plan update. Local FPAs are identified in the Points of Contact and Administrative and Technical portions of the jurisdictional annexes in Section 9 (Jurisdictional Annexes).

2.2.2 PLANNING ACTIVITIES

Members of the Planning Partnership (individually and as a whole), as well as key stakeholders, convened and/or communicated regularly to share information and participate in workshops to identify hazards; assess risks; review existing inventories of and identify new critical facilities; assist in updating and developing new mitigation goals and strategies; and provide continuity through the process to ensure that natural hazards vulnerability information and appropriate mitigation strategies were incorporated. All members of the Steering Committee and Planning Partnership had the opportunity to review the draft plan and supported interaction with other stakeholders and assisted with public involvement efforts.

A summary of committee meetings (Steering Committee and Planning Partnership) held and key milestones met during the development of the HMP update is included in Table 2-3 that also identifies which DMA 2000 requirements the activities satisfy. Documentation of meetings (e.g., agendas, sign-in sheets, meeting notes) are in Appendix C (Meeting Documentation). Table 2-3 identifies only the formal meetings held during plan development but does not reflect all planning activities conducted by individuals and groups throughout the planning process. In addition to these meetings, each jurisdiction had several individual meetings (both in person and via teleconference) to work on their jurisdictional annexes (Section 9). Further, there was a great deal of communication between the County, committee members, and the contract consultant through individual local virtual meetings, electronic mail (email), and by phone.

After completion of the HMP update, implementation and ongoing maintenance will become a function of the Planning Partnership as described in Section 7 (Plan Maintenance). The Planning Partnership is responsible for reviewing the HMP and soliciting and considering public comment as part of the five-year mitigation plan update.

Table 2-3. Summary of Mitigation Planning Activities / Efforts

Date	DMA 2000 Requirement	Description of Activity	Participants
July 22, 2020	N/A	Pre-Kick Off Meeting with County	Sussex County DEM and Tetra Tech
August 18, 2020	1b, 2, 3a, 4a	Steering Committee Meeting #1: Review of mitigation and the 2016 HMP; Review of Steering Committee guidelines; Project schedule and data request; Hazards of concern review and updated; Stakeholders identified; Outreach was discussed (social media, website, brochures); Review of goals and objectives.	See Appendix C
August 24, 2020	1b, 2, 3, 4	Sussex Rural Electric Coop: A stakeholder meeting was held with Sussex Rural Electric Coop to discuss capabilities, vulnerabilities and mitigation actions.	Sussex Rural Electric Coop and Tetra Tech
August 2020	1b, 2	Sussex County distributed stakeholder surveys to collect vulnerabilities, capabilities and mitigation actions from academia, emergency services, transportation sector, utilities, hospital and health care, business/commerce and social services.	See Section 2.3 (Stakeholder Outreach and Involvement) and Appendix D
September 2019	2	Multi-lingual (English and Spanish) social media posts released (Facebook and Twitter) regarding the commencement of the HMP update and the Sussex County dedicated webpage for mitigation was updated with including announcing the first public kickoff meeting in October. The HMP project website also contains links to the HMP brochure and citizen and stakeholder surveys.	See Appendix D
September 10, 2020	1b, 2, 3a-c, 3e, 4a, 4b	Planning Partnership Kickoff Meeting – *open to the public:* Importance of mitigation and HMP; Participation Requirements; Review of Steering Committee decisions on August 18; Hazards of concern identification and previous events exercise.	See Appendix C
October 22, 2020	1b, 2, 3a, 4a	Steering Committee #2: Project status update; Linkage procedures; Hazard ranking methodology; County hazard ranking; Strengths, Weaknesses, Obstacles and Opportunities (SWOO) exercise.	See Appendix C
October 28, 2020	1b, 2, 3a, 3b, 3c, 3d, 3e	Planning Partnership Risk Assessment Meeting – *open to the public*. Presentation of draft risk assessment results, hazard ranking exercise, SWOO exercise for high-ranked hazards, introduction to development of problem statements.	See Appendix C
November 12, 2020	1b, 2, 4a, 4b, 4c	Planning Partnership Mitigation Strategy Workshop – *open to the public* Review of FEMA and State mitigation strategy requirements; Problem statement development; Mitigation resources distributed including mitigation catalog and critical facility/lifeline risk assessment results; Review of Mitigation Action Worksheets.	See Appendix C
September 2020 – March 2021	2, 3, 4	Individual annex support meetings via in-person or virtual (teleconference)	See Appendix C

Date	DMA 2000 Requirement	Description of Activity	Participants
March 2021	2, 3, 4	Steering Committee reviewed the draft HMP and considered stakeholder comments received to date	Steering Committee; see Appendix C
March 29, 2021	2, 3, 4, 5	Steering Committee meeting to review and discuss comments on the draft HMP prior to public review.	Steering Committee; see Appendix C
April 5 through May 7, 2021	2	Draft HMP posted to public project website. All plan participants were notified and asked to assist with the public outreach including social media. Letters to neighboring Counties and stakeholders, were distributed.	Public and Stakeholders
May 13, 2021	4b, 4c, 5b	Meeting with County DEM; no public and stakeholder comments were received. Initiate collection of signature pages from participants.	Sussex County DEM and Tetra Tech
May 21, 2021	2	HMP submitted to NJOEM	NJOEM
Anticipated June 2021	2	HMP submitted to FEMA Region II	FEMA Region II
Anticipated Fall 2021	1a	Plan adoption by resolution by the governing bodies of all participating municipalities	All plan participants

Note: Each number in column 2 identifies specific DMA 2000 requirements, as follows:
1a – Prerequisite – Adoption by the Local Governing Body
1b – Public Participation
2 – Planning Process – Documentation of the Planning Process
3a – Risk Assessment – Identifying Hazards
3b – Risk Assessment – Profiling Hazard Events
3c – Risk Assessment – Assessing Vulnerability: Identifying Assets
3d – Risk Assessment – Assessing Vulnerability: Estimating Potential Losses
3e – Risk Assessment – Assessing Vulnerability: Analyzing Development Trends
4a – Mitigation Strategy – Local Hazard Mitigation Goals
4b – Mitigation Strategy – Identification and Analysis of Mitigation Measures
4c – Mitigation Strategy – Implementation of Mitigation Measures
5a – Plan Maintenance Procedures – Monitoring, Evaluating, and Updating the Plan
5b – Plan Maintenance Procedures – Implementation through Existing Programs
5c – Plan Maintenance Procedures – Continued Public Involvement

2.3 STAKEHOLDER OUTREACH AND INVOLVEMENT

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the HMP, including all planning partners. Diligent efforts were made to assure broad regional, county and local representation in this planning process. To that end, a comprehensive list of stakeholders was developed with the support of the Planning Partnership. Stakeholder outreach was performed early on, and continually throughout the planning process. This HMP update includes information and input provided by these stakeholders where appropriate, as identified in the references.

This subsection discusses the various stakeholders that were invited to participate in the development of this HMP update, and how these stakeholders participated and contributed. This summary listing cannot possibly represent the total of stakeholders that were aware of and/or contributed to this HMP update, as outreach efforts were being made, both formally and informally, throughout the process by the many planning partners involved in the effort, and documentation of all such efforts is impossible. Instead, this summary is intended to demonstrate the scope and breadth of the stakeholder outreach efforts made during the plan update process:

- All Planning Partnership meetings were open to the public and advertised via the Sussex County's website and social media platforms.

- Municipalities distributed the HMP brochure digitally, citizen and stakeholder surveys and link to the County HMP webpage, where feasible.
- Distributed a stakeholder survey via social media, Sussex County's mitigation webpage and through the StoryMap to provide input regarding vulnerabilities, capabilities and mitigation projects.
- Posted draft plan on the Sussex County DEM mitigation website and advertised using social media and on the StoryMap.
- Distributed letters to regional stakeholders and neighboring counties to participate in meetings, contribute to the development of the HMP, and review the draft HMP.

Federal Agencies

Please see Appendix B (Participation Documentation) for further details regarding federal agency participation. All responses to the stakeholder surveys may be found in Appendix D (Public and Stakeholder Outreach).

FEMA Region II: Provided updated planning guidance; provided summary and detailed NFIP data for planning area; conducted plan review.

Information regarding hazard identification and the risk assessment for this plan update were requested and received or incorporated by reference from the following agencies and organizations:

- National Climatic Data Center (NCDC)
- National Hurricane Center (NHC)
- National Oceanic and Atmospheric Administration (NOAA)
- National Weather Service (NWS)
- Storm Prediction Center (SPC)
- U.S. Army Corps of Engineers (USACE)
- U.S. Census Bureau
- U.S. Department of Agriculture (USDA)
- U.S. Department of Health and Human Services
- U.S. Environmental Protection Agency (USEPA)
- U.S. Geological Survey (USGS)

State Agencies

New Jersey State Police Office of Emergency Management (NJOEM): Administered the planning grant; provided updated planning guidance; attended the September 2020 Kickoff Meeting, October 2020 Risk Assessment Meeting, and November 2021 Mitigation Strategy Workshop; worked with local jurisdictions in developing their updated mitigation strategy; consulted with individual municipalities interested in applying for FEMA Hazard Mitigation Assistance grants; and provided review of the draft HMP update.

New Jersey Department of Environmental Protection (NJDEP): The NJDEP was requested information regarding dams in Sussex County; provided the Community Assistance Visit dates and associated NFIP information for all jurisdictions. In addition, the Bureau of Dam Safety, State Park Service, and Bureau of Flood Engineering were asked to take the stakeholder survey. The Bureau of Dam Safety attended the September 2020 Kickoff Meeting and October 2020 Risk Assessment Meeting.

New Jersey Department of Transportation (NJDOT): The NJDOT Office of Emergency Management attended the September 2020 Kickoff Meeting and was asked to take the stakeholder survey.

Please see Appendix B (Participation Documentation) for further details regarding state agency participation. All responses to the surveys may be found in Appendix D (Public and Stakeholder Outreach).

County and Regional Agencies and Commissions and Non-Profits

County

Several County departments were represented on the Steering Committee, and additional departments and divisions actively involved in the HMP update planning process; refer to Table 2-2 and Appendices C and D. As previously noted, Steering Committee members were invited to all meetings, were provided updates via email communication and invited to review the draft HMP. In addition, the following County employees were emailed an announcement regarding the HMP commencement and invited to participate in the citizen survey; refer to Appendix D (Public and Stakeholder Participation).

- Sussex County Sheriff's Office
- Sussex County Division of Emergency Management
- Sussex County Division of Public Works
- Sussex County Administrator
- Sussex County Department of Central and Shared Services
- Sussex County Engineering Department
- Sussex County Division of Planning
- Sussex County Division of Planning and Economic Development
- Sussex County Health and Human Services – Division of Health
- Sussex County Facilities Management

Regional and Local Stakeholders

All Planning Partnership meetings were announced on the Sussex County HMP project website and posted on social media to invite residents and stakeholders including the following sectors as outlined below. In addition, the County and municipal representatives emailed regional and local stakeholders requesting their participation in stakeholder sector-specific surveys to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP. Refer to Appendix C (Participation Documentation) for further details regarding regional and local stakeholder agency attendance at meetings and Appendix D (Public and Stakeholder Outreach) for additional details on the public and stakeholder outreach, including responses received to the surveys.

Emergency Services

Numerous Municipal OEM Coordinators participated as points of contact for municipalities and contributed to the plan. Emergency services stakeholders were contacted directly by Sussex County and participating municipalities to take a stakeholder survey which included questions regarding capabilities, vulnerabilities and mitigation projects/actions. Overall, two responses were received on this survey as summarized in Appendix D. The surveys were distributed to the following:

- Municipal OEM Coordinators
- All EMS agencies in Sussex County
- Sussex County Fire Coordinator
- Sussex County EMS Coordinator
- Sussex County Sheriff's Department

Health and Social Services

The following hospital, health care and social service providers were contacted directly by Sussex County and participating municipalities to take a stakeholder survey which included questions regarding capabilities, vulnerabilities and mitigation projects/actions. In addition, municipalities were asked to distribute these custom surveys to establishments in their jurisdictions.

- American Red Cross
- Newton Medical Hospital – member of the Steering Committee

Utilities

The following stakeholders were contacted directly and invited to the September 2020 Kickoff Meeting and October 2020 Risk Assessment Meeting. In addition, they were emailed directly and invited to take a stakeholder survey which included questions regarding mitigation capabilities, vulnerabilities and mitigation projects/actions. One survey response was received as of February 8, 2021.

- Sussex Rural Electric Coop – attended the September 2020 Kickoff Meeting and met separately to discuss services, vulnerabilities and historic impacts in the County
- PSE&G
- JCP&L – attended the September 2020 Kickoff Meeting
- New Jersey American Water
- Sussex County Municipal Utilities Authority
- Musconetcong Sewer Authority District
- Hardyston Township Municipal Utilities Authority
- Town of Newton Wastewater Utility
- Aqua NJ – Wallkill (owns Wallkill Sewer Company)
- Andover Utility Company Inc.
- Montague Sewer Company (owned by Utilities Inc.)
- Vernon Township Municipal Utilities Authority

Business Commerce

The Sussex County Chamber of Commerce and Sussex County Tourism were invited to the September 2020 Kickoff meeting and October 2020 Risk Assessment meeting. In addition, they were contacted via email to participate in the stakeholder survey which included questions regarding mitigation capabilities, vulnerabilities and mitigation projects/actions. In addition, municipal representatives on the Planning Partnership were asked to distribute this survey to their local chambers of commerce and large employers. No responses were received as of February 8, 2021.

Transportation

Representatives at the following transportation and public works agencies were emailed directly and invited to the September 2020 Kickoff Meeting and October 2020 Risk Assessment Meeting. In addition, these stakeholders were invited to participate in the stakeholder survey which included questions regarding mitigation capabilities, vulnerabilities and mitigation projects/actions. In addition, municipalities were asked to distribute this survey to their local public works departments. No responses were received as of February 8, 2021.

- New Jersey Transit
- North Jersey Transportation Planning Authority
- Skylands Ride Public Transportation

Academia

The following academic institutions were invited to the September 2020 Kickoff Meeting and October 2020 Risk Assessment Meeting. In addition, they were asked via email to take a stakeholder survey which included questions regarding mitigation capabilities, vulnerabilities and mitigation projects/actions. In addition, all municipalities were asked to distribute this survey to their local school districts. No responses were received as of February 8, 2021.

- Rutgers University
    - Office of the State Climatologist – provided information regarding funding sources that support this office and identified areas of need
    - School of Planning and Public Policy
    - Rutgers Cooperative Extension Water Resources Program
- Sussex County Community College (member of the Steering Committee)

Regional Agencies and Neighboring Counties

The following regional agencies and neighboring counties were invited to attend the September 2020 Kickoff Meeting and October 2020 Risk Assessment Meeting. In addition, they were invited via email to take a stakeholder survey which included questions regarding mitigation capabilities, vulnerabilities and mitigation projects/actions. In addition, Sussex County sent letters to each of the neighboring County OEM departments as well as the County Administrators. Additional participation is noted below:

- New Jersey Highlands Council – participated in the Stakeholder survey
- Sustainable Jersey
- New Jersey Future
- Upper Delaware Conservation District – member of the Steering Committee
- Morris County, New Jersey
- Warren County, New Jersey
- Passaic County, New Jersey
- Pike County, Pennsylvania – the Pike County OEM and Planning Departments attended the September 2020 Kickoff Meeting and October Risk Assessment Meeting, respectively
- Monroe County, Pennsylvania
- Orange County, New York
- Sullivan County, New York

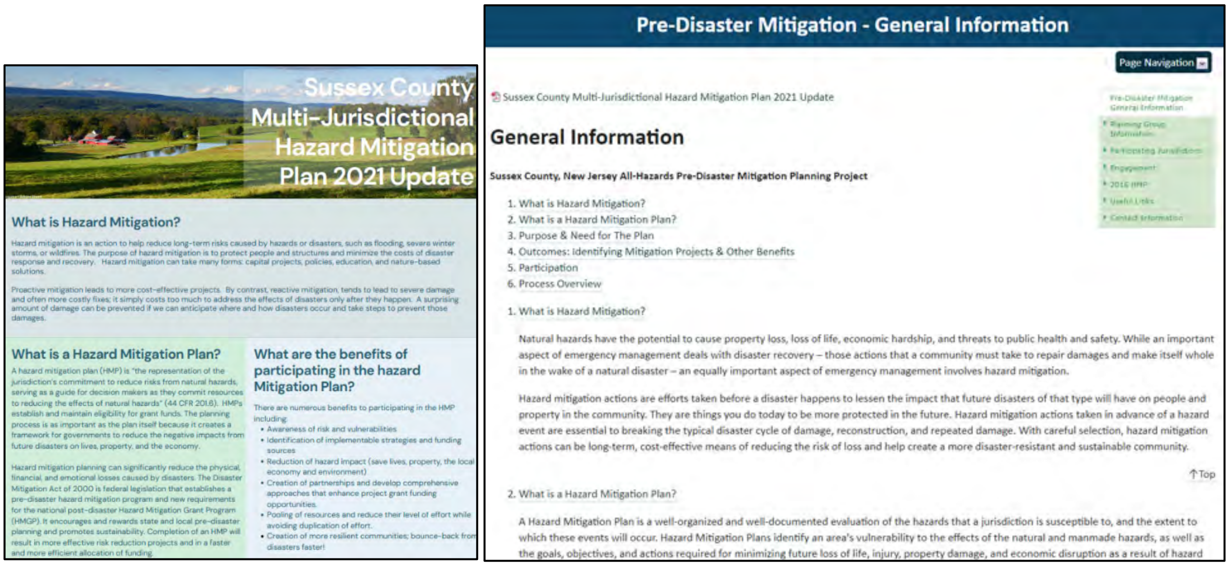
2.4 PUBLIC PARTICIPATION - CITIZEN INVOLVEMENT

In order to facilitate better coordination and communication between the Planning Partnership and citizens and to involve the public in the planning process, it was determined that meeting dates/locations will be made available to the public via the Sussex County DEM website dedicated to the HMP update and social media; and the draft HMP available on the Sussex County website. The participating partners also feel that community input on the HMP will increase the likelihood of hazard mitigation becoming one of the standard considerations in the evolution and growth of the County.

The Planning Partnership has made the following efforts toward public participation in the development and review of the HMP:

- The Sussex County DEM created a dedicated website for this project. The website went live in September 2020 and was continuously updated throughout the planning process. The public website contains a project overview, meeting announcements, a brochure, draft documents for review and comment, and a link to the citizens and stakeholder surveys; refer to Figure 2-1 for a screenshot of the public website and brochure.

Figure 2-1. Screenshots of the Brochure and Website for the 2021 HMP Update



- All hazard mitigation Planning Partnership meetings were open to the public and advertised on the Sussex County HMP website and through social media (Facebook and Twitter). The citizen survey was available through the website, social media and StoryMap as well; refer to Figure 2-2 for an example post. Additional examples of County and municipal outreach are presented in Appendix D.

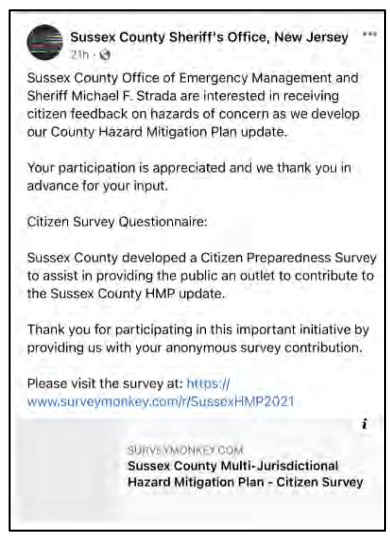


Figure 2-2. Example Social Media Post to Advertise the Resident Survey

- The Sussex County issued an official News Release that announced the commencement of the HMP update and invited the public to attend the kickoff meeting and take the citizen survey. This News Release was also posted on the County website; refer to Appendix D for a copy.

- An on-line natural hazards preparedness citizen survey was developed to gauge household preparedness that may impact the County and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards. The questionnaire asked quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs. The questionnaire also asked several demographic questions to help analyze trends. The questionnaire has been available on the public website since August 2020, and further advertised on additional County and municipal websites and on printed materials. In addition, residents were notified of its availability via social media (Facebook and Twitter) with a direct link from the StoryMap. Reponses were collected and shared with the Planning Partnership at the October 2020 and November 2020 meetings to inform problem statement development and mitigation action development. As of February 8, 2021, 243 residents responded to the survey. Appendix D summarizes public input received through the website, the online survey, and other sources.

- In October 2020, a StoryMap was released on the County's mitigation webpage and through social media (Facebook and Twitter) to provide additional information regarding the Sussex County HMP update and serve as another source of risk communication to residents. The Story Map summarizes the planning process, provides links to the citizen and stakeholder surveys and had individual pages for each hazard of concern. The pages for each hazard of concern provide a brief overview of each hazard and hyperlinks to additional resources, when available. For the spatial hazards, residents can dynamically pan a map to view the hazard area relevant to areas in the County.

- A hazard mitigation planning brochure was developed to inform the public of the planning process, provide local contact information, and encourage the public to review the plan and provide input. This brochure was provided to all plan participants in electronic format to distribute in their offices and communities; refer to Figure 2-1 and Appendix D.

- Sussex County residents were provided an opportunity to comment on the draft HMP before submittal to NJOEM and FEMA. The HMP was posted on the HMP public website on April 6, 2021 for review. All jurisdictions were requested to assist with advertising the plan was posted via their websites and social media as shared in Appendix D. The public comment period was opened through May 7, 2021. No public comments were received.

Additional examples of public outreach efforts by the Planning Partnership, and results of surveys distributed, are presented in Appendix D (Public and Stakeholder Outreach Documentation).

2.5 INCORPORATION OF EXISTING PLANS, STUDIES, REPORTS AND TECHNICAL INFORMATION

The Sussex County HMP strives to use the best available technical information, plans, studies and reports throughout the plan process to support hazard profiling; risk and vulnerability assessment; review and evaluation of mitigation capabilities; and the identification, development and prioritization of county and local mitigation strategies.

The asset and inventory data used for the risk and vulnerability assessments is presented in the County Profile (Section 3). Details of the source of this data, along with technical information on how the data was used to develop the risk and vulnerability assessment, is presented in the Risk Assessment, specifically in Section 4.2 Methodology and Tools, as well as throughout the hazard profiles in Section 4.3 (Hazard Profiles). Further, the source of technical data and information used may be found within the References section.

Plans, reports, and other technical information were identified and provided directly by the County, participating jurisdictions, and numerous stakeholders involved in the planning effort, as well as through independent research by the planning consultant. The County and participating jurisdictions were tasked with updating the inventory of their Planning and Regulatory capabilities in Section 9 (Jurisdictional Annexes) and providing relevant planning and regulatory documents, as applicable. Relevant documents, including plans, reports, and ordinances were reviewed to identify the following:

- Existing County and municipal capabilities.
- Needs and opportunities to develop or enhance capabilities, which may be identified within the County or local mitigation strategies.
- Mitigation-related goals or objectives considered in the review and update of the overall Goals and Objectives in Section 6 (Mitigation Strategy).

- Proposed, in-progress, or potential mitigation projects, actions, and initiatives to be incorporated into the updated County and local mitigation strategies.

The following local regulations, codes, ordinances, and plans were reviewed during this process to develop mitigation planning goals, objectives, and strategies that are consistent across local and regional planning and regulatory mechanisms to accomplish complementary and mutually supportive strategies:

- Master Plans
- Building Codes
- Zoning and Subdivision Ordinances
- NFIP Flood Damage Prevention Ordinances
- Site Plan Requirements
- Stormwater Management Plans
- Emergency Management and Response Plans
- Land Use and Open Space Plans
- Capital Plans
- New Jersey State Hazard Mitigation Plan (2019)

NFIP Flood Damage Prevention Ordinances were reviewed to determine if the ordinance included the state-mandated 1-foot freeboard requirement as discussed further in Section 9 (Jurisdictional Annexes). In April 2021, NJDEP released guidance on the use of the Model Code Coordinated Ordinance. Municipalities will update their ordinances accordingly as per State requirements and coordinate with the State on the implementation of this integration action.

2.6 INTEGRATION WITH EXISTING PLANNING MECHANISMS AND PROGRAMS

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the County there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those mechanisms.

Section 5 (Capability Assessment) provides a summary and description of the existing plans, programs, and regulatory mechanisms at all levels of government (federal, state, county, and local) that support hazard mitigation within the County. Within each jurisdictional annex in Section 9, the County and each participating jurisdiction identified how they integrated hazard risk management into their existing planning, regulatory, and operational/administrative framework (*integration capabilities*) and how they intend to promote this integration (*integration actions*).

A further summary of these continued efforts to develop and promote a comprehensive and holistic approach to hazard risk management and mitigation is presented in Section 7 (Plan Maintenance).

2.7 CONTINUED PUBLIC INVOLVEMENT

Sussex County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. This HMP update will be made available for review on the HMP public website. Each jurisdiction’s elected official shall be responsible for receiving, tracking, and filing public comments regarding this HMP update.

A notice regarding annual updates of the plan and the location of plan copies will be publicized annually after the annual plan evaluation meeting (refer to Section 7 – Plan Maintenance) and posted on the public website at https://www.sussex.nj.us/cn/webpage.cfm?TPID=11091

The public will be provided an opportunity to comment on the HMP update as a part of the annual mitigation planning evaluation process and the next five-year mitigation plan update. The HMP Coordinator (currently Director Robert Haffner, Division of Emergency Management) is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the 5-year plan update as appropriate; however, members of the Planning Partnership will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary. The purpose of these meetings would be to provide the public an opportunity to express concerns, opinions, and ideas about the HMP.

Further details regarding continued public involvement are provided in Section 7 (Plan Maintenance).

After completion of this HMP update, implementation and ongoing maintenance will continue to be a function of the Planning Partnership. The Planning Partnership will review the plan and accept public comment as part of an annual review and as part of five-year mitigation plan updates.

A notice regarding annual updates of the plan will be publicized annually after the HMP Committee's annual evaluation and posted on the public web site.

Director Robert Haffner has been identified as the ongoing County HMP Coordinator (see Section 7), and is responsible for receiving, tracking, and filing public comments regarding this HMP update. Contact information is:

Mailing Address:	Sussex County Division of Emergency Management 135 Morris Turnpike, Newton, NJ 07860
Contact Name:	Director Robert Haffner
Email Address:	rhaffner@sussexcountysheriff.com

SECTION 3. COUNTY PROFILE

This profile describes the general information of Sussex County (physical setting, population and demographics, general building stock, and land use and population trends) and critical facilities located in Sussex County. In Section 4 (Risk Assessment), specific profile information is presented and analyzed to develop an understanding of the study area, including the economic, structural, and population assets at risk and the particular concerns that may be present related to hazards analyzed (for example, a high percentage of vulnerable persons in an area).

2021 HMP CHANGES

- The "County Profile" is now located in Section 3; previously located in Section 4. It contains updated information regarding the County's physical setting, population and demographics and trends, general building stock, land use and trends, potential new development and critical facilities. This includes U.S. Census American Community Survey (ACS) 2018 data and additional information regarding the New Jersey Highlands Region in the Development Trends/Future Development subsection.
- The critical facility inventory was expanded to include community lifelines using FEMA's lifeline definition.

3.1 GENERAL INFORMATION

Sussex County is the northern-most county in the State of New Jersey. It is bordered to the north by New York State, to the south by Warren and Morris Counties, to the east by Passaic County and to the west by the Delaware River and the Commonwealth of Pennsylvania. The County is made up of 24 jurisdictions that span approximately 536 square miles. Historically, Sussex County has been a scenic, rural county with small municipalities, plenty of open space, and agriculture. Figure 3-1 illustrates Sussex County, its municipalities, and the surrounding jurisdictions.

3.1.1 PHYSICAL SETTING

This section presents the physical setting of Sussex County, including hydrography and hydrology, topography and geology, climate, and land use/land cover.

Hydrography and Hydrology

Numerous ponds, lakes, creeks, and rivers make up the waterscape of Sussex County. Most of the lakes in the County are found generally in two areas: along the eastern slope of the Kittatinny Ridge and in the Highlands province of eastern Sussex County. These areas are where topography and geology support the development of lakes. Most of the lakes serve recreational purposes and were developed as vacation areas in the past. The most prominent lakes in Sussex County include Lake Hopatcong (largest in New Jersey), Culvers Lake, Lake Owassa, Big Swartswood Lake, Lake Mohawk, Highland Lake, and Wawayanda Lake. Rivers and streams in Sussex County include: Delaware River, Wallkill River, Flat Brook, Paulins Kill, Pequest River, Musconetcong River, Clove Brook, Mill Brook, Kymer Brook, Lubbers Run, Papakating Creek, Pochuck Creek, Waywayanda Creek, Black Creek, Pequannock River, Pacack Brook, Russia Brook, and Rockaway River. Figure 3-1 illustrates the location of the waterbodies in the County.

Delaware River Basin

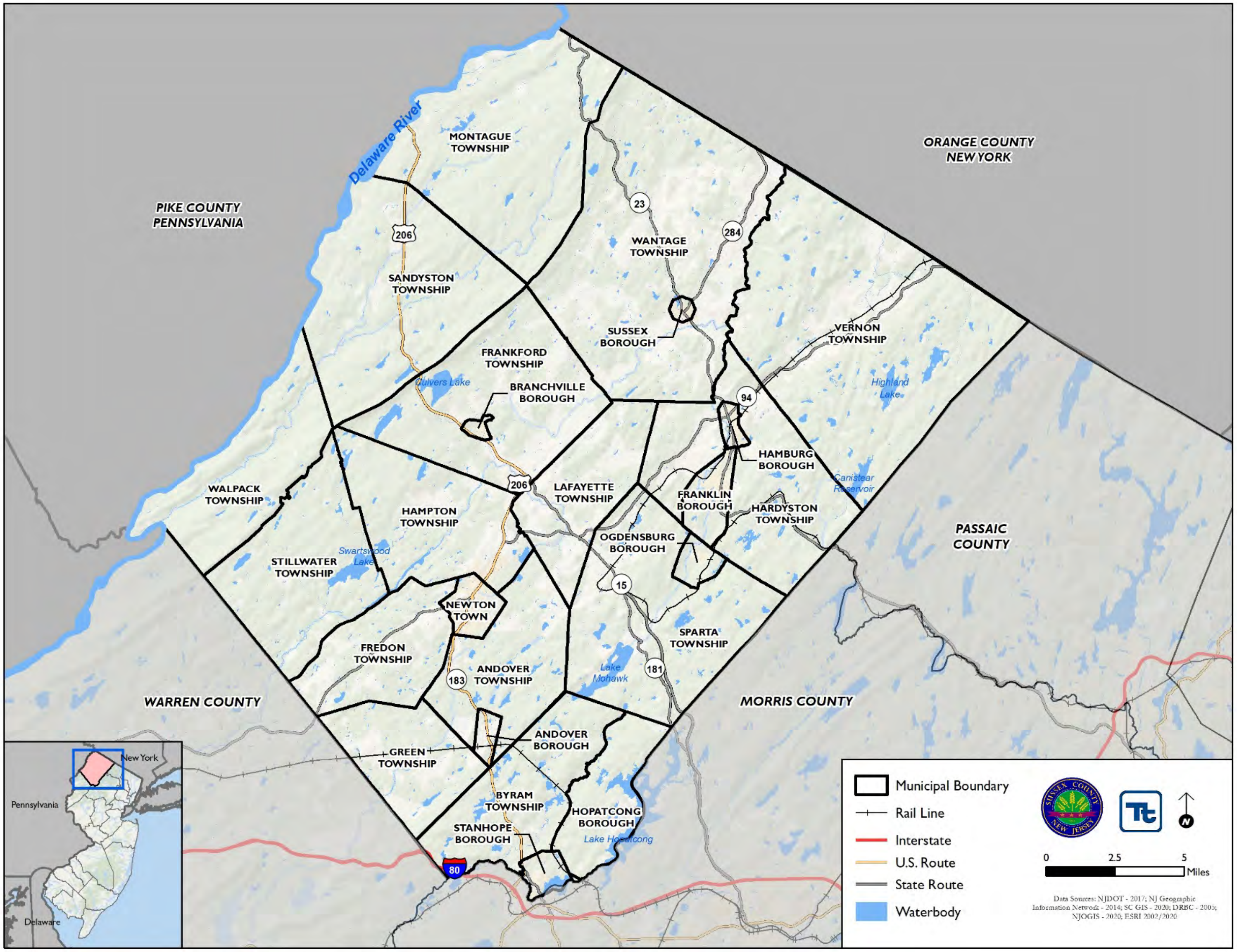
The Delaware River is the longest un-dammed river in the United States east of the Mississippi River. It runs and drains through parts of Pennsylvania, New Jersey, New York, and Delaware. The Delaware River extends

330 miles from the confluence of its east and west branches at Hancock, New York to the mouth of the Delaware Bay where it meets the Atlantic Ocean (Watershed Alliance 2019).

Overall, the Delaware River is fed by over 2,000 tributaries and spans approximately 13,600 square miles, including the 782 square mile Delaware Bay. Its hydrographic regions are divided between two main physiographic areas—the Appalachian Highlands and the Atlantic Coastal Plain. The Sussex County portion of the Delaware River falls in the Appalachian Highlands region, which consists primarily of consolidated sedimentary rock. The area's sub-region, known as Ridge and Valley, consists of mountain ridges in the north and rolling hills in the south.

Approximately 8.3 million people live in the Delaware River Basin, of which 23-percent reside in the State of New Jersey. The population in the Delaware River Basin is expected to increase 8.4-percent by 2030 and a portion of this increase is expected in Sussex County (Delaware River Basin Commission 2019).

Figure 3-1. Overview Map Sussex County, New Jersey



Watersheds

A watershed is the area of land that drains into a body of water such as a river, lake, stream, or bay. It is separated from other systems by high points in the area such as hills or slopes. It includes not only the waterway itself but also the entire land area that drains to it. Drainage basins generally refer to large watersheds that encompass the watersheds of many smaller rivers and streams.

In New Jersey, the state is divided into 20 Watershed Management Areas (WMA), which are made up of smaller watersheds. Sussex County is located in four of the 20 WMAs that are discussed further below: Upper Delaware (WMA 1); Wallkill (WMA 2); Pompton, Pequannock, Wanaque, Ramapo (WMA 3) and Upper Passaic, Whippany and Rockaway (WMA 6). Figure 3-1 illustrates the watersheds of Sussex County.

Watershed Management Area 1: Upper Delaware

WMA 1 includes portions of Sussex, Morris, and Hunterdon Counties and all of Warren County. This area is also known as the Upper Delaware River Watershed and encompasses 746 square miles in the northwest corner of New Jersey. Within WMA 1, there are six major drainage basins: Delaware River, Flat Brook, Paulins Kill, Pequest River, Lopatcong and Pohatcong River Drainage, and the Musconetcong River (NJDEP 2012).

In Sussex County, WMA 1 is located in the western and southern sections of the county and encompasses greater than half of the county's land area. Principal waterways in Sussex County's portion of WMA 1 include: Flat Book, Paulins Kill, Pequest River, and a short stretch of the Musconectong River (NJDEP 2012).

Watershed Management Area 2: Wallkill River Watershed

This WMA is also known as the Wallkill River Watershed and includes 11 Townships in Sussex County. The Wallkill River Watershed is unique in that its headwaters begin at Lake Mohawk in Sparta Township and then flow north into New York, eventually emptying into the Hudson River. Within WMA 2, there are four subwatersheds: the Wallkill River, Pochuck Creek, Papakating Creek and Rutgers Creek Tributaries (NJDEP 2012).

The Wallkill Watershed is approximately 208 square miles in area, and is comprised of a variety of land uses including rural and centralized residential development, agriculture, commercial, recreational and industrial usage. Also located within this watershed area is the Wallkill National Wildlife Refuge. The refuge watershed/wetlands complex provides migratory and nesting habitats for numerous birds and waterfowl and is home to several endangered species (NJDEP 2012).

WMA 2 occupies the northern and northeastern parts of Sussex County, extending south through Sparta and northern Byram Townships. The Wallkill River flows northeast into New York State, where it empties into the Hudson River near Kingston, New York. Major tributaries of the Wallkill River include Papakating Creek which begins its run in Frankford Township and Clove Brook which flows south from northern Wantage Township. Pochuck Creek is another major tributary which drains part of Vernon and Hardyston Townships east of Pochuck Mountain and enters the Wallkill River several miles into New York State (NJDEP 2012).

Watershed Management Area 3: Pompton, Pequannock, Wanaque, Ramapo Watersheds

WMA 3 is located within the Highlands Province of New Jersey. The Pequannock, Wanaque and Ramapo Rivers all flow into the Pompton River. The Pompton River is, in turn, a major tributary to the Upper Passaic River. WMA 3 contains some of the State's major water supply reservoir systems including the Wanaque Reservoir which is the largest surface water reservoir in New Jersey. There are four watersheds in WMA 3: Pompton, Ramapo, Pequannock and Wanaque River Watersheds. WMA 3 lies mostly in Passaic County but also includes parts of Bergen, Morris and Sussex Counties (NJDEP 2012).

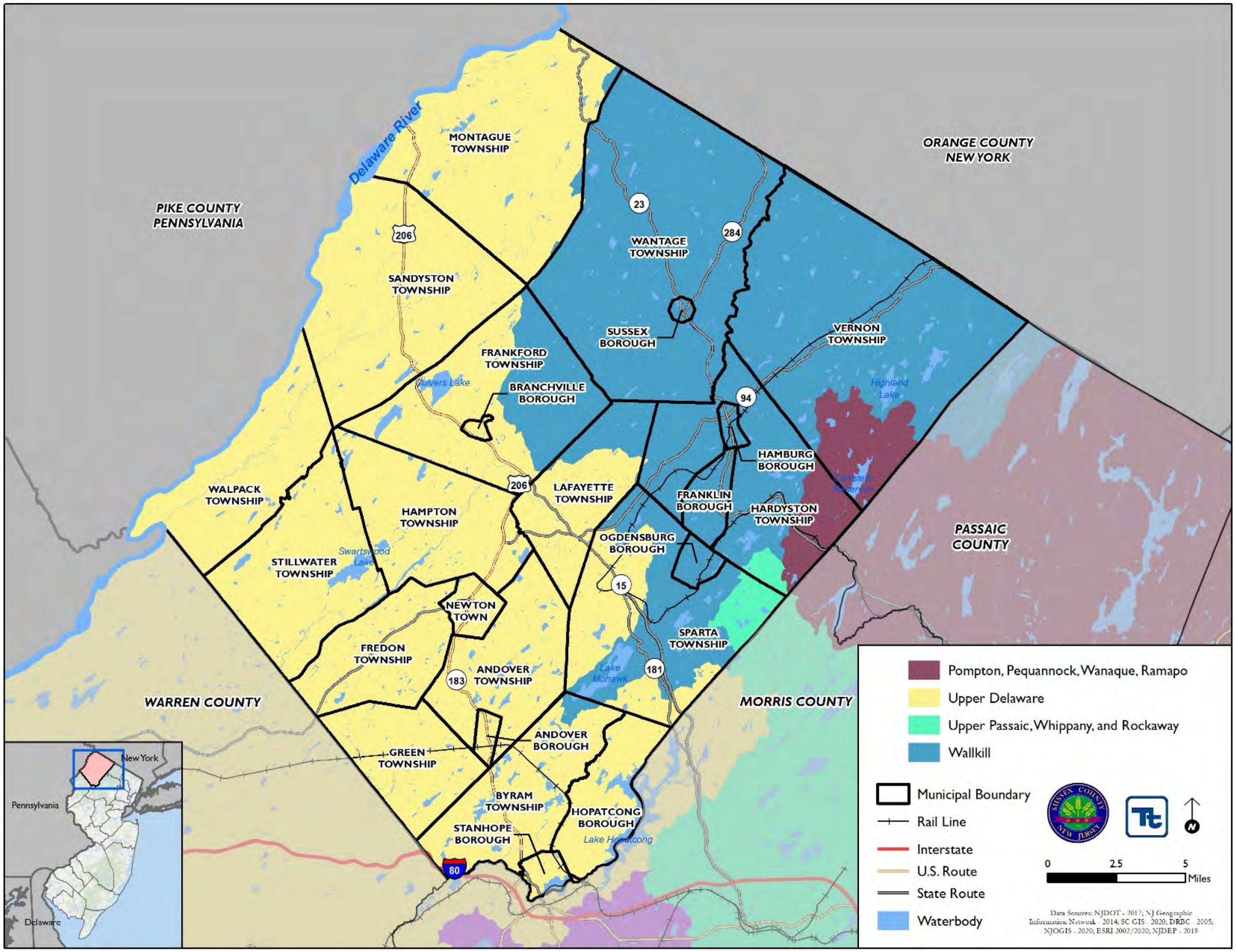
The Pequannock River Watershed occupies a small area of eastern Sussex County. It flows south out of Vernon Township and continues into Hardyston Township where it turns southeast, forming the border between Morris and Passaic Counties. The Pequannock's confluence with the Passaic River occurs at the eastern end of the Great Piece Meadows, where Morris, Passaic and Essex Counties meet. For most of its run in Sussex County, the Pequannock River flows through Newark's water supply management lands (NJDEP 2012).

Watershed Management Area 6: Upper and Mid Passaic, Whippany, Rockaway Watersheds

WMA 6 represents the area drained by waters from the upper reaches of the Passaic River Basin including the Passaic River from its headwaters in Morris County to the confluence of the Pompton River. WMA 6 is characterized by extensive suburban development and reliance upon ground water sources for water supply. WMA 6 lies in portions of Morris, Somerset, Sussex and Essex Counties and includes the Upper and Middle Passaic River, Whippany River and Rockaway River Watersheds (NJDEP 2012).

The Rockaway River begins in Jefferson Township and its system's upper reaches are in eastern Sparta Township, where several streams merge to form Russia Brook. Russia Brook flows into Jefferson Township where it meets the Rockaway River below Lake Swannanoa. From there, the Rockaway River flows into the Passaic River (NJDEP 2012).

Figure 3-2. Sussex County Watersheds



Topography and Geology

The topography of Sussex County is among the most diverse in the State of New Jersey. The eastern two-thirds lies within the Highlands physiographic province which runs in a northeast belt from Reading, Pennsylvania, across New Jersey, and into southern New York State and western Connecticut. This province is characterized by forested ridges and glacially sculpted valleys. It also contains significant water resources affecting over 11 million residents. The remainder of Sussex County lies within the Ridge and Valley physiographic province. This province is characterized by parallel northeast-southwest trending ridges wither fertile valleys in between. The capstone of the Ridge and Valley is the Kittatinny Ridge which runs approximately 40 miles through the county. The Ridge has elevations between 1,200 and 1,500 feet above sea level, and an average width of five miles. At High Point, the northernmost extent of the Kittatinny Ridge, has an elevation of 1,803 feet which is the highest point in New Jersey (Sussex County Natural Resources Inventory 2015).

The lowest points in Sussex County are found along the Delaware River at the mouth of Flat Brook (300 feet) and along the Wallkill River at the New York State line (380 feet). Located between the Highlands and Kittatinny Ridge, the Kittatinny Valley has elevations between 600 and 700 feet (Sussex County Natural Resources Inventory 2015)..

The Highlands is comprised of Precambrian rock, making it the oldest bedrock in New Jersey. The portion that runs through Sussex County is predominately granite and gneiss, with a small portion of marble. To the west of the Highlands, is Paleozoic rock, which includes shale, siltstone, and sandstone along Kittantiny Valley and limestone, shale, and sandstone along the Delaware River Basin (NJDEP 2014).

Climate

Sussex County has a temperate climate with warm summers and cold winters. The average temperatures range from approximately 32 degrees Fahrenheit (ºF) in January to 75ºF in July, with extremes common in the summer and winter months. The average precipitation yearly is approximately 54 inches (NOAA 2020).

Land Use, Land Cover, and Land Use Trends

Local zoning and planning authority are provided for under the New Jersey Municipal Land Use Law, which gives municipalities zoning and planning authority. The DMA 2000 requires that communities consider land use trends, which can impact the need for, and priority of, mitigation options over time. Land use trends significantly impact exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

This plan provides a general overview of population, land use and types of development occurring within the study area. An understanding of these development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure.

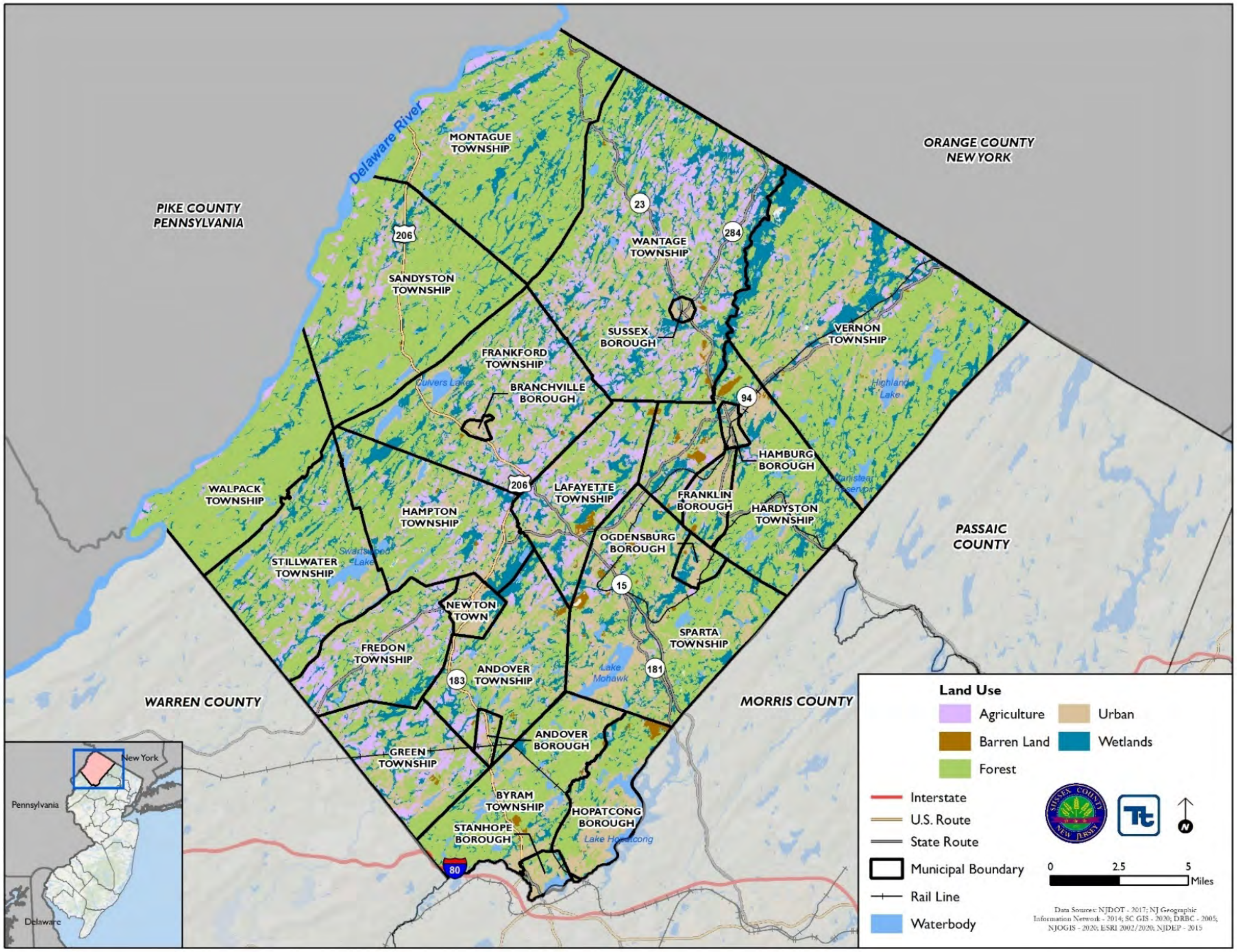
In 2012, the majority (55.9-percent) of the land in Sussex County was designated as forested land. The 2015 data shows there was a slight decrease in forested land(55.8-percent). In 2012, 15.9-percent was urban land; 13.6-percent was wetlands land; 0.6-percent was barren land; and 10.1-percent was agricultural lands. When compared with the land use land cover dataset from 2015, there has been a slight increase in urban land (16-percent). These land use types do not include water, which is just under 4-percent of the County. Refer to Figure 3-3 and Table 3-1 below.

Table 3-1. Land Use Summary of Sussex County, 2012 and 2015

Land Use Category	2012 Data		2015 Data	
	Acreage	Percent of Sussex County	Acreage	Percent of Sussex County
Agriculture	34,778	10.1%	34,629	10.1%
Barren	2,054	0.6%	2,125	0.6%
Forest	191,495	55.9%	191,143	55.8%
Urban	54,334	15.9%	54,839	16.0%
Wetlands	46,645	13.6%	46,799	13.7%

Source: NJDEP 2012/2015 LULC
Note: Urban land includes residential, industrial, transportation, and recreational land. Water is excluded from the table above.

Figure 3-3. Land Use/Land Cover in Sussex County

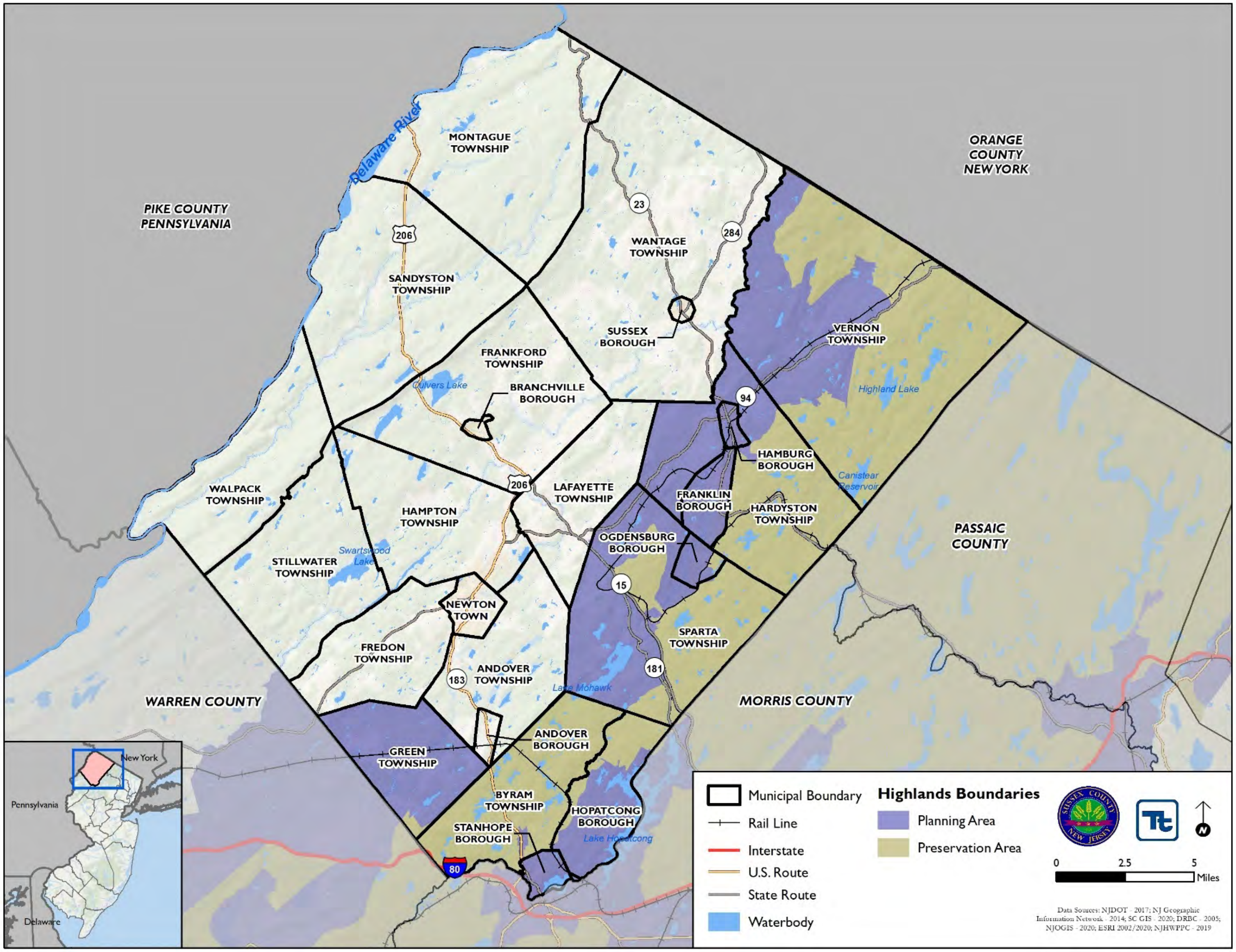


Highlands Region of New Jersey

The New Jersey Highlands is a 1,343 square mile area (over 800,000 acres) in the northwest portion of New Jersey. It is noted for its scenic beauty, environmental significance and serves as a vital source of drinking water for over half of New Jersey residents. The Highlands stretches from Phillipsburg (Warren County) in southwest New Jersey to Ringwood (Passaic County) in the northeast. The Highlands Region lies within portions of seven counties, Hunterdon, Somerset, Sussex, Warren, Morris, Passaic and Bergen, and includes 88 municipalities. The Highlands Act designates approximately 398,000 acres as the Highlands Preservation Area which is identified as an area of exceptional natural resource value. The remainder of the Highlands Region that is not located within the Preservation Area lies within the Highlands Planning Area. The distinction between the Preservation and Planning Area is that municipal and county conformance with the Highlands Regional Master Plan is required in the Preservation Area, and voluntary in the Planning Area.

The Highlands Area in Sussex County is located in the eastern portion of the County and consists of approximately 129,860 acres of land (Figure 3-4). The Townships of Byram, Green, Hardyston, Sparta and Vernon, and the Boroughs of Franklin, Hamburg, Hopatcong, Ogdensburg and Stanhope are within the Highlands boundary.

Figure 3-4. Highlands in Sussex County, New Jersey



Open Space and Parkland

Large portions of Sussex County are permanently set aside as public/conservation space. This includes the Delaware Water Gap National Recreation Area, state parks and forests (High Point and Stokes), and wildlife refuges (Wallkill). Public and conservation open space accounts for more than one-third of the County's total land area. Overall, open space in Sussex County includes federal, state, county, municipal, and water supply management land.

The National Park Service manages 5,354 acres (federal land) in western Sussex County in the municipalities of Sandyston and Stillwater. This area is known as the Delaware Water Gap National Recreation Area; a 55,857-acre unit of the National Park System located in New Jersey and Pennsylvania. The U.S. Fish and Wildlife Service manages 21,924 acres of land in County, known as the Wallkill River National Wildlife Refuge located in the Townships of Vernon and Wantage.

For state land, the New Jersey Division of Fish and Wildlife manages 12 Wildlife Management Areas in Sussex County, totaling 23,019 acres. The New Jersey Division of Parks and Forestry oversees state parks and trail corridors (Paulinskill Valley Trail, Sussex Branch Trail and Appalachian Trail) throughout New Jersey. In Sussex County, there are six state parks, one state forest, and three long-distance trails. Additionally, the New Jersey Natural Lands Trust is an independent agency within NJDEP in which properties are comparatively small relative to other state land. There are 15 Natural Lands Trust properties in Sussex County and the land management focuses on fish and wildlife habitat conservation as opposed to public recreation.

As for county-owned open space, Sussex County owns 441 acres of land in Franklin, Frankford, Hardyston, Newton, Sparta, and Vernon municipalities. On the municipal level, there are 4,499 acres of land used for parks, recreation areas, municipal buildings, and support services. Refer to Table 3-2 below for a summary of open space in Sussex County.

Additionally, there are 1,274 acres of private land used as open space and/or protected via conservation easements. There are also 10,175 acres of open space used for utilities in Sussex County. This land is primarily in Hardyston Township and Vernon Township, with the largest parcel being a 2,223 acre watershed in Vernon. Various non-profit organizations also own open space in Sussex County, totally 5,599 acres. For instance, The Nature Conservancy, New Jersey Audubon, and The Orange YMCA own 1,755, 570, and 607 acres, respectively. Lastly, there is 18,202 of acres of preserved farmland in the County (Sussex County Open Space and Recreation Plan 2016).

Table 3-2. Federal, State, County, or Municipal Open Space

Name of Facility	Federal, State, County or Municipal Owned	Size (acres in Sussex County)	Municipality
Wallkill River National Wildlife Refuge	Federal	4,635	Hardyston, Vernon, Wantage
Delaware Water Gap National Recreation Area	Federal	21,771	Walpack, Sandyston, Montague
Bear Swamp Wildlife Management Area (WMA)	State	2, 036	Frankford and Hampton
Culvers Brook Access WMA	State	4	Frankford
Flatbrook WMA	State	2,090	Sandyston, Walpack
Little Flatbrook Access WMA	State	4	Sandyston
Hainesville WMA	State	281	Montague, Sandyston
Hamburg Mountain WMA	State	2,737	Hardyston, Vernon

Name of Facility	Federal, State, County or Municipal Owned	Size (acres in Sussex County)	Municipality
Paulinskill River WMA	State	777	Fredon, Hampton
Sparta Mountain WMA	State	1,602	Hardyston, Ogdensburg, Sparta
Trout Brook WMA	State	1,098	Stillwater
Walpack WMA	State	387	Walpack
Weldon Brook WMA	State	829	Sparta
Whittingham WMA	State	1,930	Green, Fredon
Allamuchy Mountain State Park	State	5,000	Byram, Green, Stanhope
High Point State Park (includes AT west of Wallkill)	State	15,278	Wantage, Montague, Frankford
Hopatcong State Park	State	4	Hopatcong
Kittatinny Valley State Park	State	1,313	Andover Borough, Andover Township
Paulinskill Valley Trail/Sussex Branch Trail	State	556	Andover Borough, Andover Township, Byram, Frankford, Fredon, Hamburg, Hampton, Lafayette, Newton, Ogdensburg, Stillwater, Sparta
Stokes State Forest	State	15,734	Montague, Sandyston, Frankford, Hampton, Stillwater
Swartswood State Park	State	2,250	Hampton, Stillwater
Wawayanda State Park (includes AT east of Wallkill)	State	15,000	Vernon
Newark-Pequannock Watershed Easemen	State	3,896	Vernon
Congleton -CLC Partners/Smith (easement)	State	15	Hardyston
Congleton - Violante (easement)	State	16	Hardyston, Wantage
Congleton Wildlife Sanctuary	State	79	Hardyston, Wantage
Congleton Wildlife Sanctuary - CCK Realty)	State	127	Hardyston, Wantage, Lafayette
Congleton - Ferra (easement)	State	14	Hardyston
Congleton - Padula (easement)	State	18	Hardyston
Congleton - Williams (easement)	State	12	Hardyston
Congleton - Wildlife Sanctuary - Farm Association - Marx	State	100	Hardyston, Wantage
Crooked Swamp Caves	State	18	Lafayette
Elm Spring Preserve	State	11	Wantage
Lubbers Run	State	35	Byram
Lubbers Run - Vanderbilt	State	28	Byram
Lubbers Run - Vanderbilt II	State	28	Byram
McCarthy	State	4	Hopatcong
Papakating Creek	State	11	Frankford
Quarryville Brook	State	44	Wantage
Reinhardt - Weber	State	5	Montague
Reinhardt Preserve	State	240	Montague

Name of Facility	Federal, State, County or Municipal Owned	Size (acres in Sussex County)	Municipality
Reinhardt Preserve - Bunnell (easement)	State	34	Montague
Reinhardt Preserve - Coss	State	6	Montague
Reinhardt Preserve - Layne (easement	State	24	Montague
Reinhardt Preserve - Reinhardt I	State	14	Montague
Wallkill - May/Green Acres	State	13	Ogdensburg
Wallkill River	State	10	Sparta
Wallkill River Addition -NJCF	State	80	Ogdensburg
Wallkill River Addition - Predmore/Bennett	State	4	Ogdensburg
Wallkill River - Pope John High School	State	40	Sparta
Wallkill River Preserve - NJDOT	State	34	Sparta
Sussex County Park	County	1	Newton
Andover Township	Municipal	278	Andover Township
Byram	Municipal	92	Byram
Frankford	Municipal	9	Frankford
Fredon	Municipal	69	Fredon
Hamburg	Municipal	2	Hamburg
Hopatcong	Municipal	172	Hopatcong
Lafayette	Municipal	250	Lafayette
Newton	Municipal	49	Newton
Stanhope	Municipal	15	Stanhope
Stillwater	Municipal	242	Stillwater
Sussex Borough	Municipal	63	Sussex Borough
Vernon	Municipal	123	Vernon
Wantage	Municipal	157	Wantage

Source: Open Space and Recreation Plan 2003

3.2 POPULATION AND DEMOGRAPHICS

Knowledge of the composition of the population, how it has changed in the past and how it may change in the future is needed to make informed decisions. Information about population is a critical part of planning because it directly relates to needs such as housing, industry, stores, public facilities and services, and transportation.

3.2.1 POPULATION CHARACTERISTICS

The population of Sussex County was estimated at 142,298 in the 2014-2018 American Community Survey (ACS). According to the 2010 U.S. Census, Sussex County had a population of 149,265 people which represents a 4.7-percent decrease. Alternatively, there has been an increase in the elderly population (65 and over). The elderly population grew from 17,850 in 2010 to 22,889 in the 2014-2018 ACS 5-Year Census, which represents a 28-percent increase.

Table 3-3 and Table 3-4 present the population statistics for Sussex County based on the 2010 decennial Census' and the 2014-2018 American Community Survey (ACS) 5-Year Estimates. Figure 3-5 shows the distribution of the general population density (persons per square mile) based on the 2014-2018 ACS 5-Year Estimates by Census block. Western Sussex County is not as densely populated as eastern Sussex County due to its location within the Delaware River Basin. The basin has steep grades, making it difficult to construct homes and businesses.

Population density has a strong correlation with hazard vulnerability and loss. Urban areas tend to have larger populations and numbers of structures; therefore, these areas tend to experience greater loss during hazard events. Hazus demographic data will be used in the loss estimating analyses in Section 4 (Risk Assessment) of this plan. All demographic data in Hazus corresponds to the 2010 U.S. Census.

Table 3-3. Sussex County 2010 Population Statistics

Jurisdiction	U.S. Census 2010						
	Total	Population 65+	Percent (%)Population 65+	Population Under 16	Percent (%)Population Under 16	Low Income Population*	Percent (%) Low Income Population*
Andover (B)	606	73	12.0%	128	21.1%	28	4.6%
Andover (Twp)	6,319	1,012	16.0%	1,374	21.7%	91	1.4%
Branchville (B)	841	141	16.8%	183	21.8%	46	5.5%
Byram (Twp)	8,350	843	10.1%	2,146	25.7%	104	1.2%
Frankford (Twp)	5,565	921	16.5%	1,176	21.1%	124	2.2%
Franklin (B)	5,045	659	13.1%	1,119	22.2%	323	6.4%
Fredon (Twp)	3,437	469	13.6%	882	25.7%	52	1.5%
Green (Twp)	3,601	388	10.8%	1,021	28.4%	50	1.4%
Hamburg (B)	3,277	385	11.7%	741	22.6%	212	6.5%
Hampton (Twp)	5,196	768	14.8%	1,095	21.1%	142	2.7%
Hardyston (Twp)	8,213	1,194	14.5%	1,741	21.2%	348	4.2%
Hopatcong (B)	15,147	1,489	9.8%	3,394	22.4%	262	1.7%
Lafayette (Twp)	2,538	325	12.8%	593	23.4%	52	2.0%
Montague (Twp)	3,847	536	13.9%	877	22.8%	140	3.6%
Newton (T)	7,997	1,481	18.5%	1,718	21.5%	810	10.1%
Ogdensburg (B)	2,410	275	11.4%	590	24.5%	104	4.3%
Sandyston (Twp)	1,998	234	11.7%	448	22.4%	57	2.9%
Sparta (Twp)	19,722	2,198	11.1%	5,688	28.8%	251	1.3%
Stanhope (B)	3,610	374	10.4%	817	22.6%	74	2.0%
Stillwater (Twp)	4,099	459	11.2%	896	21.9%	199	4.9%
Sussex (B)	2,130	261	12.3%	485	22.8%	176	8.3%
Vernon (Twp)	23,943	2,019	8.4%	5,824	24.3%	403	1.7%
Walpack (Twp)	16	4	25.0%	2	12.5%	0	0.0%
Wantage (Twp)	11,358	1,342	11.8%	2,835	25.0%	163	1.4%
Sussex County (Total)	**149,265**	**17,850**	**12.0%**	**35,773**	**24.0%**	**4,211**	**2.8%**

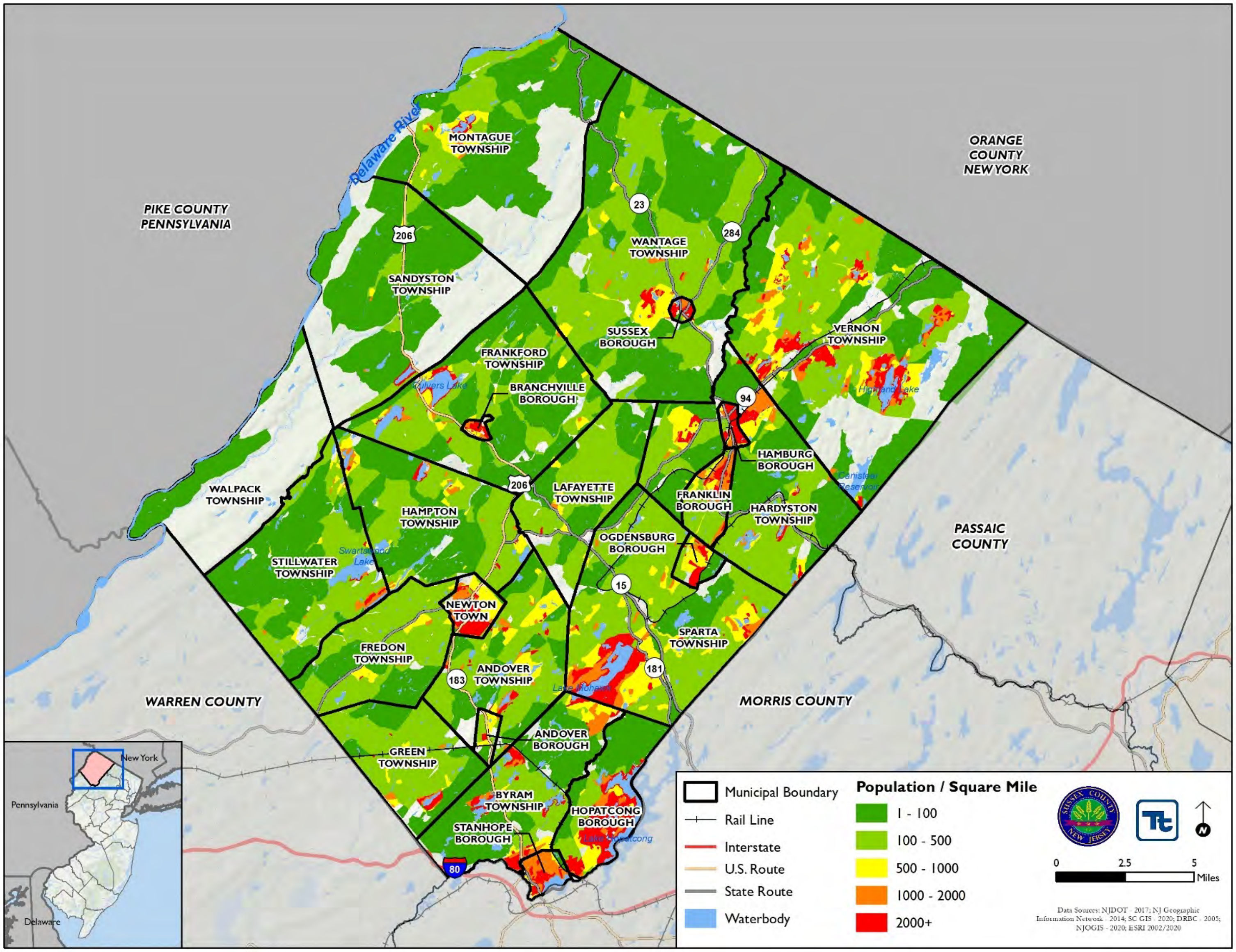
Source: U.S. Census Bureau: Census 2010; Hazus v4.2 2010 population demographics
*Note: * Individuals below poverty level (Hazus v4.2 - Income less than $20,000)*
B = Borough; T = Town; Twp = Township

Table 3-4. Sussex County 2014-2018 American Community Survey Population Statistics

Jurisdiction	2014-2018 American Community Survey										
	Total	Population 65+	Percent (%) Population 65+	Population Under 5	Percent (%) Under 5	Population Below Poverty Level*	Percent (%) Below Poverty Level	Disability Population	Percent (%) Disability Population	Non-English Speaking Population	Percent (%) Non-English Speaking Population
Andover (B)	594	99	16.7%	30	5.1%	28	4.7%	53	8.9%	9	1.5%
Andover (Twp)	5,996	1,392	23.2%	219	3.7%	340	5.7%	671	11.2%	252	4.2%
Branchville (B)	896	128	14.3%	62	6.9%	88	9.8%	113	12.6%	3	0.3%
Byram (Twp)	8,010	1,101	13.7%	379	4.7%	194	2.4%	678	8.5%	176	2.2%
Frankford (Twp)	5,361	1,080	20.1%	171	3.2%	305	5.7%	567	10.6%	49	0.9%
Franklin (B)	4,807	654	13.6%	287	6.0%	394	8.2%	613	12.8%	87	1.8%
Fredon (Twp)	3,214	577	18.0%	120	3.7%	251	7.8%	352	11.0%	17	0.5%
Green (Twp)	3,495	530	15.2%	83	2.4%	188	5.4%	402	11.5%	109	3.1%
Hamburg (B)	3,152	485	15.4%	132	4.2%	217	6.9%	226	7.2%	34	1.1%
Hampton (Twp)	4,916	956	19.4%	138	2.8%	345	7.0%	655	13.3%	191	3.9%
Hardyston (Twp)	7,886	1,485	18.8%	436	5.5%	261	3.3%	696	8.8%	121	1.5%
Hopatcong (B)	14,362	1,965	13.7%	732	5.1%	511	3.6%	1,539	10.7%	786	5.5%
Lafayette (Twp)	2,390	434	18.2%	128	5.4%	124	5.2%	298	12.5%	158	6.6%
Montague (Twp)	3,716	644	17.3%	138	3.7%	178	4.8%	644	17.3%	34	0.9%
Newton (T)	7,895	1,417	17.9%	315	4.0%	1,027	13.0%	1,232	15.6%	502	6.4%
Ogdensburg (B)	2,314	369	15.9%	83	3.6%	129	5.6%	240	10.4%	100	4.3%
Sandyston (Twp)	1,925	381	19.8%	113	5.9%	80	4.2%	264	13.7%	71	3.7%
Sparta (Twp)	18,841	2,590	13.7%	993	5.3%	533	2.8%	1,455	7.7%	532	2.8%
Stanhope (B)	3,377	450	13.3%	123	3.6%	138	4.1%	415	12.3%	89	2.6%
Stillwater (Twp)	3,936	857	21.8%	224	5.7%	247	6.3%	532	13.5%	0	0%
Sussex (B)	1,854	233	12.6%	105	5.7%	297	16.0%	285	15.4%	62	3.3%
Vernon (Twp)	22,369	3,059	13.7%	979	4.4%	848	3.8%	2,261	10.1%	439	2.0%
Walpack (Twp)	6	6	100.0%	0	0%	0	0%	0	0%	0	0%
Wantage (Twp)	10,986	1,997	18.2%	458	4.2%	468	4.3%	1,027	9.3%	179	1.6%
Sussex County (Total)	**142,298**	**22,889**	**16.1%**	**6,448**	**4.5%**	**7,191**	**5.1%**	**15,218**	**10.7%**	**4,000**	**2.8%**

Source: U.S. Census Bureau 2014-2018
*Note: * Individuals below poverty level (Census poverty weighted average threshold for a 3-person family unit in 2018 was approximately $19,985)*
B = Borough; T = Town; Twp = Township

Figure 3-5. Distribution of General Population for Sussex County, New Jersey



3.2.2 VULNERABLE POPULATIONS

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. Identifying concentrations of vulnerable populations can assist communities in targeting preparedness, response and mitigation actions. For the purposes of this planning process, vulnerable populations in Sussex County include children, elderly, low-income, the physically or mentally disabled, non-English speakers and the medically or chemically dependent.

Age

Children are considered vulnerable because they are dependent on others to safely access resources during emergencies. The elderly are more apt to lack the physical and economic resources necessary for response to hazard events and are more likely to suffer health-related consequences making recovery slower. Those living on their own may have more difficulty evacuating their homes. The elderly are also more likely to live in senior care and living facilities where emergency preparedness occurs at the discretion of facility operators. Senior care and living facilities are also most vulnerable to hazards like pandemics in light of the close living arrangements combined with older populations with potentially weakened immune systems or pre-existing health issues that may be accentuated during an event like a pandemic.

According to the 2014-2018 ACS 5-Year estimates, the mean age in Sussex County was 44.8 years. Of the 2014-2018 population, 22,889 (13.6%) of the County's population is age 65 and older; an increase from 2010 (28-percent). The Census also reports a population under 5 of 6,448. Figure 3-5 shows the distribution of persons under the age of 5 and over 65 in purple and orange, respectively based on the 2014-2018 ACS 5-Year estimates.

Income

Of the total population, economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The 2014-2018 ACS data identified approximately 7,191 people as low-income. According to the Census' 2019 poverty thresholds, the weighted average thresholds for a family of four in 2018 was $25,701; for a family of three, $19,985; for a family of two, $12,784, and for unrelated individuals, $13,016. Figure 3-5 shows the distribution of low-income persons in Sussex County.

According to the 2014-2018 ACS 5-Year estimates, there were 7,191 people in poverty in Sussex County; an increase from the 2010 low-income population (4,211). It is noted that the 2010 Census data for household income provided in Hazus includes two ranges ($0-10,000 and $10,000-$20,000/year) that were totaled to provide the "low-income" data used in this study. This does not correspond exactly with the "poverty" thresholds established by the updated ACS statistics; however, this difference is not believed to be significant for the purposes of this planning effort.

Physically or Mentally Disabled

The Center for Disease Control and Prevention (CDC) defines a disability as a "condition of the body or mind (impairment) that makes it more difficult for the person with the condition to do certain activities (activity limitation) and interact with the world around them (participation restrictions)" (CDC 2020). These impairments may increase the level of difficulty that individuals may face during an emergency. Cognitive impairments may reduce an individual's capacity to receive, process, and respond to emergency information or warnings. Individuals with a physical or sensory disability may face issues of mobility, sight, hearing, or reliance on specialized medical equipment. According to the 2014-2018 ACS, 10.7-percent of residents of Sussex County are living with a disability. Figure 3-5 shows the geographic distribution of disabled individuals throughout

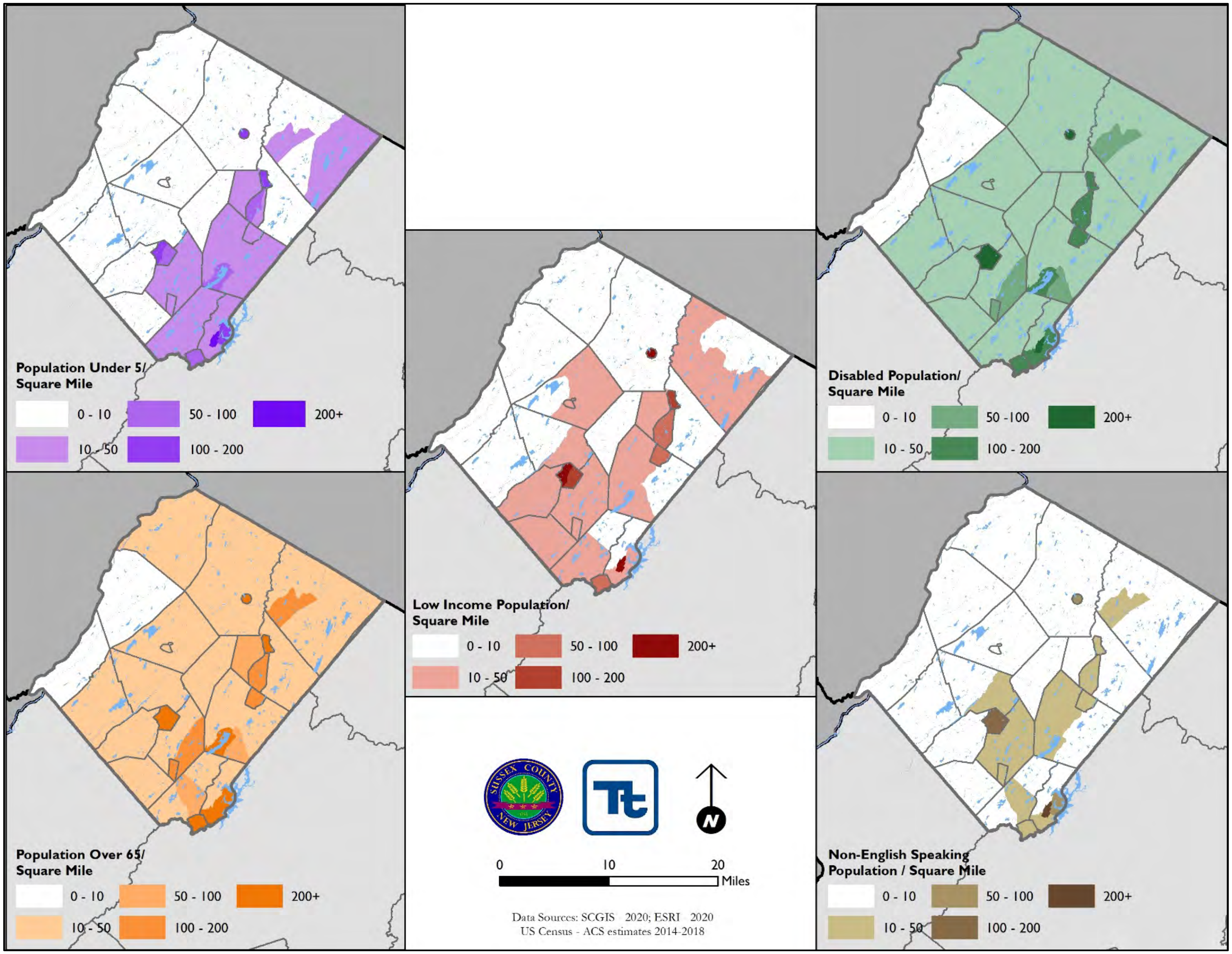
Sussex County which includes individuals with hearing, vision, cognitive, ambulatory, self-care, and independent living difficulties.

Non-English Speakers

Individuals who are not fluent or have a working proficiency in English may be vulnerable to hazard events because they may have difficulty with understanding information being conveyed to them. Cultural differences can also add complexity to how information is being conveyed to populations with limited proficiency of English (CDC 2020).

According to the 2014-2018 ACS, 2.8-percent of the County's population over the age of 5 speaks a language other than English at home; this is significantly less than the State average of 30-percent. Figure 3-6 shows the geographic distribution of non-English speakers throughout Sussex County.

Figure 3-6. Distribution of Socially Vulnerable Populations in Sussex County



3.2.3 POPULATION TRENDS

Population trends can provide a basis for making decisions on the type of mitigation approaches to consider and the locations in which these approaches should be applied. This information can also be used to support planning decisions regarding future development in vulnerable areas.

According to the 2014-2018 ACS, Sussex County's population was 142,298 persons, which is a 4.7-percent decrease from the 2010 Census population of 149,265. Between 1900 and 2010, the County experienced overall growth. Between 1960 and 1970, the County experienced its largest increase in population: 57.4-percent. The smallest increase was between 2000 and 2010, when the population increased by 3.5-percent. Since 2010, the population has been decreasing, but the largest decrease was between 1910 and 1920, when the County experienced a 7-percent decrease in population (New Jersey State Data Center 2001).

Over the past 10 years, the County experienced population decline and is expected to shrink in the coming years. Table 3-5 displays the population and change in population from 1900 to 2018 in Sussex County.

Table 3-5. Sussex County Population Trends, 1900 to 2018

Year	Population	Change in Population	Percent Population Change
1900	24,134	N/A	N/A
1910	26,781	2,647	11.0%
1920	24,905	-1,876	-7.0%
1930	27,830	2,925	11.7%
1940	29,632	1,802	6.5%
1950	34,423	4,791	16.2%
1960	49,255	14,832	43.1%
1970	77,528	28,273	57.4%
1980	116,119	38,591	49.8%
1990	130,943	14,824	12.8%
2000	144,166	13,223	10.1%
2010	149,265	5,099	3.5%
2014	146,888	-2,377	-1.6%
2018	142,298	-4,590	-3.1%

Source: U.S. Census Bureau 2018; New Jersey State Data Center 2001
Note: % - Percent
Change in population and percent in population change was calculated from available data

Table 3-6 displays the ten largest municipalities in Sussex County. According to the 2014-2018 ACS data, the Township of Vernon was the most populous municipality, comprising 15.7-percent of the County's total population.

Table 3-6. Ten Largest Municipalities in Sussex County

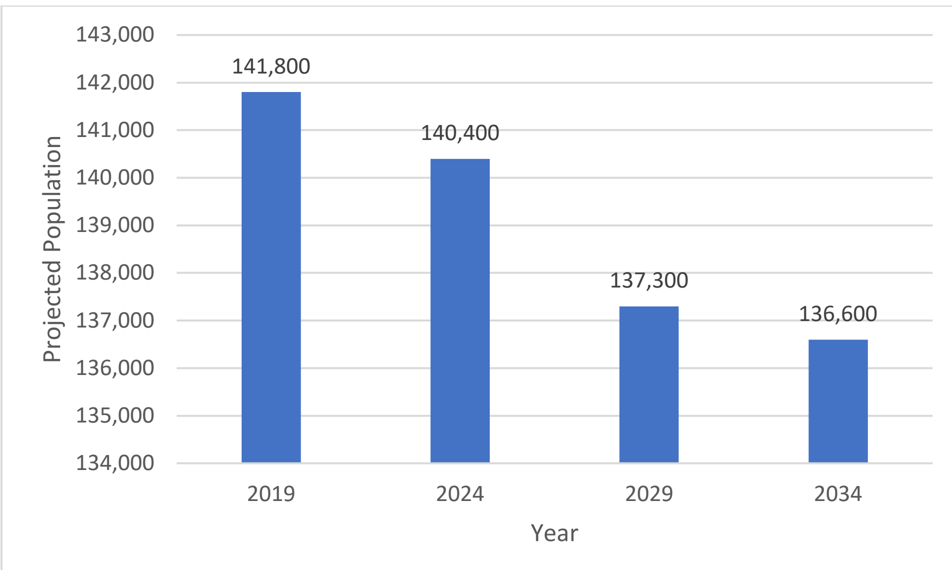
Rank	Jurisdiction	Total
1	Vernon (Twp)	22,369
2	Sparta (Twp)	18,841
3	Hopatcong (B)	14,362

Rank	Jurisdiction	Total
4	Wantage (Twp)	10,986
5	Byram (Twp)	8,010
6	Newton (T)	7,895
7	Hardyston (Twp)	7,886
8	Andover (Twp)	5,996
9	Frankford (Twp)	5,361
10	Hampton (Twp)	4,916

Source: 2014-2018 ACS Census
B = Borough; T = Town; Twp = Township

Over the next 15 years, it is projected that population will continue to decline in Sussex County (-3.7-percent). Based on New Jersey Department of Labor population projections, the County population is expected to reduce to 140,400 by 2024, 137,300 by 2029, and 136,600 by 2034 (Figure 3-7 and Table 3-7).

Figure 3-7. Sussex County Population Projections, 2019 to 2034



Source: New Jersey Department of Labor and Workforce Development 2019

Table 3-7. Population Trends in Sussex County by Jurisdiction

Jurisdiction	2010 Census	2014-2018 ACS	Change in Population	Percent Population Change
Andover (B)	606	594	-12	-2.0%
Andover (Twp)	6,319	5,996	-323	-5.1%
Branchville (B)	841	896	55	6.5%
Byram (Twp)	8,350	8,010	-340	-4.1%
Frankford (Twp)	5,565	5,361	-204	-3.7%
Franklin (B)	5,045	4,807	-238	-4.7%
Fredon (Twp)	3,437	3,214	-223	-6.5%
Green (Twp)	3,601	3,495	-106	-2.9%

Hamburg (B)	3,277	3,152	-125	-3.8%
Hampton (Twp)	5,196	4,916	-280	-5.4%
Hardyston (Twp)	8,213	7,886	-327	-4.0%
Hopatcong (B)	15,147	14,362	-785	-5.2%
Lafayette (Twp)	2,538	2,390	-148	-5.8%
Montague (Twp)	3,847	3,716	-131	-3.4%
Newton (T)	7,997	7,895	-102	-1.3%
Ogdensburg (B)	2,410	2,314	-96	-4.0%
Sandyston (Twp)	1,998	1,925	-73	-3.7%
Sparta (Twp)	19,722	18,841	-881	-4.5%
Stanhope (B)	3,610	3,377	-233	-6.5%
Stillwater (Twp)	4,099	3,936	-163	-4.0%
Sussex (B)	2,130	1,854	-276	-13.0%
Vernon (Twp)	23,943	22,369	-1,574	-6.6%
Walpack (Twp)	16	6	-10	-62.5%
Wantage (Twp)	11,358	10,986	-372	-3.3%
Sussex County (Total)	**149,265**	**142,298**	**-6,967**	**-4.7%**

Source: 2014-2018 ACS Census
B = Borough; T = Town; Twp = Township

Between 2010 and 2018, all jurisdictions, but one, experienced population decline. The Borough of Branchville was the only municipality to increase its population (841 to 896). The Township of Walpack and the Borough of Sussex were the two municipalities with the largest percentage of population reduction: 62.5-percent and 13-percent, respectively.

3.3 GENERAL BUILDING STOCK

The 2014-2018 ACS data identified 53,361 households (62,371 housing units) in Sussex County which is a small decrease in total households (-2.8-percent) but an increase in housing units (+0.5-percent) from 2010 to 2018. The U.S. Census defines a household as all persons who occupy a housing unit, and a housing unit as a house, apartment, mobile home, group of rooms, or a single room that is occupied (or if vacant, is intended for occupancy) as separate living quarters. Therefore, you may have more than one household per housing unit. The median price of a single-family home in Sussex County was estimated at $279,600 (ACS, 2014-2018).

For the HMP update, a custom-building inventory was developed to assess the current built environment's risk to natural hazards. The building stock update was performed using the most current parcel and tax assessment data provided by the New Jersey Geographic Information Network. There are approximately 72,021 structures included in the inventory with an estimated replacement cost value (RCV) of approximately $60 billion (structure and contents). Estimated content value was calculated by using 50-percent of the residential and parking replacement cost value, 100-percent of the commercial, industrial construction, religious, government and primary education values, and 150-percent of hospitals, industrial, emergency government and secondary education values. Actual content value various widely depending on the usage of the structure. Approximately 86.7-percent of the total buildings in the County are residential, which make up approximately 39.8-percent of the County's total replacement cost value. Table 3-8 presents building stock statistics by occupancy class for Sussex County.

The 2014-2018 ACS for Sussex County identified that the majority of housing units (80.1-percent) are one-unit detached units. The 2018 U.S. Census Bureau's County Business Patterns data identified a total 3,207 business establishments employ 31,622 people in Sussex County. The Construction industry has the greatest number of establishments in the County, with 512 and the Healthcare and Social Assistance industry has the greatest number of employees in the County, with 5,998.

Figure 3-8 through Figure 3-10 show the distribution and exposure density of residential, commercial, and industrial buildings in Sussex County. Exposure density is the dollar value of structures per unit area, including building content value. The densities are shown in units of $1,000 ($K) per square mile. Viewing exposure distribution maps can assist communities in visualizing areas of high exposure and in evaluating aspects of the study area in relation to the specific hazard risks.

Table 3-8. Number of Buildings and Replacement Cost Value by Occupancy Class

Jurisdiction	All Occupancies				Residential		Commercial		Industrial	
	Count	Replacement Cost Value (Structure Only)	Replacement Cost Value (Contents Only)	Total Replacement Cost Value (Structure + Contents)	Count	Total Replacement Cost Value (Structure + Contents)	Count	Total Replacement Cost Value (Structure + Contents)	Count	Total Replacement Cost Value (Structure + Contents)
Andover (B)	328	$332,119,752	$296,343,278	$628,463,030	234	$113,045,719	69	$464,742,666	2	$1,963,145
Andover (Twp)	2,584	$1,950,232,362	$1,659,447,362	$3,609,679,724	2,144	$976,175,392	159	$1,915,807,334	14	$69,582,340
Branchville (B)	426	$283,245,897	$249,131,471	$532,377,368	339	$123,183,329	71	$351,922,955	1	$23,764,725
Byram (Twp)	3,676	$1,568,849,755	$1,177,700,691	$2,746,550,446	3,345	$1,195,284,013	112	$1,258,359,318	2	$4,331,196
Frankford (Twp)	3,537	$1,739,300,413	$1,390,587,892	$3,129,888,305	2,783	$1,193,756,590	174	$818,858,093	9	$49,270,892
Franklin (B)	2,061	$1,074,588,863	$846,622,993	$1,921,211,856	1,819	$750,769,532	150	$855,563,757	14	$96,080,193
Fredon (Twp)	1,615	$779,059,999	$592,990,935	$1,372,050,934	1,213	$585,811,657	43	$90,249,154	6	$44,769,432
Green (Twp)	1,698	$920,306,992	$678,328,812	$1,598,635,804	1,377	$791,714,893	28	$133,482,533	4	$93,921,824
Hamburg (B)	1,594	$859,898,957	$728,150,334	$1,588,049,291	1,473	$469,464,565	95	$849,357,791	8	$99,532,914
Hampton (Twp)	2,763	$1,239,383,737	$956,747,861	$2,196,131,598	2,303	$865,409,960	106	$635,639,668	1	$7,938,962
Hardyston (Twp)	4,403	$1,807,469,173	$1,375,564,369	$3,183,033,542	3,965	$1,400,824,808	188	$1,196,445,035	20	$112,756,086
Hopatcong (B)	8,040	$1,767,028,668	$1,121,543,007	$2,888,571,676	7,641	$1,924,437,823	180	$652,082,684	0	$0
Lafayette (Twp)	1,462	$1,036,755,531	$921,418,534	$1,958,174,065	958	$501,339,546	95	$489,709,499	28	$87,340,680
Montague (Twp)	2,175	$833,154,433	$626,456,587	$1,459,611,020	1,870	$633,887,759	92	$423,339,200	8	$16,169,966
Newton (T)	2,679	$2,711,511,234	$2,381,764,573	$5,093,275,807	2,245	$1,333,560,567	284	$2,879,641,363	21	$275,709,494
Ogdensburg (B)	992	$462,330,280	$357,549,349	$819,879,629	909	$339,343,924	49	$332,727,893	3	$31,865,808
Sandyston (Twp)	1,528	$666,040,739	$546,585,925	$1,212,626,664	1,094	$381,205,972	89	$295,884,103	7	$38,069,215
Sparta (Twp)	8,132	$5,023,898,047	$4,046,196,238	$9,070,094,285	7,386	$3,177,699,823	429	$4,849,008,402	41	$225,283,240
Stanhope (B)	1,557	$602,241,781	$448,941,800	$1,051,183,581	1,449	$547,646,500	66	$250,585,937	7	$136,583,953
Stillwater (Twp)	2,493	$824,560,953	$593,018,445	$1,417,579,398	1,970	$696,478,590	144	$210,525,888	0	$0
Sussex (B)	678	$1,002,618,047	$942,960,869	$1,945,578,916	551	$392,993,541	80	$1,357,013,187	7	$46,870,858
Vernon (Twp)	12,039	$3,408,279,379	$2,250,691,784	$5,658,971,163	11,182	$3,599,814,313	384	$967,786,928	49	$141,369,394
Walpack (Twp)	51	$32,321,714	$31,369,836	$63,691,550	11	$2,855,635	21	$15,107,778	0	$0
Wantage (Twp)	5,510	$2,745,134,777	$2,132,409,108	$4,877,543,885	4,168	$1,898,743,239	196	$922,529,675	6	$12,851,984
Sussex County (Total)	**72,021**	**$33,670,331,484**	**$26,352,522,055**	**$60,022,853,539**	**62,429**	**$23,895,447,689**	**3,304**	**$22,216,370,842**	**258**	**$1,616,026,301**

Source: New Jersey Geographic Information Network 2019

B = Borough; RCV = Replacement Cost Value; T = Town; Twp = Township

Figure 3-8. Distribution of Residential Building Stock and Value Density in Sussex County

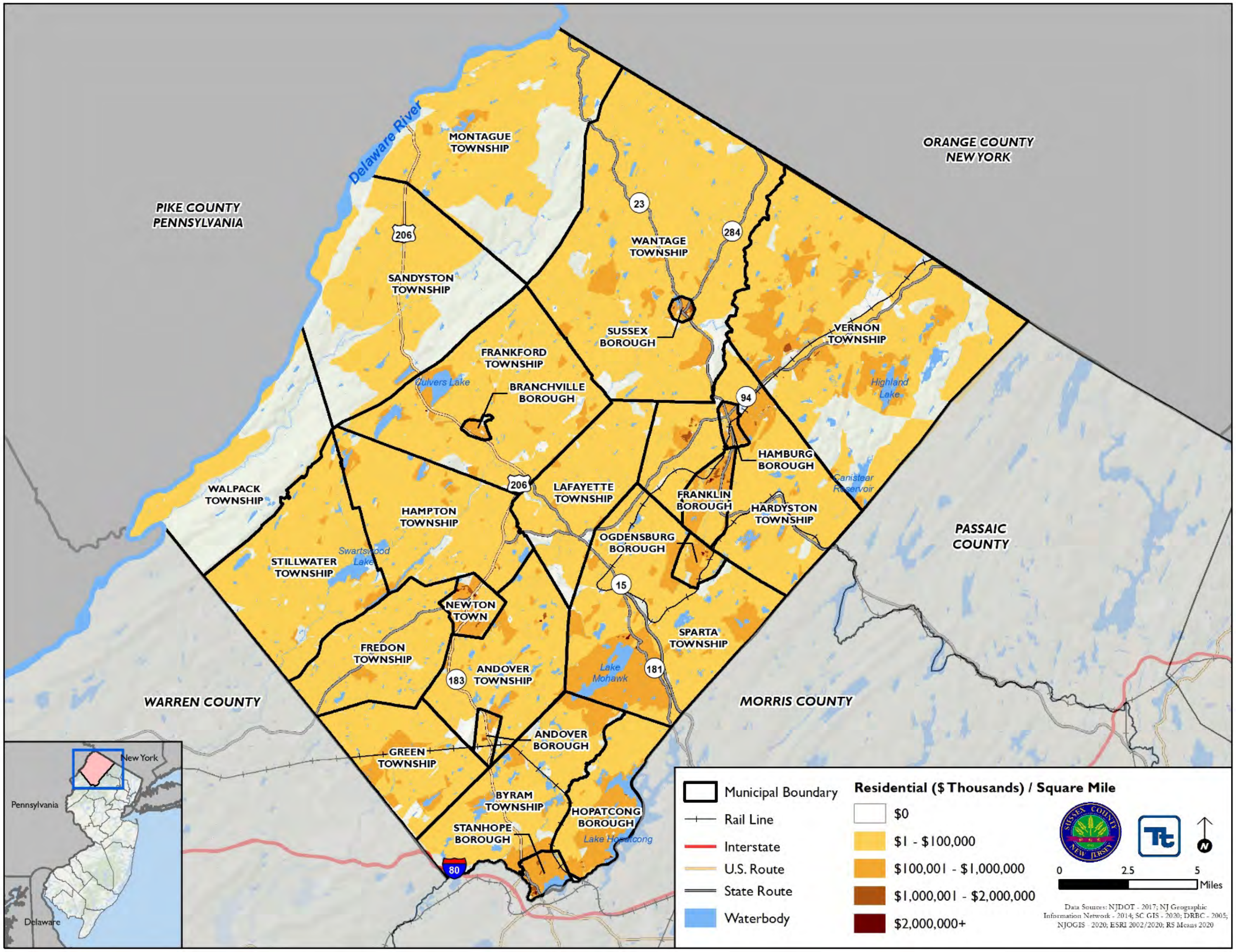


Figure 3-9. Distribution of Commercial Building Stock and Value Density in Sussex County

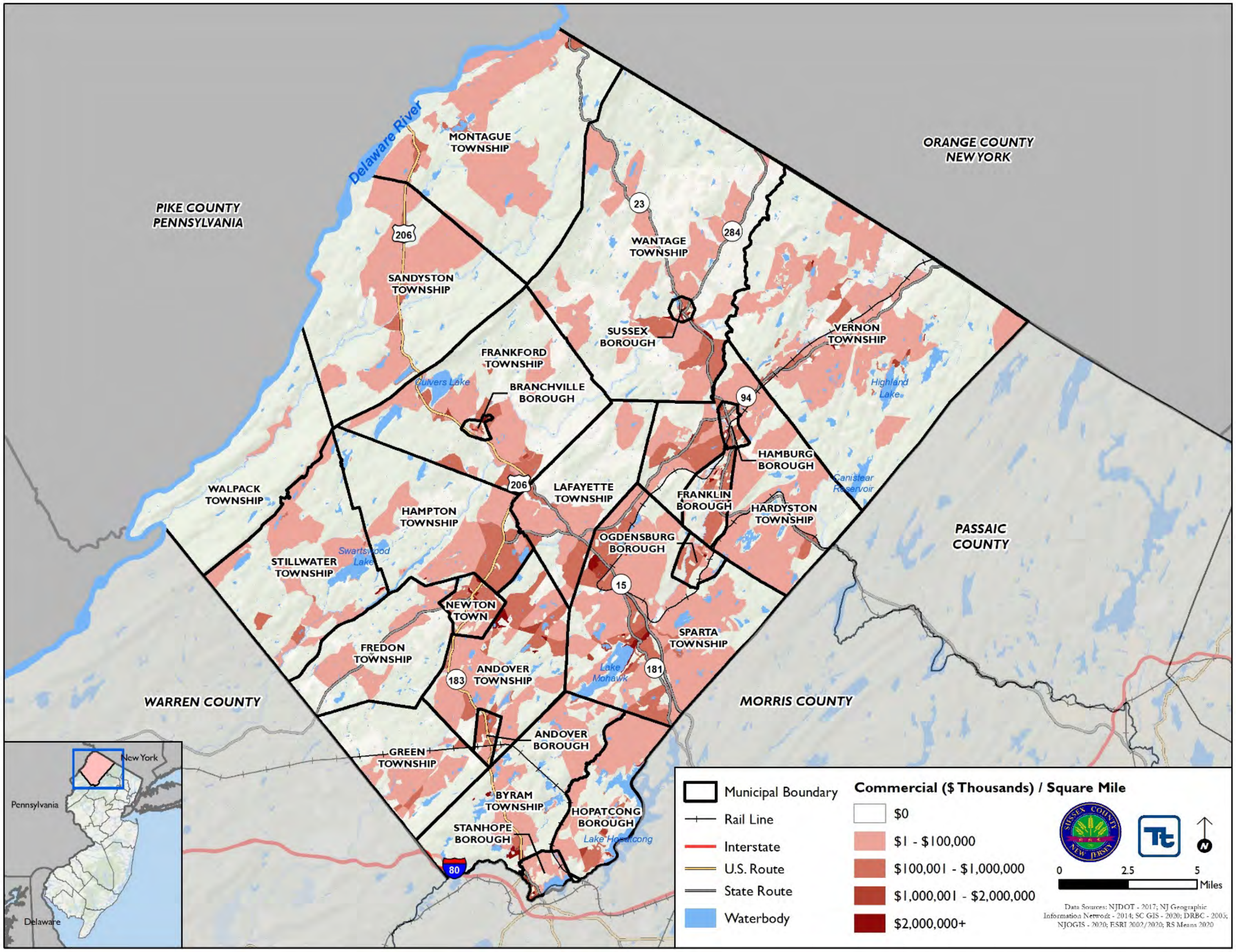
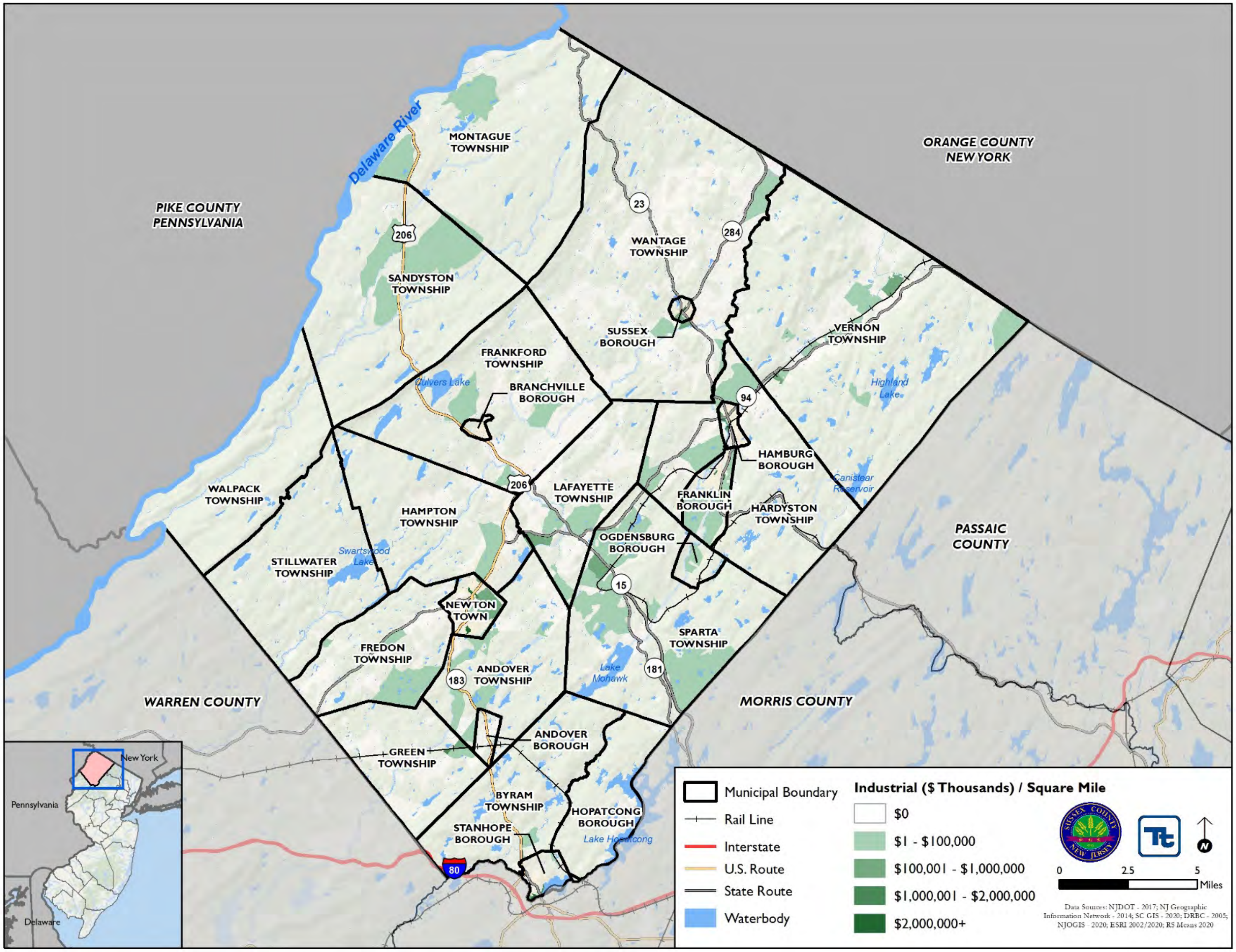


Figure 3-10. Distribution of Industrial Building Stock and Value Density in Sussex County



3.4 ECONOMY

As discussed in the FEMA Local Mitigation Handbook, after a natural hazard event, economic resiliency drives recovery. An understanding of the major employers and economic sectors in the County whose losses or inoperability would impact the community and its ability to recover from a disaster is essential. The following provides information regarding the economy in Sussex County.

Sussex County's early industry and commerce were chiefly centered on agriculture, milling, and iron and zinc mining. The local economy expanded due to the introduction of the railroads, which helped the development of factories following the Civil War and continuing to the 1960s. In the second half of the twentieth century, the auto-dependent suburban areas surrounding New York City boomed. Highway infrastructure was set in place and formally rural areas were engulfed by the migration of the middle-class. However, by the 1970's manufacturing began to move to the south, leaving factories out-of-business and vacant (Together New Jersey 2014).

Sussex County completed the Strategic Growth Plan Update in November 2014. The plan identified six focus areas: Tourism, Transportation, Housing, Industrial and Commercial Development, Reducing the Regulatory Burden, and Agriculture. Of these focus areas, Tourism, Transportation, and Housing were considered high priority, Industrial and Commercial Development and Reducing Regulatory Burden were considered medium priority, and Agriculture was considered low priority. These focus areas were assessed to 1) find existing conditions and trends; 2) identify key assets and resources, and; 3) highlight issues and process for securing economic growth. The report presented a total of 45 actions, which included recommended policy or legislative changes, additional studies to be performed, implementation strategies, and new specific projects (Sussex County 2014).

While manufacturing in the County has declined, the County is still home to several manufacturers including Ames Rubber Corp, a manufacturer of molded components, protective coatings, and dispensed gaskets for high-tech applications and ThorLabs, a manufacturer of high-tech components for the laser and fiber optics industry. Today, the fastest growing sectors of the economy are tourism and recreation. The industries represented by the 10 largest employers include recreation, healthcare, retail, education and government; refer to Table 3-9.

Table 3-9. Top Ten Sussex County Employers

Employer	Location	Employment	Industry
Crystal Springs Golf and Spa Resort	Vernon/Hardyston	2,000	Recreation
Newton Medical Center	Newton	1,200	Healthcare
Selective Insurance	Branchville	900	Insurance
Mountain Creek Resort	Vernon	800	Recreation
County of Sussex	Newton	500	Government
Ames Rubber Corp.	Hamburg	445	Manufacturing
Shop Rite Supermarkets	Newton	301	Retail
Andover Subacute and Rehab Center	Andover	300	Healthcare
Sussex County Community College	Newton	300	Education
Raider Express	Andover	250	Trucking/Logistics

Source: Sussex County 2014

According to the 2014 update of the Strategic Growth Plan, the largest employment sector in Sussex County is Education and Healthcare, followed by Trade, Transportation, and Utilities, and Leisure and Hospitality. Sussex

County appears to be under-represented in its share of employment in higher-paying industries such as Information, Financial Activities, and Business & Professional Services. These industries are typically considered export-based industries that bring money into the region and have a wealth creating impact on the local economy. The county is over-represented in lower paying industries such as Education and Healthcare, Leisure and Hospitality, and Personal Services. These industries are considered non-basic industries, and except for Leisure and Hospitality, do not bring money into the local economy and as a result have smaller multiplier impacts on the local economy (Sussex County 2014).

Sussex County employment has decreased in a majority of the industry sectors since 2000 with the exception of Education and Healthcare (25.8 percent), Leisure and Hospitality (28.5 percent), and Other Services (47.7 percent). All other industries are below their 2000 employment levels, with many industries significantly below, including Information (55.1 percent), Manufacturing (21.2 percent), and Professional and Business Services (20.8 percent) (Sussex County 2014).

3.5 DEVELOPMENT TRENDS AND NEW DEVELOPMENT

An understanding of population and development trends can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place to protect human health and community infrastructure. The DMA 2000 requires that communities consider land use trends, which can impact the need for, and priority of, mitigation options over time. Land use and development trends significantly impact exposure and vulnerability to various hazards. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

Local zoning and planning authority are provided for under the New Jersey Municipal Land Use Law, which gives municipalities zoning and planning authority. Refer to Sections 5 (Capability Assessment) and Section 9 (Jurisdictional Annexes) for further details on the planning and regulatory capabilities for the County and each municipality.

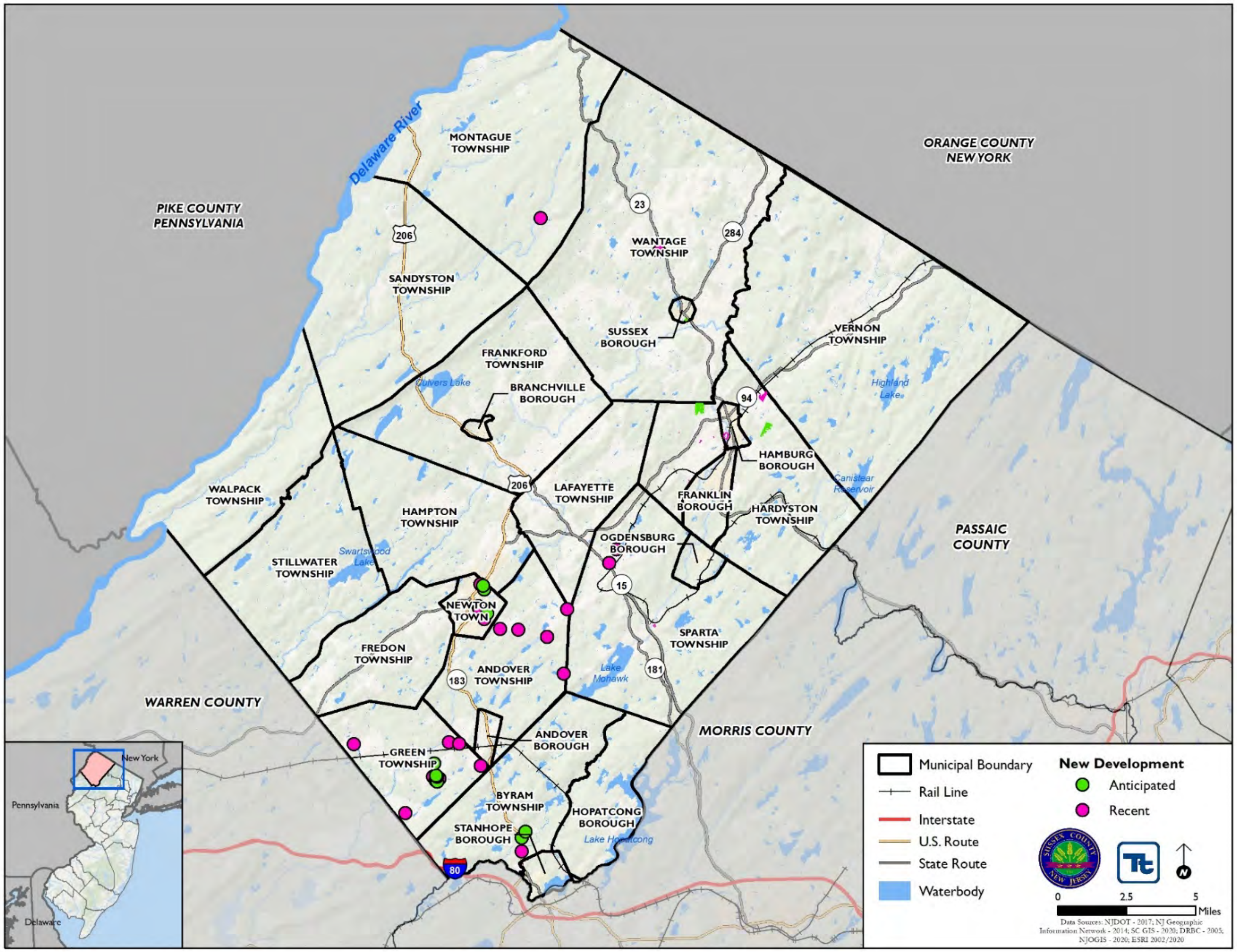
Sussex County is located partially in the New Jersey Highlands Region Preservation Area and partially in the Planning Area. The Highlands Region was officially formed in 2004 to support more regional approaches to land and water conservation, preservation, and management. The Region is found in New Jersey but also neighboring states of New York, Pennsylvania, and Connecticut. The County recognizes the unique value of the Highlands Area and seeks to protect and enhance it while ensuring that land use and development activities occur only in a manner and location that is consistent with the Highlands Regional Master Plan.

The Sussex County Economic Development Partnership (SCEDP) facilitates the recruitment, retention, and expansion of businesses that will complement and be consistent with the character and environment of the County. Additionally, the Sussex County Planning Board is responsible for approving site plan and subdivision applications within their jurisdiction. A development review committee reviews all applications and acts on behalf of the Planning Board.

The New Jersey Highlands Council has identified areas of existing development as well as areas of potential growth that may provide insight as to where potential new development may occur in Sussex County. These areas include the Existing Community Zone (both in-fill of new development and re-development) and Designated Centers; refer to Figure 3-9. The New Jersey Highlands Council assists with planning and considers hazard areas such as floodplains when evaluating new and re-development in the region. In addition, the NJDEP Sewer Service Areas are also shown. These areas show the planned method of wastewater disposal for specific areas, i.e. whether the wastewater will be collected to a regional treatment facility or treated on site and disposed of through a surface water discharge of groundwater discharge.

According to the Sussex County Department of Planning and Economic Development website, there has been a total of 308 permits for new residential buildings from 2015 to 2017 with the largest increase in multi-family use; more recent data is not posted at this time (https://www.sussex.nj.us/documents/planning/residential-building-permits-2010-2017.pdf). New development that has occurred in the last five years within the County and potential future development in the next five years has been identified by each municipality. An exposure analysis was conducted to determine the relationship between the identified potential new development and natural hazard areas evaluated in the HMP update. The results of this spatial analysis have been reviewed with each jurisdiction and are documented in Table 9.X-2 in each jurisdiction annex. In addition, the summary of this analysis and hazard-specific maps are included at the end of each vulnerability assessment (Section 4 – Risk Assessment). Figure 3-9 illustrates the potential new development identified by each jurisdiction, as well as Highlands Existing Community Zones, Designated Centers and Sewer Service Areas which are areas of potential future growth in Sussex County.

Figure 3-11. Areas of Potential Growth and Development in Sussex County



3.6 CRITICAL FACILITIES AND LIFELINES

Critical facilities and infrastructure are necessary for a community's response to and recovery from natural hazard events. Critical facilities include essential facilities, transportation systems, lifeline utility systems, high potential loss facilities and hazardous material facilities. Transportation systems include roadways, bridges, airways, and waterways. Utility systems include potable water, wastewater, oil, natural gas, electric power facilities, and emergency communication systems.

A comprehensive inventory of critical facilities in Sussex County was updated from the 2016 HMP. The Sussex County DEM, Sussex County Division of Planning and individual municipalities provided additional information regarding new, existing, and closed critical facilities.

Critical facilities and infrastructure provide services and functions essential to a community, especially during and after a disaster. As defined for this HMP, critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities and hazardous material facilities.

A ***community lifeline***, a type of critical facility, enables the continuous operation of government functions and critical business and is essential to human health and safety or economic security.

An enhancement to the 2021 HMP was the identification of community lifelines across Sussex County. Sussex County's definition for a lifeline aligns with FEMA: "a type of critical facility that 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." Identifying community lifelines will help government officials and stakeholders to prioritize, sequence, and focus response efforts towards maintaining or restoring the most critical services and infrastructure within their respective jurisdiction(s). Identifying potential impacts to lifelines can help to inform the planning process and determining priorities in the event an emergency occurs; refer to Appendix E for the FEMA fact sheet on lifelines. Overall, there are 590 critical facilities in Sussex County all of which are identified as community lifelines. This inventory is used for the risk assessment in Section 4.

The inventory developed for the HMP update is considered sensitive information. It is protected by the Protected Critical Infrastructure Information (PCII) program and under New Jersey Executive Order 21. Therefore, individual facility names and addresses are not provided in this HMP. A summary of the facility types used for the risk assessment are presented further in this section.

3.6.1 ESSENTIAL FACILITIES

This section provides information on emergency facilities, hospital and medical facilities, schools, shelters, and senior care and living facilities. As stated above, these assets provide indispensable services that need to remain in operation before, during and after natural hazard events. Refer to Section 9 (Jurisdictional Annexes) for mitigation strategies identified by plan participants to reduce future impacts to vulnerable essential facilities and lifelines. Figure 3-11 illustrates the inventory of these essential facilities in Sussex County.

> ***Essential facilities*** are a subset of critical facilities that include those facilities that are important to ensure a full recovery following the occurrence of a hazard event. For the County risk assessment, this category was defined to include police, fire, EMS, EOCs, schools, shelters, senior facilities and medical facilities.
>
> ***Emergency Facilities*** are for the purposes of this Plan, emergency facilities include police, fire, emergency medical services (EMS) and emergency operations centers (EOC).

Emergency Facilities

For the purposes of this HMP, emergency facilities include police, fire, EMS and emergency operations centers (EOC). Sussex County has a highly coordinated and interconnected network of emergency facilities and services at the County and municipal level. The Sussex County Sheriff Department's DEM serves as the primary coordinating agency between local, state and federal agencies. In response to an emergency event, the Division will work with County and municipal health agencies and healthcare providers, emergency facilities and the Sheriff's Department to provide aid to residents of the County.

Each municipality is responsible for maintaining its own fire department with the exception of Walpack Township who has a shared agreement with the Sandyston Township Volunteer Fire Department. Andover Township, Byram Township, Franklin Borough, Hamburg Borough, Hardyston Township, Hopatcong Borough, Newton Town, Ogdensburg Borough, Sparta Township, Stanhope Borough, and Vernon Township all maintain their own police department and provide support to surrounding municipalities. All of the municipalities also maintain their own emergency medical service facilities with the exception of Andover Borough, Branchville Borough, Hamburg Borough, Hampton Township, Sandyston Township, Sussex Borough, and Walpack Township.

Overall, there are 12 enforcement facilities, 65 fire and EMS facilities, and 9 EOCs in Sussex County.

Hospital and Medical Facilities

Sussex County has a dynamic health care industry that includes hospitals, adult day care centers, and long-term care facilities. The two major health centers in the County are Newton Memorial Hospital in Newton Town and Saint Claire's Hospital in Sussex Borough. Additionally, adult care and long-term care facilities are located in Andover Borough, Andover Township, Hampton Township, Hopatcong Borough, Newton Town, and Sparta Township.

Schools

More than 50 schools, ranging from elementary to post-secondary education, service the County. Schools can function as shelters in times of need and are important resource for the community. Several municipalities have their own school systems, while several others are serviced by regional school districts. The primary higher education school in Sussex County is Sussex County Community College in Newton.

There is a total of 54 education facilities located in the County.

Shelters

There were 29 shelters identified within the County during this planning process; many of which are schools, community centers, and municipal buildings.

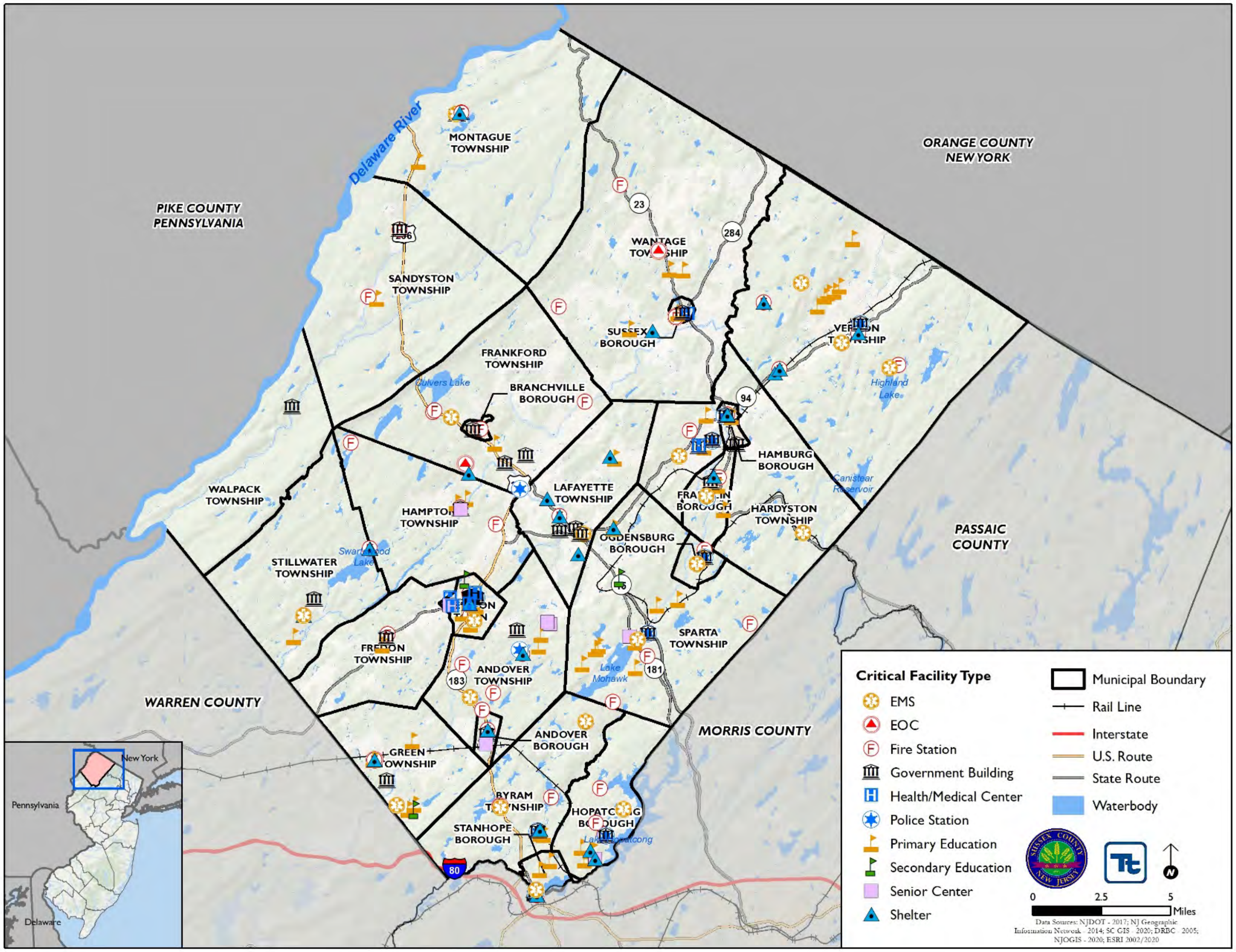
Senior Care and Living Facilities

It is important to identify and account for senior facilities, as they are highly vulnerable to the potential impacts of disasters. Understanding the location and numbers of these types of facilities can help manage effective response plan post disaster. There are seven senior facilities located in the inventory for the risk assessment.

Government Buildings

In addition to the facilities discussed, other County and municipal buildings, and department of public works facilities are essential to the continuity of operations pre-, during and post-disasters. There are 37 additional government facilities located in the County.

Figure 3-12. Essential Facilities in Sussex County



3.6.2 TRANSPORTATION SYSTEMS

One of the County's strongest assets is its transportation infrastructure. Air and land are available and major roadways include Interstate 80, State Routes 15, 23, 94, 181, and 284, and US Route 206. There are three private airports in the County, and 29 bus and park and ride locations. Figure 3-13 illustrates the transportation facilities in Sussex County.

Three organizations provide limited public transportation services within Sussex County, between Sussex County and Morris County, and extended service to Newark and New York. New Jersey Transit (NJ Transit) provides bus service for County residents. Sussex County Transit provides deviated fixed route and demand response service for the general public and paratransit mobility options for elderly or disabled residents. Lakeland Bus Lines, under contract with NJ Transit, provides service between Sussex County and adjacent counties as well as commuter service to Newark and New York. There are also private agencies in the County that provide transportation for their clients who are either elderly or disabled (Sussex County 2005).

Bus Service

The NJ Transit provides bus service to Sussex County residents. The NJ Transit directly operates some of the services that they provide and contracts out to local providers for other services. The NJ Transit provides one bus route in Sussex County through its Wheels program. The Sparta Diamond Express bus provides peak hour service between Sparta Township and Parsippany (Sussex County 2005).

Lakeland Bus Lines, Inc. operates five routes that are available to County residents under contract by the NJ Transit. Two of the five routes are operated inside Sussex County. One is a local circulator and the other is a commuter service to New York City. The other three routes provide commuter service to New York City starting in Dover (Sussex County 2005).

Sussex County Transit provides both fixed route and demand response services in the County. The fixed routes are open to the public but the demand response paratransit service is only available to senior citizens and persons with disabilities (Sussex County 2005).

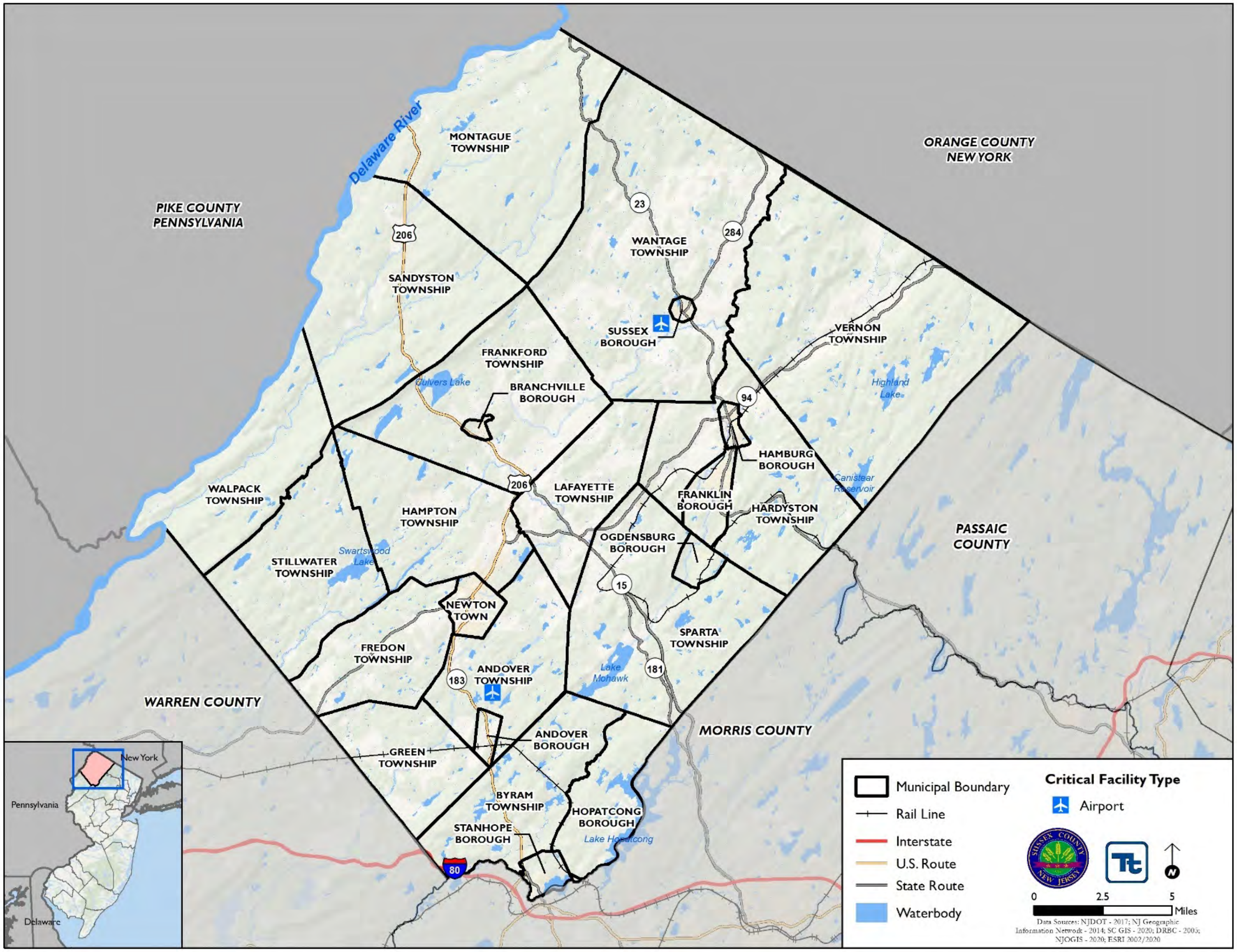
Rail Service

Passenger rail service does not enter Sussex County; residents travel to Morris and Warren Counties to use rail service (Sussex County 2005). The County maintains a freight rail that is operated by regional and short line railroads.

Sussex County Skylands Ride

The Sussex County Skylands Ride is a transportation service that provides five transportation services for Sussex County residents. During the week, the Skylands Connect service runs between the Sussex-Wantage Library and Hampton Township with stops in Hamburg Borough, Franklin Borough, Ogdensburg Borough, Sparta Township, and Newton Town; the Skylands Connect Saturday service is also provided and follows the same route. Skylands New Freedom services is offered on weekdays and runs between the Newton Park & Ride and Netcong train station. Skylands On-Request is provided to senior citizens, veterans, people with disabilities, and residents going to work, school, or training. The Shopper's Service provides scheduled transportation to various stores in the County. Depending on the day, the service is provided to varying communities throughout the County (Sussex County 2020).

Figure 3-13. Transportation Facilities in Sussex County



3.6.3 LIFELINE UTILITY SYSTEMS

This section presents communication, potable water, wastewater, and energy resource utility system data. Due to heightened security concerns, local utility lifeline data sufficient to complete the analysis have only partially been obtained.

Communication

Sussex County has a network of communication facilities and cell towers. These facilities are controlled by both public and private institutions. The County identified six essential communication facilities for the purposes of this plan.

Potable Water

There are community water supply systems in Sussex County that serve municipalities, places with higher density development, and some lake communities. Twenty-one of the County's municipalities are partially or fully served by public water. The Townships of Lafayette, Sandyston, and Walpack do not have public water supply systems (Wastewater Management Plan 2017).

Approximately 95-percent of Sussex County residents rely on groundwater for consumption. It is pumped to County residents from aquifers through either private on-site wells, community wells, or municipal wells (Natural Resources Inventory 2014).

There are five surface water bodies that are used for potable water supply purposes in Sussex County:

- Morris Lake in Sparta Township – used by the Town of Newton
- Lake Rutherford in Wantage Township – used by the Borough of Sussex
- Branchville Reservoir in Frankford Township – used by the Borough of Branchville
- Franklin Pond in the Borough of Franklin – used by the Borough as an emergency water supply
- Lake Hopatcong – used as emergency water supply for several municipalities
- Canistear Reservoir in Vernon Township – located on the Newark water supply management lands
- Heaters Pond in Ogdensburg – used as an emergency water supply

(Natural Resources Inventory 2014).

The County identified ten potable water pumps, two potable water treatment facilities, and 12 wells as critical assets for the purposes of this planning effort.

Wastewater Facilities

The Sussex County Municipal Utilities Authority (SCMUA) operates the largest sewer treatment plant, located in Hardyston Township. The SCMUA also operates other wastewater facilities in the County, including the Hampton Commons facility in Hampton Township. Additionally, the Town of Newton is the owner and operator of its own wastewater treatment plant. The Musconetcong Sewer Authority owns and operates a wastewater treatment plant located in Mount Olive (Morris County), which provides sewer service into Stanhope, Byram, and Hopatcong in Sussex County and portions of Morris County. There are smaller treatment plants located throughout the County that serve schools, commercial, and industrial sites. There are no combined sewers in Sussex County(Wastewater Management Plan 2017).

Table 3-10. Wastewater Districts, Franchise Areas and Municipalities

Wastewater Utility	Municipalities
Sussex County Municipal Utilities Authority	Andover Borough, Andover Twp., Branchville, Frankford, Franklin, Green, Hamburg, Hardyston, Lafayette, Montague, Ogdensburg, Sandyston, Sparta, Stillwater, Sussex, Vernon, Walpack, Wantage
Musconetcong Sewer Authority District	Byram, Hopatcong, Stanhope
Hardyston Township Municipal Utilities Authority	All of Hardyston Township, except Aqua NJ area
Town of Newton	Newton
Aqua NJ – Wallkill (owns Wallkill Sewer Company)	Portion of Hardyston Township
Andover Utility Company Inc.	Portion of Andover Township
Montague Sewer Company (owned by Utilities Inc.)	Portion of Montague
Vernon Township Municipal Utilities Authority	Portion of Vernon Township

Source: Sussex County Wastewater Management Plan 2017

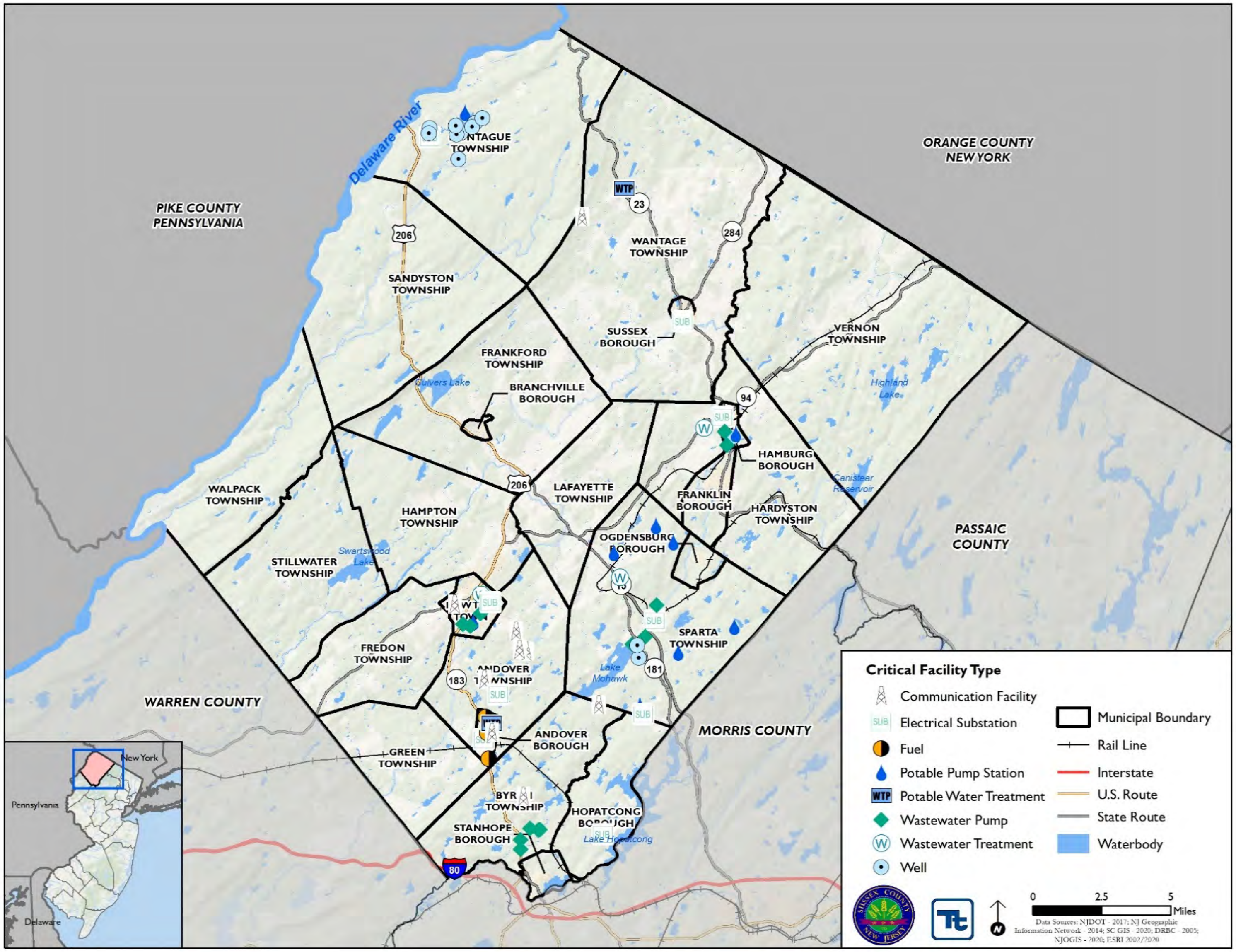
The County identified three wastewater treatment plants and 14 wastewater pump stations identified as critical.

Energy Resources

JCP&L is the primary electric and gas utility company in Sussex County with Sussex Rural Electric Cooperative also providing electric to many of the communities. A portion of the Susquehanna-Roseland line, owned by PSE&G, runs through Fredon, Andover Township, Byram, and Hopatcong in southern Sussex County (PSE&G). There were seven electric substations identified by the County as critical assets.

Figure 3-13 illustrates the general location of the utility lifelines in Sussex County.

Figure 3-14. Utilities in Sussex County



3.6.4 HIGH-POTENTIAL LOSS FACILITIES

High-potential loss facilities include dams and hazardous material sites. Figure 3-15 displays the general locations of dams and hazmat sites in the County and are discussed further below.

According to the NJDEP, there are four hazard classifications of dams in New Jersey. The classifications relate to the potential for property damage and/or loss of life should the dam fail:

- Class I (High-Hazard Potential) - Failure of the dam may result in probable loss of life and/or extensive property damage
- Class II (Significant-Hazard Potential) - Failure of the dam may result in significant property damage; however loss of life is not envisioned.
- Class III (Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life and/or significant property damage.
- Class IV (Small-Dam Low-Hazard Potential) - Failure of the dam is not expected to result in loss of life or significant property damage.

According to the NJDEP Bureau of Dam Safety, there are 239 dams located in Sussex County, 40 of which are classified with a high-hazard potential.

3.6.5 OTHER FACILITIES

The Planning Partnership identified additional facilities (user-defined facilities) as critical. These facilities include one correctional facility, 21 DPW sites, seven food pantries, and three post offices. Figure 3-16 illustrates the general locations of these facilities.

Figure 3-15. High-Potential Loss Facilities in Sussex County

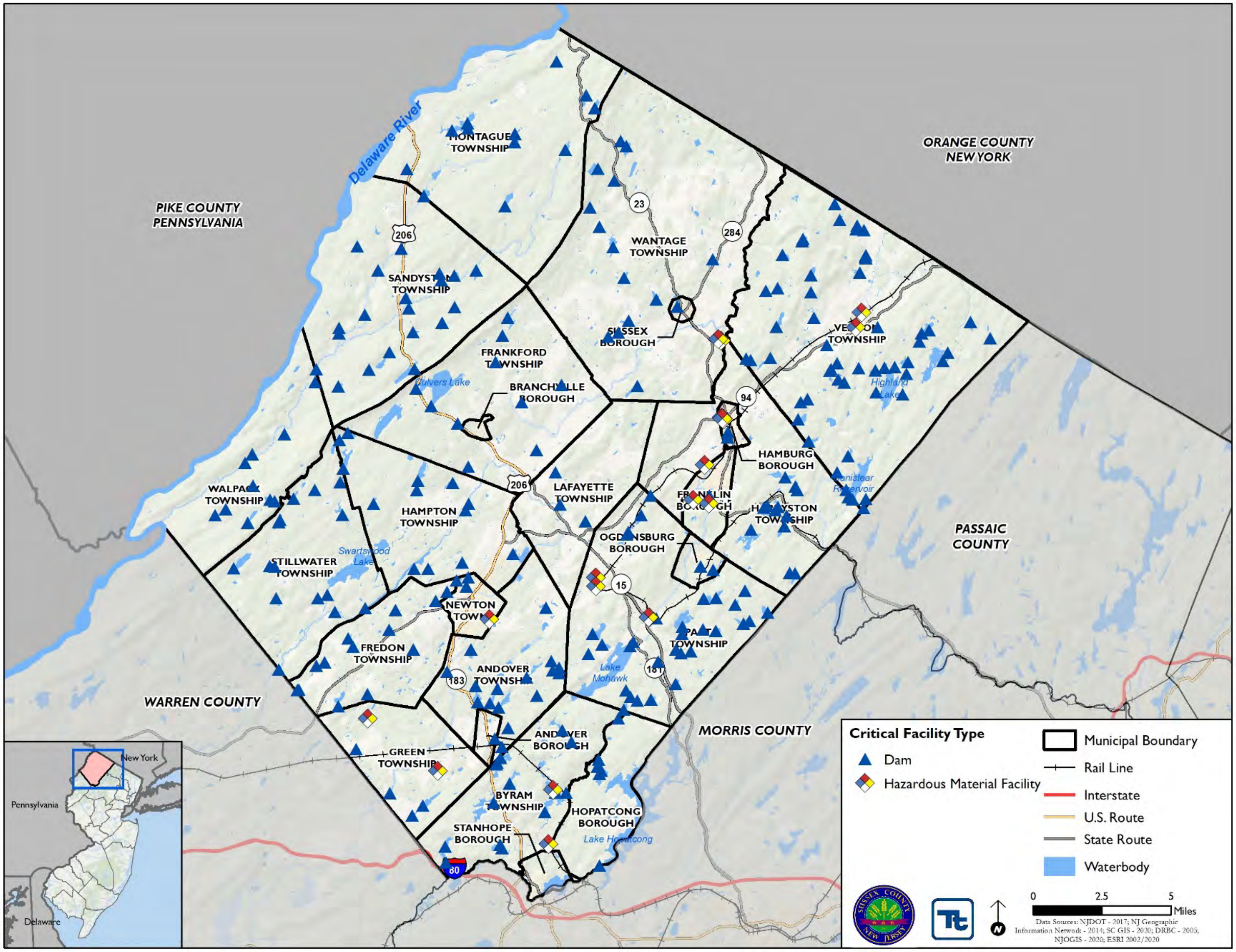
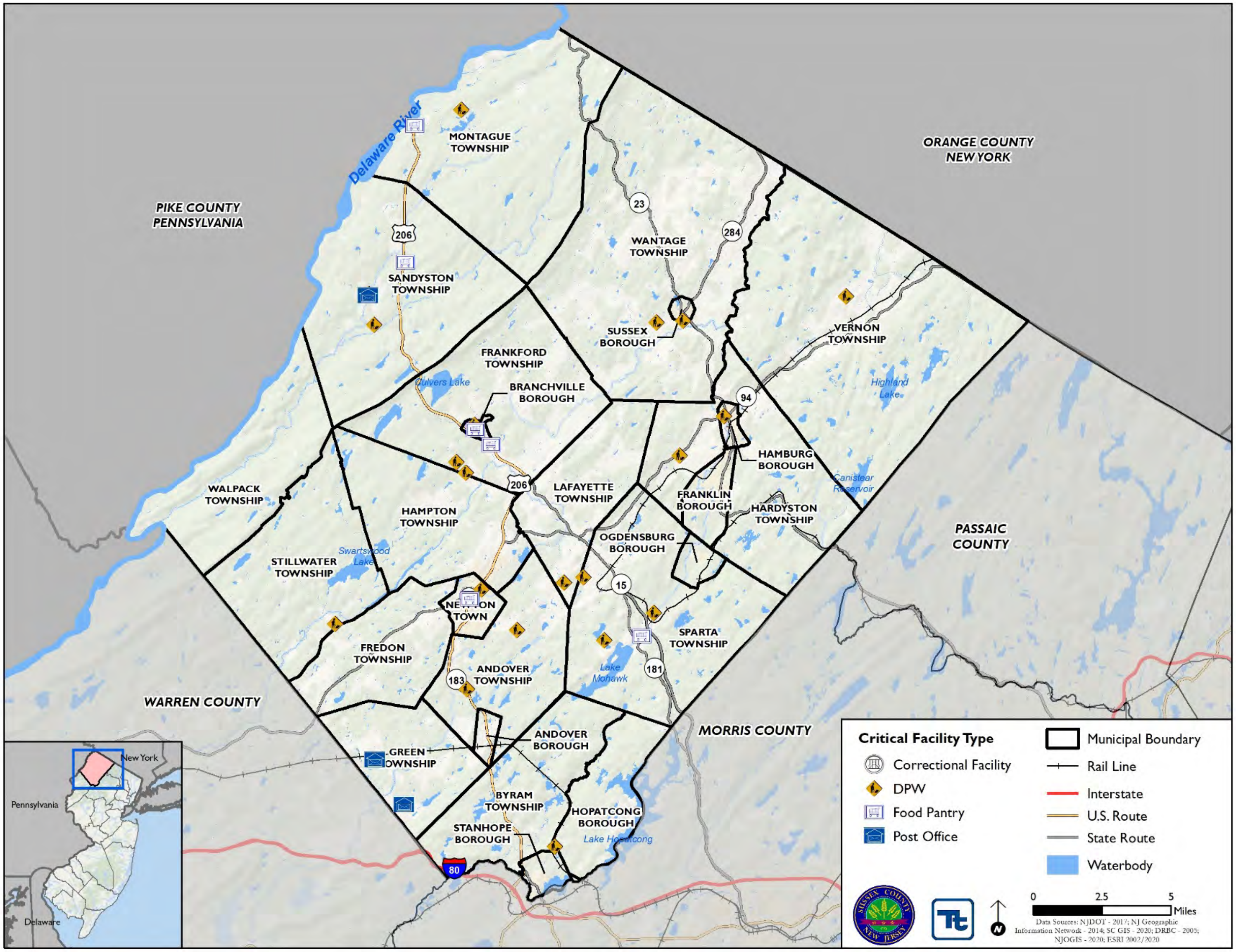


Figure 3-16. Other Critical Facilities in Sussex County



SECTION 4. RISK ASSESSMENT

A risk assessment is the process of measuring the potential loss of life, personal injury, economic and property damage resulting from identified hazards. It allows planning personnel to address and reduce hazard impacts and emergency management personnel to establish early response priorities by identifying potential hazards and vulnerable assets. Results of the risk assessment are used to inform mitigation planning processes, including determining and prioritizing mitigation actions that reduce a community's risk to a specified hazard. Past, present, and future conditions must be evaluated to most accurately assess risk for each jurisdiction. The Sussex County risk assessment is presented in Section 4 and outlined as follows:

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

4.1 IDENTIFICATION OF HAZARDS OF CONCERN

2021 HMP Changes

- The 2016 HMP 'Hazard Identification' was presented in subsection 5.2. For the 2021 HMP update, it is presented in subsection 4.1 (Identification of Hazards of Concern).
- The 2021 HMP flood hazard includes increased discussion of urban flooding and two new hazards of concern: disease outbreak and infestation and invasive species.

Hazards of Concern are defined as those hazards that are considered most likely to impact a community. These are identified using available data and local knowledge.

To provide a strong foundation for mitigation strategies considered in Section 6 (Mitigation Strategy) and Section 9 (Jurisdictional Annexes), Sussex County considered a full range of hazards that could impact the area, and then identified and ranked those hazards that presented the greatest concern. The natural hazard of concern identification process incorporated input from the County and participating jurisdictions; review of the State of New Jersey Hazard Mitigation Plan (NJ HMP) and previous hazard identification efforts; research and local, state, and federal information on the frequency, magnitude, and costs associated with the various hazards that have previously, or could feasibly, impact the region; and qualitative or anecdotal information regarding natural hazards and the perceived vulnerability of the study area's assets to them. Table 4.1-1 documents the process of identifying the natural hazards of concern for further profiling and evaluation.

For the purposes of this planning effort, the Planning Partnership chose to group some natural hazards together, based on the similarity of hazard events, their typical concurrence or their impacts, consideration of how hazards have been grouped in FEMA guidance documents (FEMA 386-1, "Understanding Your Risks, Identifying Hazards and Estimating Losses; FEMA's "Multi-Hazard Identification and Risk Assessment – The Cornerstone of the National Mitigation Strategy"), and consideration of hazard grouping in the NJ HMP. With the exception of hazardous substance release (fixed and in-transit), Sussex County chose to focus on natural hazards in this plan as non-natural hazards (technological and intentional hazards) are covered in other local and State plans.

Table 4.1-1. Identification of Natural Hazards of Concern for Sussex County

Hazard	Is this a hazard that may occur in Sussex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
Avalanche	No	No	• The NJ HMP does not identify avalanche as a hazard of concern for New Jersey. • The topography and climate of Sussex County does not support the occurrence of an avalanche event. • New Jersey in general has a very low occurrence of avalanche events based on statistics provided by the American Avalanche Association (AAA) between 1950 and 2014.	• NJ HMP • Review of NAC-AAA database • Steering and Planning Committee Input
Coastal Erosion	No	No	• The NJ HMP identifies coastal erosion as a hazard of concern for New Jersey. Counties bounded by coastal waters are most affected by coastal erosion. • Sussex County is not bounded by coastal waters or located in the Coastal Erosion Hazard Area (CEHA).	• NJ HMP • NOAA • Steering and Planning Committee Input
Coastal Storm	Yes	Yes	See Hurricane and Nor'Easter	
Dam Failure	Yes	Yes	• The NJ HMP identifies dam failure as a hazard of concern for New Jersey. • According to NJDEP, Sussex County has 239 dams (40 high hazard, 41 significant hazard, 158 low hazard).	• NJ HMP • NJ DEP • Steering and Planning Committee Input
Disease Outbreak	Yes	Yes	• The NJ HMP identifies pandemic as a hazard of concern for New Jersey. • According to the NJ HMP, New Jersey's geographic and demographic characteristics make it particularly vulnerable to importation and spread of infectious diseases. All 21 counties in New Jersey have experienced the effects of a pandemic or disease outbreak. • Sussex County has been impacted by mosquito and tick-borne diseases, food-borne illness and most recently the COVID-19 pandemic. • Sussex County was part of a statewide emergency declaration for West Nile Virus in 2000 (EM-3156) and the DR-4488/EM-3451 for COVID-19.	• NJ HMP • FEMA • Steering and Planning Committee Input
Drought	Yes	Yes	• The NJ HMP identifies drought as a hazard of concern for New Jersey. • The drought hazard is a concern for Sussex County because the County's water is supplied by both surface water and groundwater. Surface water supplies are affected more quickly during droughts than groundwater sources. • Nearly 10% of the County's land use is agricultural and agriculture is an important economic sector to plan participants. • The USDA declared an agricultural disaster for Sussex County in 2015 (excessive heat and drought).	• NJ HMP • USGS • NRCC • NOAA • NOAA-NCEI Storm Database • Steering and Planning Committee Input

Hazard	Is this a hazard that may occur in Sussex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
Earthquake	Yes	Yes	• The NJ HMP identifies earthquake as a hazard of concern for New Jersey. Although they are known to occur on a regular basis, records indicate that no major earthquakes have struck the State since the establishment of historical record-keeping (1500's). • Sussex County is located in the Highlands and Valley and Ridge Physiographic Provinces and near the Ramapo Fault line. • Since 2015, there have been two earthquakes in the region that were felt in Sussex County.	• NJ HMP • NJDEP • NJGS • Steering and Planning Committee Input
Expansive Soils	Yes	No	• The NJ HMP does not identify expansive soils as a hazard of concern for New Jersey. • Soils that expand (swell) as they become wet and contract (shrink) as they dry are called expansive soils. This change can cause the ground to move up and down several inches during a cycle of wetting and drying. Expansive soils that are predominately clay minerals have the ability to absorb water. • According to the USGS 1989 Swelling Clays Map of the Conterminous United States, Sussex County soils have slight to moderate swelling potential and in some areas, contain little or no swelling clay. Based on the soil type and no history of expansive soil incidence occurring in the County, expansive soils are not a hazard of concern for Sussex County.	• NJ HMP • USGS 1989 Swelling Clays Map of the Conterminous U.S. • Steering and Planning Committee Input
Extreme Temperature	Yes	Yes	Please see Severe Weather.	
Flood (Riverine, Flash Flooding, and Urban Flooding)	Yes	Yes	• The NJ HMP identifies flooding as a hazard of concern in New Jersey. • Sussex County has 28 NFIP policies and 243 Write-Your-Own policies. • There has been a total of over $1.7 million paid claims in Sussex County. • There are 16 repetitive and severe repetitive loss properties in the County. • A total of 66 facilities identified as lifelines in Sussex County are exposed to the 1-percent annual chance flood hazard event.	• NJ HMP • FEMA • FEMA FIS • NFIP • NOAA-NCEI Storm Database • Steering and Planning Committee Input
Geological Hazards	Yes	Yes	• The NJ HMP identifies geological hazards as a hazard of concern for New Jersey. • There have been historic debris flow, rockfall and rockslide landslide events in Sussex County. • Carbonate rock formations are found in the northern portion of the County which are susceptible to natural subsidence. • The southeastern areas of Sussex County contain numerous abandoned mines.	• NJHMP • NJGWS • NJDEP • Steering and Planning Committee Input

Hazard	Is this a hazard that may occur in Sussex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			• Between 2015 and 2020, there have been no identified geological hazard events in Sussex County.	
Hailstorm	Yes	Yes	Please see Severe Weather.	
Hurricane (and other Tropical Cyclones)	Yes	Yes	• The NJ HMP identifies hurricanes/tropical storms as hazards of concern for New Jersey. • Due to its proximity to the Atlantic Ocean, Sussex County is susceptible to hurricanes and tropical storms. • In 2020, two tropical storms came within 65 nautical miles of Sussex County.	• NJ HMP • FEMA • NOAA-NHC • NOAA-NCEI Storm Database • Steering and Planning Committee Input
Ice Storm	Yes	Yes	Please see Severe Winter Weather.	
Infestation and Invasive Species	Yes	Yes	• Sussex County has a diverse landscape with development woven through natural areas. • Pests in Sussex County that compete for natural resources or transmit diseases to humans, livestock and the environment include insects and invasive plants. • Due to large forested areas and the abundance of parkland throughout the County, pests that damage trees have become an increased focus. • Sussex County has experienced harmful algal blooms in the past causing impacts to natural systems and the local economy. • Infestation and invasive species is added as a new hazard of concern to the 2021 HMP update.	• Steering and Planning Committee Input
Land Subsidence	Yes	No	Please see Geological Hazards.	
Landslide	Yes	No	Please see Geological Hazards.	
Nor'Easters	Yes	Yes	• The NJ HMP identifies Nor'Easters as a hazard of concern for New Jersey. • Due to its proximity to the Atlantic Ocean and location geographically, Sussex County is susceptible to Nor'Easters. • Between 2015 and 2020, Sussex County experienced several impactful Nor'Easter events.	• NJ HMP • FEMA • NOAA • NOAA-NCEI Storm Database • Steering and Planning Committee Input
Radon	Yes	No	• Radon is a naturally-occurring radioactive gas, which has always been a part of our environment. It's a natural decay product of uranium and is found in soil everywhere in varying concentrations and is a serious health risk. • The NJ HMP does not identify radon as a hazard of concern for New Jersey.	• NJ HMP

Hazard	Is this a hazard that may occur in Sussex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			• The revised building code requires radon control measures be installed for new construction. • Testing is required at time of real estate transactions. • The Sussex County Division of Health has information regarding this hazard posted on their website. https://www.sussex.nj.us/cn/webpage.cfm?tpid=9641 • The Borough of Franklin has information on their municipal website with the radon map and the Radon Awareness Program: http://www.franklinborough.org/. The Mayor of Franklin declared February Radon Awareness Month as noted in their Press Release. • Hampton Township advertises on their website that residents can obtain free radon testing kits at municipal offices: http://www.hamptontownshipnj.info/. In addition, the Township's proclamation identifies January as Radon Awareness Month. • This hazard was not evaluated further in the 2021 HMP.	
Severe Weather (Extreme Temperatures, Windstorms, Thunderstorms, Hail, Lightning, and Tornados)	Yes	Yes	• The NJ HMP identifies severe weather as a hazard of concern for New Jersey. • Severe weather events occur annually in Sussex County causing a range of impacts from property damage, flooding and loss of power. • NOAA's NCEI storm events database indicates that Sussex County was impacted by approximately 45 severe weather events between 2015 and 2020. • The largest hailstone on record for Sussex County was 1.75 inches. • The strongest tornado on record in Sussex County was an EF-2. • The NJ HMP identifies extreme temperature as a hazard of concern for New Jersey as a type of severe weather. • Sussex County has experienced excessive heat and extreme cold temperature events.	• NJ HMP • NOAA – NCEI • FEMA • NJ OEM • ONJSC • Steering and Planning Committee Input
Severe Winter Weather (Heavy Snow, Blizzards, Freezing Rain/Sleet, Ice Storms)	Yes	Yes	• The NJ HMP identifies severe winter weather as a hazard of concern for New Jersey. • Normal seasonal snowfall in Sussex County ranges between 40 to 50 inches. • NOAA-NCEI has indicated that Sussex County has experienced the impacts of 16 severe winter weather events between 2015 and 2020.	• NJ HMP • FEMA • NOAA – NCEI Storm Database • ONJSC • Steering and Planning Committee Input
Tornado	Yes	Yes	Please see Severe Weather.	
Tsunami	No	No	• The NJ HMP does identify tsunami as a hazard of concern for New Jersey. • Sussex County is not bounded by coastal waters; therefore, tsunami is not identified as a hazard of concern.	• NJ HMP • Steering and Planning Committee Input

Hazard	Is this a hazard that may occur in Sussex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
Volcano	No	No	• The NJ HMP does not identify volcano as a hazard of concern for New Jersey.	• NJ HMP
Wildfire	Yes	Yes	• The NJ HMP identifies as wildfire as a hazard of concern for New Jersey. • In Sussex County, nearly 70 square miles are located in the extreme and very high wildfire fuel zones according to the New Jersey Forest Fires Service. • Between 2015 and 2020, there was one wildfire in Sussex County that damaged a home. • Based on input from the Planning Committee, wildfire is considered a hazard of concern for Sussex County due to the large areas of State forests and development proximate to these areas.	• NOAA – NCEI Storm Events Query • USGS • NJ HMP • NJFFS • Steering and Planning Committee Input
Windstorm	Yes	Yes	Please see Severe Weather.	

DIR	*Drought Impact Reporter*
DR	*Presidential Disaster Declaration Number*
EM	*Presidential Disaster Emergency Number*
FEMA	*Federal Emergency Management Agency*
HMP	*Hazard Mitigation Plan*
K	*Thousands ($)*
M	*Millions ($)*
NCEI	*National Oceanic and Atmospheric Administration National Climatic Data Center*
NJ	*New Jersey*
NJDEP	*New Jersey Department of Environmental Protection*
NJDOH	*New Jersey Department of Health*
NJFFS	*New Jersey Forest Fire Service*
NJGS	*New Jersey Geological Survey (as part of the NJDEP)*
NOAA	*National Oceanic and Atmospheric Administration*
NRCC	*Northeast Regional Climate Center*
NWS	*National Weather Service*
OEM	*Office of Emergency Management*
ONJSC	*Office of New Jersey State Climatologist*
SPC	*Storm Prediction Center*
USGS	*U.S. Geologic Survey*

Table 4.1-2. Identification of Non-Natural Hazards of Concern for Sussex County

Hazard	Is this a hazard that may occur in Sussex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
Hazardous Substances	Yes	Yes	• The NJ HMP identifies hazardous substances as a hazard of concern for New Jersey. • Major highways in the County over which hazardous materials are transported daily include U.S. Route 206 and State Highway 15. • Hazardous substances may also be transported via rail or pipeline in the County. • Between 2015 and 2018, Sussex County had a total of 36,960 pounds of chemicals released on-site (USEPA 2020). • In 2015, a rail accident occurred involving hazardous materials. • The Planning Committee identified hazardous substances as a hazard of concern for Sussex County due to its extensive transportation network and vulnerability to surrounding communities if there is a release.	• NJ HMP • NJ.com • USEPA • PHMSA • Steering and Planning Committee Input

NJ HMP *New Jersey Hazard Mitigation Plan*
PHMSA *Pipeline and Hazardous Materials Safety Administration*
USEPA *United States Environmental Protection Agency*

According to input from the County, and review of all available resources, a total of 12 natural hazards and one human-caused hazards of concern were identified as significant hazards affecting the entire planning area, to be addressed in this plan.

Natural Hazards of Concern:

- Dam Failure
- Disease Outbreak
- Drought
- Earthquake
- Flood (including riverine, flash, urban flooding)
- Geologic (landslide, subsidence, and sinkholes)
- Hurricane and Tropical Storm
- Infestation and Invasive Species
- Nor'Easter
- Severe Weather (High Winds, Tornadoes, Thunderstorms, Hail)
- Severe Winter Weather (Heavy Snow, Blizzards, Ice Storms)
- Wildfire

Human-Caused Hazards of Concern:

- Hazardous Materials (Fixed Sites and Transportation)

There are other natural and human-caused hazard events that have occurred in Sussex County; however, they have a low potential to occur or are covered in other plans that specifically address technological and intentional hazards. Therefore, these hazards will not be further addressed in the 2021 HMP. However, if deemed necessary by the County, these hazards may be considered in future versions of this plan.

4.2 METHODOLOGY AND TOOLS

2021 HMP Changes

The risk assessment was updated using best available information.

- The 2014-2018 American Community Survey (ACS) 5-year Population Estimates were utilized.
- Countywide 2020 parcels, 2018 MOD-IV data, and 2020 RSMeans values were used to develop a structure-level building inventory and estimate replacement cost value for each building.
- The 2016 HMP critical facility inventory was reviewed and updated by the Planning Partnership.
- Community lifelines were identified in the critical facility inventory to align with FEMA's lifeline definition.
- Hazus v4.2 was used to estimate potential impacts to the flood, seismic and wind hazards.

4.2.1 ASSET INVENTORIES

Sussex County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Sussex 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 and community lifelines, information on properties assessed is presented in aggregate, without details about specific individual properties.

Population

Total population statistics from the 2014-2018 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. Borough, town, and township populations were extracted directly from the ACS. 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 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.

FEMA's Hazus program was used to model estimate potential losses to flood, seismic and wind hazards; as discussed further later in this section. Hazus still contains 2010 U.S. Census data and was used to estimate sheltering and injuries as part of the hazard analysis.

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 Sussex County included in the risk assessment are children, elderly, population below the poverty level, non-English speaking individuals, and persons institutionalized with a disability.

Buildings

A custom general building stock was created countywide. To develop the building inventory, updated building footprints provided by Sussex County and parcels from the 2018 MOD-IV tax assessor data obtained from the New Jersey Geographic Information Network Open Data portal were used. Attributes provided in the associated files were used to further define each structure, such as year built, number of stories, basement type, occupancy class, and square footage. The centroid of each building footprint was used to estimate the building location. Structural and content replacement cost values (RCV) were calculated for each building using the available assessor data, the building footprint, and RSMeans 2020 values. The analysis used a location factor of 1.14 and 0.96 for non-residential and residential occupancy classes, respectively. These location factors were associated with the zip-code options for Sussex County. Replacement cost value 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. 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

*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).*

The 2016 HMP critical facility inventory was updated using GIS data provided by Sussex County GIS & Mapping Services. The dataset, which includes essential facilities, utilities, transportation features and user-defined facilities as outlined in Section 3, was enhanced with attributes provided within the spatial layers. The inventory was then reviewed by the Planning Partnership allowing for County and municipal input. 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 the addition of community lifelines in accordance with FEMA's definition; refer to Appendix E (Risk Assessment Supplement). To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities.

New Development

In addition to summarizing the current vulnerability, Sussex County examined new development that can affect the planning area's vulnerability to hazards. New development that occurred within the last five years and development that is projected to occur in the next five years were identified by the County and participating municipalities using Survey123; a cloud-based ESRI ArcGIS online platform. Identifying these changes and integrating them into the risk assessment ensures their vulnerability, if any, is considered when developing the mitigation strategy to reduce future risk. An exposure analysis was conducted and the results shared with the plan participants (one tool in the Mitigation Toolbox discussed in Section 6 – Mitigation Strategy). The new development and exposure analysis results are presented in Section 9 (Jurisdictional Annexes), as a table in each annex.

4.2.2 METHODOLOGY

To address the requirements of the DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Sussex County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three levels of analysis were used depending on the data available for each hazard as described below. Table 4.2-1 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 might be affected by the hazard. If the center of each asset is located in the hazard area, it is deemed exposed and potentially vulnerable to the hazard.

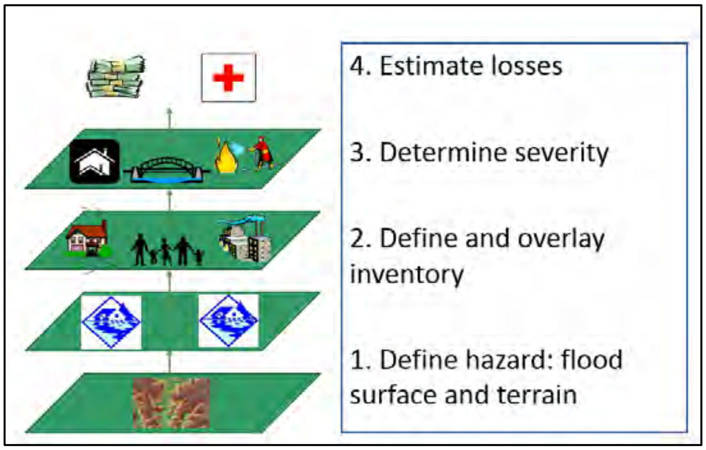
3. **Loss estimation**—The FEMA Hazus modeling software was used to estimate potential losses for the following hazards: flood, earthquake, and hurricane. In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards.

Table 4.2-1 Summary of Risk Assessment Analyses

Hazard	Data Analyzed			
	Population	General Building Stock	Critical Facilities	New Development
Dam Failure	Q	Q	Q	Q
Disease Outbreak	Q	Q	Q	Q
Drought	Q	Q	Q	Q
Earthquake	H	H	H	Q
Flood	E, H	E, H	E, H	E
Geological	E	E	E	E
Hazardous Material Release	E	E	E	E
Hurricane and Tropical Storms	H	H	H	Q
Infestation and Invasive Species	Q	Q	Q	Q
Nor'Easter	Q	Q	Q	Q
Severe Weather	Q	Q	Q	Q
Severe Winter Weather	Q	Q	Q	Q
Wildfire	E	E	E	E

Notes: 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 for identification of 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 (severe storms) and flood (riverine) hazards. Hazus is a Geographic Information System (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 damage reports, 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 Hazus provided 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, 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, probabilistic analyses were performed to develop expected and estimated distribution of losses (mean return period losses) for the flood, seismic and wind hazards. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). Table 4.2-2 displays the various levels of analyses that can be conducted using the Hazus software.

Table 4.2-2. Summary of Hazus Analysis Levels

Hazus Analysis Levels	
Level 1	Hazus provided 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 and is typically done in conjunction with the use of local data.

Dam Failure

A qualitative analysis was conducted for the dam failure hazard. The dam classifications and their status were obtained from NJDEP. For security reasons, these asset locations and downstream inundation due to a failure are not displayed on maps or discussed in this plan.

Disease Outbreak

A qualitative analysis was conducted using data from the County's COVID-19 resource website and research from the Centers for Disease Control and Prevention to review the County's risk to illnesses, including the most recent COVID-19 outbreak.

Drought

A qualitative analysis was conducted for the drought hazard. 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 the 2019 NJ HMP, NJDEP and the National Drought Mitigation Center (NDMC) were used to assess the potential impacts to the population from a drought event.

Earthquake

A probabilistic assessment was conducted for Sussex County for the 100- and 500-year mean return period (MRPs) events through a Level 2 analysis in Hazus 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.*" However, Hazus' potential loss estimates are acceptable for the purposes of this HMP.

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. In 2012, the NJDOT published a map of zip-codes in New Jersey and their associated soil classification. 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. These are referred to as National Earthquake Hazard Reductions Program (NEHRP) soils. The NJDOT map indicates Sussex County contains Class C and D soils. An associated soil layer with Class C and D soils was imported into Hazus to inform the seismic model.

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. 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. For example, two municipalities are located within one census tract. The total replacement cost value of Municipality A is 90% of the total census tract replacement cost value, while Municipality B is 10% of the total value. Therefore, 90% of the losses for the census tract will be applied to Municipality A, and 10% will be applied to Municipality B.

Flood

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

The following data was used to evaluate exposure and determine potential future losses:

- The effective Sussex County FEMA Digital Flood Insurance Rate Maps (DFIRMs) dated September 2011.
- The 1-percent annual chance flood depth grid generated for the 2016 Sussex County HMP which was generated using a DEM from the NJ Office of Information Technology and the base flood and cross-section elevations for the detailed study areas. The depth grid 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 asset inventories (population, building stock, critical facilities, and new development) were overlaid on the 2011 DFIRM. Asset centroids that intersected the flood boundaries were totaled to estimate the building replacement cost value and population located in the FEMA delineated floodplain.

A Level 2 Hazus riverine flood analysis was performed to estimate potential future loss. Both the critical facility and building inventories were formatted to be compatible with Hazus and its Comprehensive Data Management System (CDMS) and integrated into Hazus. The Hazus riverine flood model was run to estimate potential losses in Sussex County for the 1-percent annual chance flood event. A user-defined analysis was also performed for the building stock. Buildings located in the floodplain were imported as user-defined facilities to estimate potential losses 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.

Geological

An exposure assessment was conducted using steep slope and carbonate layers to determine the County's risk to the geologic hazard. Steep slopes are an indication of where slides 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. A steep slope layer was created using NJ DEP contour lines layer. The surface slope was calculated between the contour lines and slopes greater than 15-percent were selected. To determine what assets are exposed to steep slopes and carbonate rock, the County's assets were overlaid with these hazard areas. Assets with their centroid located in the hazard area(s) were totaled to estimate the number (or count) and replacement cost values exposed to a hazard event.

Resources from the New Jersey Geological and Water Survey and 2014 US Geological Survey (USGS) were also referenced to assess potential impacts to the County.

Hazardous Material Release

An exposure analysis was conducted for the County's assets (population, building stock, critical facilities, and new development) using a radius around potential HazMat incident sites as follows: exposure within one mile of 2019 NJDOT railways, exposure within one mile of 2020 EPA Superfund and TRI Sites, and within 50-miles of the Indian Point Energy Center in New York State. 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.

Hurricane/Severe Storm

A Hazus analysis was performed to analyze the potential future wind losses associated with 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 Sussex 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.

Infestations and Invasive Species

A qualitative assessment was conducted to analyze infestation and invasive species on the County. Resources from the USDA Forest Service, New Jersey Department of Agriculture, and NJDEP were referenced to assess the potential impacts to the County's assets.

Nor'Easter

A qualitative assessment was conducted for the Nor'Easter hazard. The Hazus model's wind speeds and associated losses may be used as a reference for Nor'Easter wind impacts. Research from the National Weather Service, National Climatic Data Center, and Office of the New Jersey State Climatologist were used to assess the nature of Nor'Easters and their impact on the County.

Severe Storm

A qualitative assessment was performed to analyze the impacts of severe storm events. Data and studies from the Storm Prediction Center, FEMA, and National Weather Service were analyzed in order to measure the vulnerability of the County to thunderstorms, lightning, hailstorms, windstorms, tornadoes, and extreme temperatures.

Severe Winter Storm

All of Sussex 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.

Wildfire

The NJFFS uses Wildfire Fuel Hazard data to assign wildfire fuel hazard rankings across the State. This data, developed in 2009, is based upon NJDEP's 2002 Land Use/Land Cover datasets and NJDEP's 2002 10-meter Digital Elevation Grid datasets. For the wildfire hazard, the NJFFS Wildfire Fuel Hazard "extreme', 'very high' and 'high' areas are identified as the wildfire hazard area. The defined hazard area was overlaid upon the asset data (population, building stock, critical facilities and potential new development) to estimate the exposure to each hazard.

Asset data (population, building stock, critical facilities, and new development) 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 wildfire, the County's assets 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

- All Hazards
    - Create an updated user-defined general building stock dataset using up-to-date parcels, footprints, and RS Means values.
    - 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.
- Dam Failure
    - Utilize dam failure inundation areas to estimate potential losses.
- Disease Outbreak
    - As more information has been collected about COVID-19, future assessments should consider adding in an evaluation of how the County responded to the pandemic, identify critical facilities with vulnerabilities/limitations to respond effectively, and major transit routes connecting the community to facilities that help treat or vaccinate patients impacted by the pandemic.
- Earthquake
    - Gather more detailed NEHRP soil data to perform an earthquake exposure analysis
    - 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.
- Extreme Temperature
    - 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.
    - Conduct a Hazus loss analysis for more frequent flood events (e.g., 10 and 50-year flood events).
    - 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.
- Geological Hazards
    - A pilot study conducted in Schenectady County, NY (Landslide Susceptibility – A Pilot Study of Schenectady County, NY) provided a detailed methodology for delineating high-risk landslide areas. This study looked at a variety of environmental characteristics including slope and soil conditions to determine areas at risk to landslide. To coincide with the methodology of that study, the generated slopes were categorized into five classes: 0%-2%; 3%-7%; 8%-15%; 16%-25%; Greater than 25%. Should the County determine the need for a more detailed assessment of risk, it could determine steep slope by other percent categorizations. Additional

environmental and soil characteristics used in the Schenectady County plan can be collected and used to follow the methodology used to further delineate the County's most at risk areas.

- Hurricane
  - General building stock inventory can be updated to include attributes regarding protections against strong winds, such as hurricane straps, to enhance loss estimates.
- 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 may 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.

4.2.3 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	2010; 2014-2018	Digital (GIS) format
Building Inventory	Sussex Parcel Data, MOD-IV, Tetra Tech	2020; 2018	Digital (GIS) format
Critical facilities	Sussex Planning Partnership and County Jurisdictions	2020	Digital (GIS) format
Digitized Effective FIRM maps	FEMA	2011	Digital (GIS) format
Digital Elevation Model	NJOIT	2014	Digital (GIS) format
Road and Rail Network	NJDOT	2017; 2019	Digital (GIS) format
Carbonate Hazard Area	USGS	2014	Digital (GIS) format
EPA Superfund and TRI Sites	US EPA	2020	Digital (GIS) format
New Development Data	Sussex County Planning Partnership	2020	Digital (GIS) Format
Wildfire Fuel Hazard	NJDEP/NJFFS	2009	Digital (GIS) format
NEHRP soils by zip-code	NJDOT	2012	Image
Depth Grid	New Jersey State HMP	2014	Digital (GIS) format
Contour Lines	USGS/NJ DEP	1999	USGS Line Graphs converted by NJ DEP to Digital (GIS) format

DEP Department of Environmental Protection
DFIRM Digital Flood Insurance Rate Map
EPA Environmental Protection Agency
FEMA Federal Emergency Management Agency
FIRM Flood Insurance Rate Map
GIS Geographic Information System
NJDEP New Jersey Department of Environmental Protection
NJDOT New Jersey Department of Transportation
NJFFS New Jersey Forest Fire Service
NJOIT New Jersey Office of Information Technology
USDA United States Department of Agriculture
USGS United States Geological Survey

Limitations

For this risk assessment, the 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.

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 to assist in estimating potential losses, Sussex County will collect additional data and update and refine existing inventories.

Potential economic loss is based on the present value of the general building stock using best-available data. The county acknowledges significant impacts can 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, as well as 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.

4.3 HAZARDS OF CONCERN

The Sussex County hazards of concern are presented in Section 4.3 and outlined as follows:

- **Hazard Profile**
  - Location - geographic area most affected by the hazard
  - Extent – severity of each hazard
  - Previous Occurrences and Losses
  - Impacts of Climate Change
  - Probability of Future Hazard Events
- **Vulnerability Assessment**
  - Impact to Life, Health and Safety
  - Impact to the General Building Stock
  - Impact to Critical Facilities and Lifelines
  - Impact to the Economy
  - Impact to the Environment
  - Future Changes that may Impact Vulnerability
  - Change of Vulnerability Since the 2016 HMP

4.3.1 DAM FAILURE

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 dam failure hazard in Sussex County.

2021 HMP Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2015 and 2020.

Profile

Hazard Description

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

- Overtopping caused by floods that exceed the capacity of the dam or levee (inadequate spillway capacity);
- Prolonged periods of rainfall and flooding;
- Deliberate acts of sabotage (terrorism);
- Structural failure of materials used in dam construction;
- Movement and/or failure of the foundation supporting the dam;
- Settlement and cracking of concrete or embankment dams;
- Piping and internal erosion of soil in embankment dams;

- Inadequate or negligent operation, maintenance and upkeep;
- Failure of upstream dams on the same waterway; or
- Earthquake (liquefaction / landslides) (FEMA 2018).

Regulatory Oversight of Dams

Potential for catastrophic flooding caused by dam failures led to enactment of the National Dam Safety Act (Public Law 92-367), which for 30 years has protected Americans from dam failures. The National Dam Safety Program (NDSP) is a partnership among states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most dams in the United States (FEMA 2016).

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state's and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 2019).

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. A total of 3,036 dams are part of regulated hydroelectric projects and are included in the FERC program. Two-thirds of these dams are more than 50 years old. Concern about their safety and integrity grows as dams age, rendering oversight and regular inspection especially important (FERC 2017). FERC staff inspect hydroelectric projects on an unscheduled basis to investigate the following:

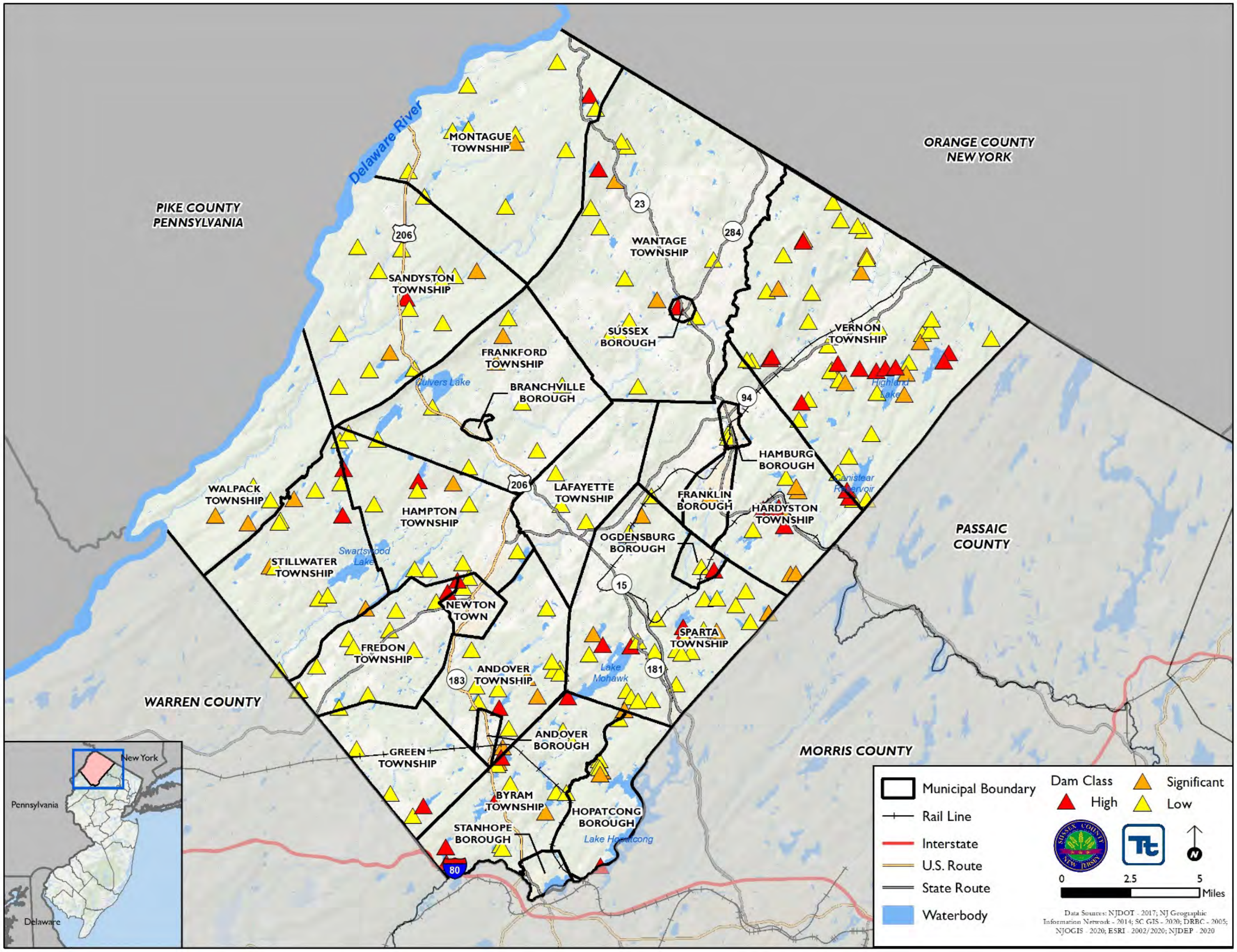
- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with terms and conditions of a license (FERC 2017).

Every 5 years, an independent consulting engineer, approved by FERC, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with total storage capacity of more than 2,000 acre-feet (FERC 2017).

Location

According to NJDEP, Sussex County has 239 dams. Of these dams, 40 are considered high hazard, 41 are considered significant hazard, and 158 are considered low hazard. There are 41 dams classified as in a poor state of repair with one dam in an unsatisfactory state of repair. Figure 4.3.1-1 shows the dams by class throughout the County.

Figure 4.3.1-1. Dams by Class in Sussex County



Extent

The NJ DEP classifies dams according to their hazard potential using the following criteria:

- Class I - High Hazard Potential: This classification includes those dams, the failure of which may cause the probable loss of life or extensive property damage.
    - i. The existence of normally occupied homes in the area that are susceptible to significant damage in the event of a dam failure will be assumed to mean "probable loss of life".
    - ii. Extensive property damage means the destructive loss of industrial or commercial facilities, essential public utilities, main highways, railroads or bridges. A dam may be classified as having a high hazard potential based solely on high projected economic loss.
    - iii. Recreational facilities below a dam, such as a campground or recreation area, may be sufficient reason to classify a dam as having a high hazard potential.
- Class II - Significant Hazard Potential: This classification includes those dams, the failure of which may cause significant damage to property and project operation, but loss of human life is not envisioned. This classification applies to predominantly rural, agricultural areas, where dam failure may damage isolated homes, major highways or railroads or cause interruption of service of relatively important public utilities.
- Class III - Low Hazard Potential: This classification includes those dams, the failure of which would cause loss of the dam itself but little or no additional damage to other property. This classification applies to rural or agricultural areas where failure may damage farm buildings other than residences, agricultural lands or non-major roads.
- Class IV - Small Dams: This classification includes any project which impounds less than 15 acres/feet of water to the top of the dam, has less than 15 feet height-of-dam and which has a drainage area above the dam of 150 acres or less in extent. No dam may be included in Class IV if it meets the criteria for Class I or II. Any applicant may request consideration as a Class III dam upon submission of a positive report and demonstration proving low hazard.

Dam failures cause serious downstream flooding either because of partial or complete dam collapse. Failures are usually associated with intense rainfall and prolonged flood conditions; however, dam breaks may occur during dry periods as a result of progressive erosion of an embankment. The greatest threat from a dam break is to areas immediately downstream. Dam failures may or may not leave enough time for evacuation of people and property, depending on their abruptness. Seepages in earth dams usually develop gradually, and if the embankment damage is detected early, downhill residents have at least a few hours or days to evacuate. Failures of concrete or masonry dams tend to occur suddenly, sending a wall of water and debris down the valley at more than 100 mph. Survival would be a matter of having the good fortune not to be in the flood path at the time of the break. Dam failures due to the overtopping of a dam normally give sufficient lead time for evacuation.

The environmental impacts of a dam or levee failure can include significant water-quality and debris-disposal issues. Flood waters 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 flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters 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.

It is required by the State of New Jersey that all High Hazard and Significant Hazard dams must have NJDEP-approved Emergency Action Plans (EAP) in place. It is the responsibility of the dam owner to review and update the EAP on an annual basis. New Jersey Dam Safety Standards also require that are periodically inspected to identify conditions that may adversely affect the safety and functionality a dam its appurtenant structures; to note the extent of deterioration as a basis for long term planning, periodic maintenance or immediate repair; to evaluate conformity with current design and construction practices; and to determine the appropriateness of the existing hazard classification. Inspection guidelines, as identified in the State Hazard Mitigation Plan, are reproduced in Table 4.3.1-1 in brief. Complete inspection and operating requirements for dams can be found in the New Jersey Dam Safety Standards (N.J.A.C 7:20-1.11).

Table 4.3.1-1. New Jersey Dam Inspection Requirements

Dam Size/Type	Regular Inspection	Formal Inspection
Class I (High Hazard) Large Dam	Annually	Once every 3 years
Class I (High Hazard) Dam	Once every 2 years	Once every 6 years
Class II (Significant Hazard) Dam	Once every 2 years	Once every 10 years
Class III (Low Hazard) Dam	Once every 4 years	Only as required
Class IV (Zero Hazard) Dam	Once every 4 years	Only as required

In New Jersey, every dam in the State as defined in the Safe Dam Act, N.J.S.A. 58:4 is required to meet State dam safety standards. Dam Safety Laws provide the NJDEP with enforcement capabilities to achieve statewide compliance with dam safety standards. This includes issuing orders for compliance to dam owners and pursuing legal action if the owner does not comply (with the goal of compliance and possible fines levied on a per-day basis for violations).

Previous Occurrences and Losses

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2019, no disasters (DR) or emergencies (EM) were declared for dam failure in the State of New Jersey.

U.S. Department of Agriculture Disaster 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 2015 and 2019, Sussex County was not included in any USDA declaration involving dam failure.

Dam Failure Events

For the 2021 HMP update, known dam failure events that have impacted Sussex County between 2015 and 2019 were researched. No events were found to have occurred (NOAA NCEI 2020, FEMA 2020, NPDP 2020). For events prior to 2015, refer to Appendix E (Risk Assessment Supplement).

Probability of Future Occurrences

Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, and excessive rainfall and snowmelt. As stated in the 2019 New Jersey State HMP, dam failures can occur suddenly, without warning, and may occur during normal operating conditions. This is referred to as a "sunny-day" failure. Dam failures may also occur during a large storm event. Significant rainfall can quickly inundate an area and cause floodwaters to overwhelm a reservoir. If the spillway of the dam cannot safely pass the resulting flows, water will begin flowing in areas not designed for such flows, and a failure may occur. New

Jersey has seen significant property damage including damage or loss of dams, bridges, roads, and buildings as a result of storm events and dam failures (NJOEM 2019).

There is a "residual risk" associated with dams. Residual risk is the risk that remains after safeguards have been implemented. For dams, the residual risk is associated with events beyond those that the facility was designed to withstand. However, the probability of any type of dam failure is low in today's dam safety regulatory and oversight environment (NJOEM 2019).

According to the 2011 HMP, 2016 HMP, and 2019 State HMP, there were at least 31 dam failures identified based on information queried from the National Performance of Dams Program (NPDP) database; however, details regarding every incident in the County were not included. Eighteen of these dam failures were associated with a severe storm in August 2000 where more than 14 inches of rain fell over a 4-day period. For the 2021 HMP update, however, a query of the NPDP database was conducted and it identified 16 dam incidents in Sussex County, with 15 occurring during the August 2000 severe storm event. Information from the Stanford University's NPDP database and the NOAA-NCDC storm events database were both used to identify the number of failures/incidents that occurred between 1950 and 2020. Using both sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year (NOAA-NCDC 2020; NPDP 2020). Based on these statistics, there is an estimated 23% chance of a dam failure/incident occurring in any given year in Sussex County.

Table 4.3.1-2. Probability of Future Dam Damage and Failure Events

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent Chance of occurrence in any given year
Dam Incident	16*	0.23	4.44	0.23	23%

Source: NOAA NCEI 2020; NPDP 2020
**15 events were associated with the August 2000 storm event which occurred over a 4-day period. The recurrence interval of this storm event is not known; therefore, the dam failure event probability is likely over-estimated.*

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for dam failure in the county is considered 'rare' (between 1 and 10 percent annual probability of a hazard event occurring, as presented in Table 4.4-1). The ranking of the dam failure hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

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

Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017). As temperatures increase so will the energy in a storm system, increasing the potential for more intense tropical storms (Huang et al. 2017), especially those of Category 4 and 5 (Melillo et al. 2014).

Vulnerability Assessment

Dam failure inundation maps and downstream hazard areas are considered sensitive information and were not available for use in this risk assessment. To assess Sussex County's risk to dam failure, a qualitative review was conducted.

Impact on Life, Health, and Safety

The impact of dam and levee failure on life, health, and safety is dependent on several factors such as the class of dam/levee, the area that the dam/levee is protecting, the location of the dam/levee, and the proximity of structures, infrastructure, and critical facilities to the dam or levee structure. According to the State HMP, the level of impact that a failure would have can be predicted based upon the hazard potential classification as rated by the United States Army Corps of Engineers (State of NJ 2019). Table 4.3.1-3 outlines the recommended hazard classifications.

Table 4.3.1-3. United States Army Corps of Engineers Hazard Potential Classification

Hazard Category(a)	Direct Loss of Life (b)	Lifeline Losses (c)	Property Losses (d)	Environmental Losses (e)
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

a. Categories are assigned to overall projects, not individual structures at a project.
b. Loss-of-life potential is based on inundation mapping of area downstream of the project. Analyses of loss-of-life potential should take into account the population at risk, time of flood wave travel, and warning time.

Hazard Category(a)	Direct Loss of Life (b)	Lifeline Losses (c)	Property Losses (d)	Environmental Losses (e)
c. Lifeline losses include indirect threats to life caused by the interruption of lifeline services from project failure or operational disruption; for example, loss of critical medical facilities or access to them. d. Property losses include damage to project facilities and downstream property and indirect impact from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply. e. Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.				

Source: State of NJ 2019

The entire population residing within a dam failure inundation zone is considered exposed and potentially vulnerable to a dam failure event. The potential for loss of life is affected by the warming time provided, and capacity and number of evacuation routes available to populations living within these areas. Those most at risk include the economically disadvantaged and the population over the age of 65. The 2018 American Community Survey population estimates indicate there were 22,889 persons over 65 years old and 7,191 living below the poverty level in Sussex County. These populations are more at risk during a dam failure event because economically disadvantaged populations are likely to evaluate their risk and make the decision to evacuate based upon the net economic impact to their family, while elderly populations are likely to seek or need medical attention. The availability of medical attention may be limited due to isolation during a flood event and other difficulties in evacuating. There is often limited warning time for a dam failure event. Populations without adequate warning of the event are highly vulnerable.

Dam failure can cause persons to become displaced if flooding of structures occurs. Dam failure may mimic flood events, depending on the size of the dam reservoir and breach. Understanding potential outcomes of flooding for each dam in Sussex County would require intensive hydraulic modeling.

Impact on General Building Stock

All buildings and infrastructure located in the dam failure inundation zone are considered exposed and potentially vulnerable. Property located closest to the dam inundation area has the greatest potential to experience the largest, most destructive surge of water. All transportation infrastructure in the dam failure inundation zone is vulnerable to damage and potentially cutting off evacuation routes, limiting emergency access, and creating isolation issues. Utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

Dam failure can cause severe downstream flooding and may transport large volumes of sediment and debris, depending on the magnitude of the event. Widespread damage to buildings and infrastructure affected by an event would result in large costs to repair these locations. In addition to physical damage costs, businesses can be closed while flood waters retreat and utilities are returned to a functioning state.

Impact on Critical Facilities and Lifelines

Dam failures may also impact critical facilities and infrastructure located in the downstream inundation zone. Consequentially, dam failure can cut evacuation routes, limit emergency access, and/or create isolation issues. Widespread damage to buildings and infrastructure affected by an event would result in large costs to repair these locations. In addition to physical damage costs, businesses can be closed while flood waters retreat and utilities are returned to a functioning state. Further, utilities such as overhead power lines, cable and phone lines could also be vulnerable. Loss of these utilities could create additional isolation issues for the inundation areas.

Impact on the Economy

Severe flooding that follows an event like a dam failure can cause extensive structural damage and withhold essential services. The cost to recover from flood damages after a surge will vary depending on the hazard risk of each dam. The State HMP discusses damages from dam failures ranging from $7 million to $25 million as a result of previous events in the State. This cost likely varies because of the density of structures and businesses that surround the dam protected area.

Severe flooding that follows an event like a dam failure 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 can become temporarily out of operation. Debris from surrounding buildings can accumulate should the dam mimic major flood events, such as the 1-percent annual chance flood event that is discussed in Section 4.3.5 (Flood).

Impact on the Environment

The environmental impacts of a dam failure can include significant water-quality and debris-disposal issues or severe erosion that can impact local ecosystems. Flood waters 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 may get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be offline for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties.

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. Several factors are examined in this section to assess hazard vulnerability.

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by a dam or levee failure event if the structures are located within the flood protection area and mitigation measures are not considered. Therefore, it is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards at the local level. Due to the sensitive nature of dam locations and downstream inundation zones, an assessment to determine the proximity of these new development sites to potential dam inundation cannot be performed at this time.

Projected Changes in Population

Sussex County has experienced a population decline since 2010. According to the U.S. Census Bureau, the County's population has decreased 4.7-percent between 2010 and 2018 (U.S. Census Bureau 2020). The population is expected to continue to decrease as residents move away from the suburbs and towards urban centers (Stirling 2018). Even though the population has decreased, any changes in the density of population can impact the number of persons exposed to the probable maximum flood inundation hazard areas. Higher density can not only create issues for local residents during evacuation of a dam failure event, but can also have an effect on commuters that travel into and out of the County for work. Refer to Section 3 (County Profile) for more information about population trends in the County.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual precipitation. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk to dam failures. Increases in precipitation may stress the dam wall.

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

Vulnerability Change Since 2016 HMP

For the 2021 HMP update, risks to the County's population, building stock, and critical facilities were assessed. Overall, Sussex County remains potentially vulnerable to the dam failure hazard. To estimate losses to these elements in the future, dam inundation areas and depths of flooding may be used to analyze exposure and generate depth grids. Hazus could be implemented to estimate potential losses for Sussex County. In addition, inspections of dams may also inform the status of each and maintenance and mitigation measure that may be needed.

4.3.2 DISEASE OUTBREAK

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 disease outbreak hazard in Sussex County.

2021 HMP Changes

- This is a new hazard of concern for Sussex County.

Profile

Hazard Description

An outbreak or an epidemic occurs when new cases of a certain disease, in a given population, substantially exceed what is expected. An epidemic may be restricted to one locale, or it may be global, at which point it is called a pandemic. Pandemic is defined as a disease occurring over a wide geographic area and affecting a high proportion of the population. A pandemic can cause sudden, pervasive illness in all age groups on a local or global scale. A pandemic is a novel virus to which humans have no natural immunity that spreads from person-to-person. A pandemic will cause both widespread and sustained effects and is likely to stress the resources of both the State and federal government (NJOEM 2019).

Of particular concern in Sussex County are arthropod-borne viruses (arboviruses), which are viruses that are maintained in nature through biological transmission between susceptible hosts (mammals) and blood-feeding arthropods (mosquitos and ticks). More than 100 arboviruses can cause disease in humans; over 30 have been identified as human pathogens in the western hemisphere (New Jersey Department of Health and Senior Services 2008). New Jersey has been impacted by various past and present infestations including: high population of mosquitoes (mosquito-borne diseases) and deer ticks (tick-borne diseases).

Mosquito-borne diseases are diseases that are spread through the bite of an infected female mosquito. The three most common mosquito-borne diseases in New Jersey are: West Nile Virus (WNV), Eastern equine encephalitis (EEE) virus, and St. Louis encephalitis (SLE) virus. These diseases rely on mosquitos to spread. They become infected by feeding on birds carrying the virus; and then spread to humans and other animals when the mosquito bites them (New Jersey Department of Health 2013).

Tick-borne diseases are bacterial illnesses that spread to humans through infected ticks. The most common tick-borne diseases in New Jersey are: Lyme disease, Ehrlichiosis, Anaplasmosis, Rocky Mountain Spotted Fever, and Babesiois. These types of diseases rely on ticks for transmission. Ticks become infected by micro-organisms when feeding on small infected mammals (mice and voles). Different tick-borne diseases are caused by different micro-organisms, and it is possible to be infected with more than one tick-borne disease at a time. Anyone who is bitten by an infected tick may get a tick-borne disease. People who spend a lot of time outdoors have a greater risk of becoming infected. The three types of ticks in New Jersey that may carry disease-causing micro-organisms are the deer tick, lone star tick, and the American dog tick (New Jersey Department of Health 2013b).

For the purpose of this HMP update, the following arboviruses will be discussed in further detail: West Nile Virus, Eastern Equine Encephalitis virus, St. Louis Encephalitis virus, Lyme disease, and Ebola virus. Influenza will also be discussed due to several outbreaks in the past five years. In addition, due to the COVID-19 pandemic that emerged during the development of this plan update, a brief description is described in this section.

West Nile Virus

West Nile Virus (WNV) encephalitis is a mosquito-borne viral disease, which can cause an inflammation of the brain. WNV is commonly found in Africa, West Asia, the Middle East and Europe. For the first time in North America, WNV was confirmed in the New York metropolitan area during the summer and fall of 1999. WNV successfully over-wintered in the northeastern U.S. and has been present in humans, horses, birds, and mosquitoes since that time. WNV is spread to humans by the bite of an infected mosquito. A mosquito becomes infected by biting a bird that carries the virus (New Jersey Department of Health 2014).

Eastern Equine Encephalitis

Eastern Equine Encephalitis (EEE) is a virus disease of wild birds that is transmitted to horses and humans by mosquitoes. It is a rare but serious viral infection. EEE is most common in the eastern half of the U.S. and is spread by the bite of an infected mosquito. EEE can affect humans, horses, and some birds. The risk of getting this virus is highest from late July through early October (New Jersey Department of Health 2012a). New Jersey represents a major focus for the infection with some form of documented viral activity nearly every year. Horse cases are most common in the southern half of New Jersey because the acid water swamps that produce the major mosquito vectors are especially prevalent on the southern coastal plain (Crans 2013).

St. Louis Encephalitis

St. Louis Encephalitis (SLE) is a rare but serious viral infection. It is transmitted to humans by the bite of an infected mosquito. Most cases of SLE disease have occurred in eastern and central states. Most persons infected with SLE have no apparent illness. Initial symptoms of those who become ill include fever, headache, nausea, vomiting, and tiredness. Severe neuroinvasive disease (often involving encephalitis, an inflammation of the brain) occurs more commonly in older adults (CDC 2019).

Lyme Disease

Lyme disease is an illness caused by infection with the bacterium *Borrelia burgdorferi*, which is carried by ticks. The infection can cause a variety of symptoms and, if left untreated, can be severe. Lyme disease is spread to people by the bite of an infected tick. In New Jersey, the commonly infected tick is the deer tick. Immature ticks become infected by feeding on infected white-footed mice and other small mammals. Deer ticks can also spread other tick-borne diseases. Anyone who is bitten by a tick carrying the bacteria can become infected (New Jersey Department of Health 2012b).

Influenza

The risk of a global influenza pandemic has increased over the last several years. This disease is capable of claiming thousands of lives and adversely affecting critical infrastructure and key resources. An influenza pandemic has the ability to reduce the health, safety, and welfare of the essential services workforce; immobilize core infrastructure; and induce fiscal instability. Densely populated areas will spread diseases quicker than less densely populated areas (NJOEM 2019).

Pandemic influenza is different from seasonal influenza (or "the flu") because outbreaks of seasonal flu are caused by viruses that are already among people. Pandemic influenza is caused by an influenza virus that is new to people and is likely to affect many more people than seasonal influenza. In addition, seasonal flu occurs every year, usually during the winter season, while the timing of an influenza pandemic is difficult to predict. Pandemic influenza is likely to affect more people than the seasonal flu, including young adults. A severe pandemic could change daily life for a time, including limitations on travel and public gatherings (Barry-Eaton District Health Department 2013).

At the national level, the CDC's Influenza Division has a long history of supporting the World Health Organization (WHO) and its global network of National Influenza Centers (NIC). With limited resources, most international assistance provided in the early years was through hands-on laboratory training of in-country staff, the annual provision of WHO reagent kits (produced and distributed by CDC), and technical consultations for vaccine strain selections. The Influenza Division also conducts epidemiologic research including vaccine studies and serologic assays and provided international outbreak investigation assistance (CDC 2010).

Ebola Virus

Ebola, previously known as Ebola hemorrhagic fever, is a rare and deadly disease caused by infection with one of the Ebola virus strains. According to the CDC, the 2014 Ebola epidemic is the largest in history affecting multiple countries in West Africa. Two imported cases, including one death, and two locally-acquired cases in healthcare workers have been reported in the United States. CDC and partners are taking precautions to prevent the further spread of Ebola in the United States (CDC 2014).

Coronavirus

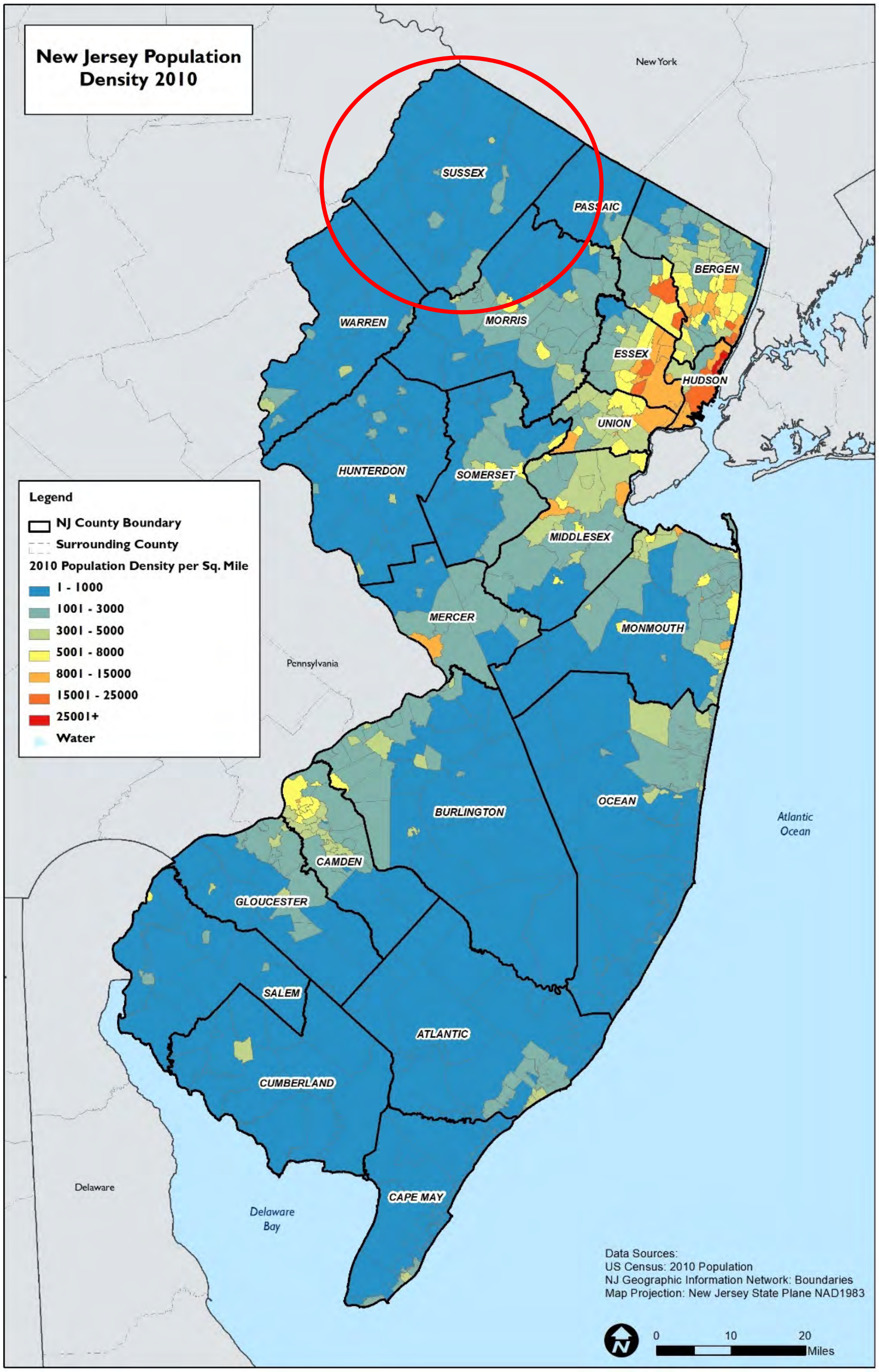
Coronavirus disease (COVID-19) is an infectious disease first identified in 2019. The virus rapidly spread into a global pandemic by spring of 2020. The elderly and those with underlying medical conductions such as cardiovascular disease, diabetes, chronic respiratory disease, and cancer are more likely to develop serious illness (WHO 2020). With the virus being relatively new, information regarding transmission and symptoms of the virus is emerging from the research. The COVID-19 virus spreads primarily through droplets of saliva or discharge from the nose when an infected person coughs or sneezes. Reported illnesses have ranged from mild symptoms to severe illness and death. Reported symptoms include trouble breathing, persistent pain or pressure in the chest, new confusion or inability to arouse, and bluish lips or face. Symptoms may appear 2-14 days after exposure to the virus (based on the incubation period of MERS-CoV viruses) (CDC 2020).

In an effort to slow the spread of the virus, the federal government and States have urged the public to avoid touching of the face, properly wash hands often, and use various social distancing measures. At the time of this plan update, there are no specific vaccines or treatments for COVID-19. However, there are many ongoing clinical trials evaluating potential treatments (WHO 2020).

Location

New Jersey's geographic and demographic characteristics make it particularly vulnerable to importation and spread of infectious diseases. All 21 counties in New Jersey have experienced the effects of a pandemic or disease outbreak. In terms of pandemic influenza, all counties may experience pandemic influenza outbreak caused by factors such as population density and the nature of public meeting areas. Densely populated areas will spread diseases quicker than less densely populated areas. Figure 4.3.2-1 shows population density throughout the State. Additionally, much of the State can experience other diseases such as WNV due to the abundance of water bodies throughout the State, which provide a breeding ground for infected mosquitos.

Figure 4.3.2-1. New Jersey Population Density (United States Census 2010)



Source: United States Census 2010; New Jersey Geographic Information Network (NJGIN)
Note: Sussex County is circled in red.

Extent

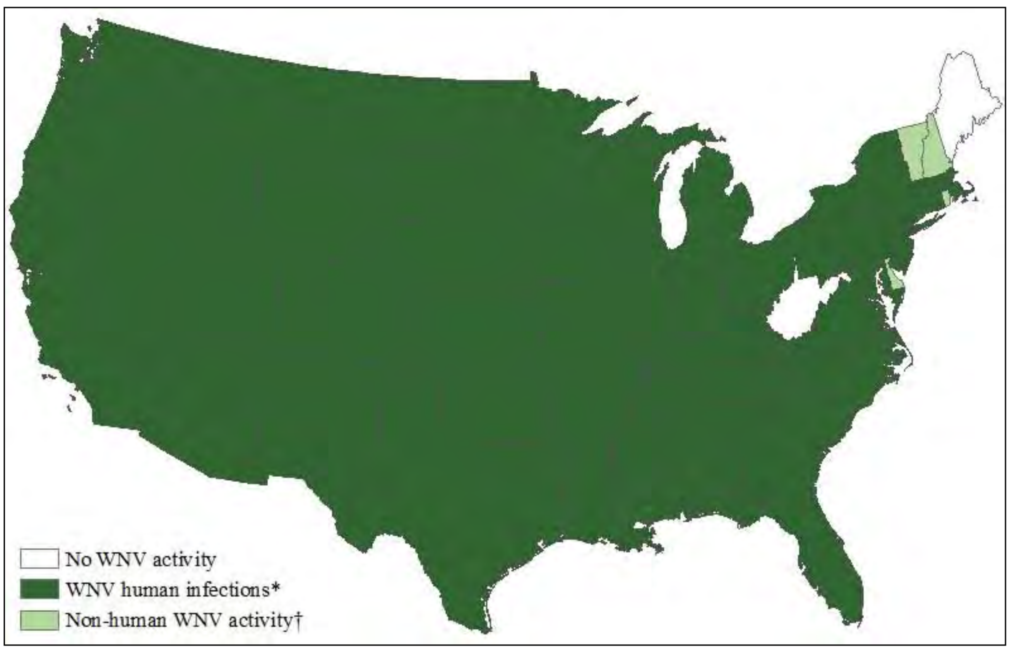
The exact size and extent of an infected population depends on how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in more densely populated areas. The transmission rate of infectious diseases will depend on the mode of transmission of a given illness.

The extent and location of disease outbreaks depends on the preferred habitat of the species, as well as the species' ease of movement and establishment. The magnitude of disease outbreaks species ranges from nuisance to widespread. The threat is typically intensified when the ecosystem or host species is already stressed, such as periods of drought. The already weakened state of the ecosystem causes it to more easily be impacted to an infestation. The presence of disease-carrying mosquitoes and ticks has been reported throughout most of New Jersey and Sussex County.

West Nile Virus

Since it was discovered in the western hemisphere, WNV has spread rapidly across North America, affecting thousands of birds, horses and humans. As of January 2020, every state in the continental United States aside from Maine and West Virginia has WNV activity with Delaware, Rhode Island, Vermont, and New Hampshire only being impacted by non-human WNV activity. Figure 4.3.2-2 shows the activity of WNV by state.

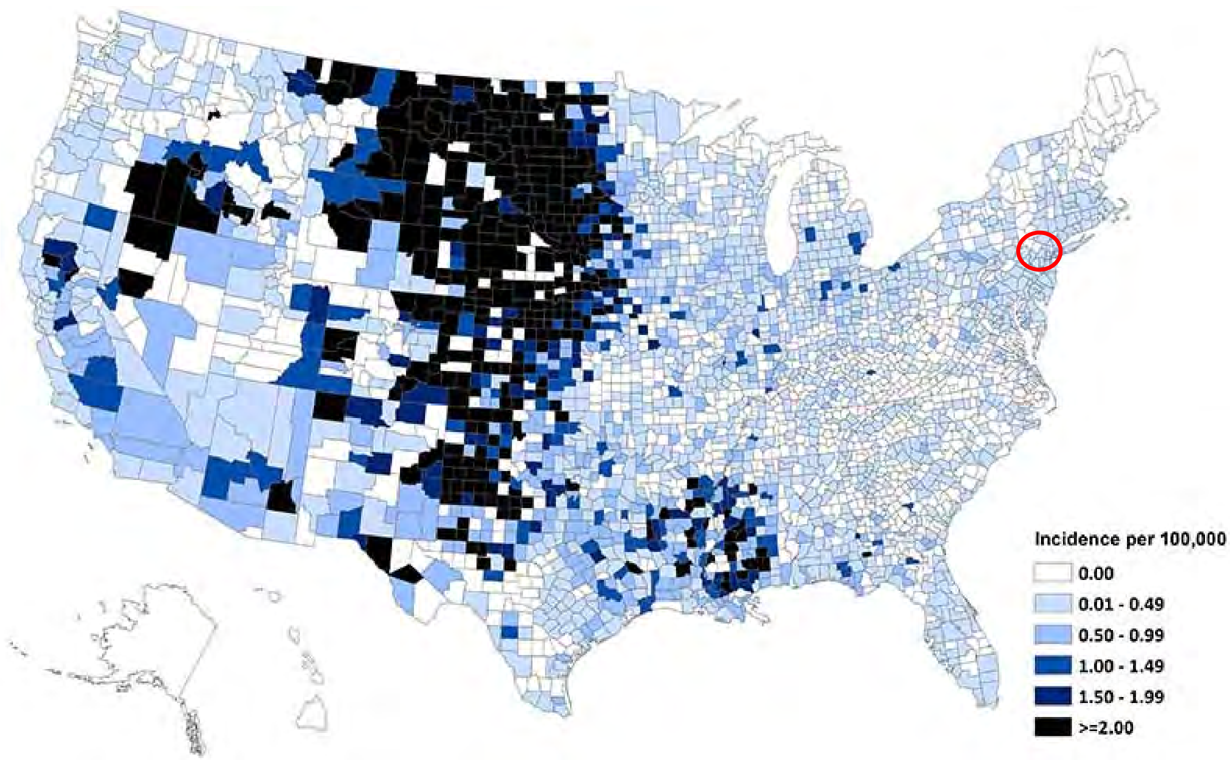
Figure 4.3.2-2. WNV Activity by State 2019



Source: CDC 2020

The CDC has a surveillance program for WNV. Data is collected on a weekly basis and reported for five categories: wild birds, sentinel chicken flocks, human cases, veterinary cases and mosquito surveillance (CDC 2019). Figure 4.3.2-3 illustrates WNV activity in the U.S. from 1999-2018.

Figure 4.3.2-3. Average Annual Incidence of West Nile Virus Neuroinvasive Disease Reported to CDC by County, 1999-2018



Source: CDC 2019
Note: The circle indicates the approximate location of Sussex County.

Eastern Equine Encephalitis

In the State of New Jersey, there has been five cases of EEE from 2010-2019 (CDC 2019.)

St. Louis Encephalitis

In the State of New Jersey, there have been no cases of St. Louis virus neuroinvasive disease from 2010-2019. However, nearby states have reported cases (CDC 2019).

Lyme Disease

Lyme disease is the most commonly reported vector borne illness in the U.S. Between 2014 and 2018, there were 1,404 confirmed cases of Lyme disease in Sussex County (NJ DOH 2020). Figure 4.3.2-4 shows the reported cases of Lyme disease in the northeast U.S. for 2018.

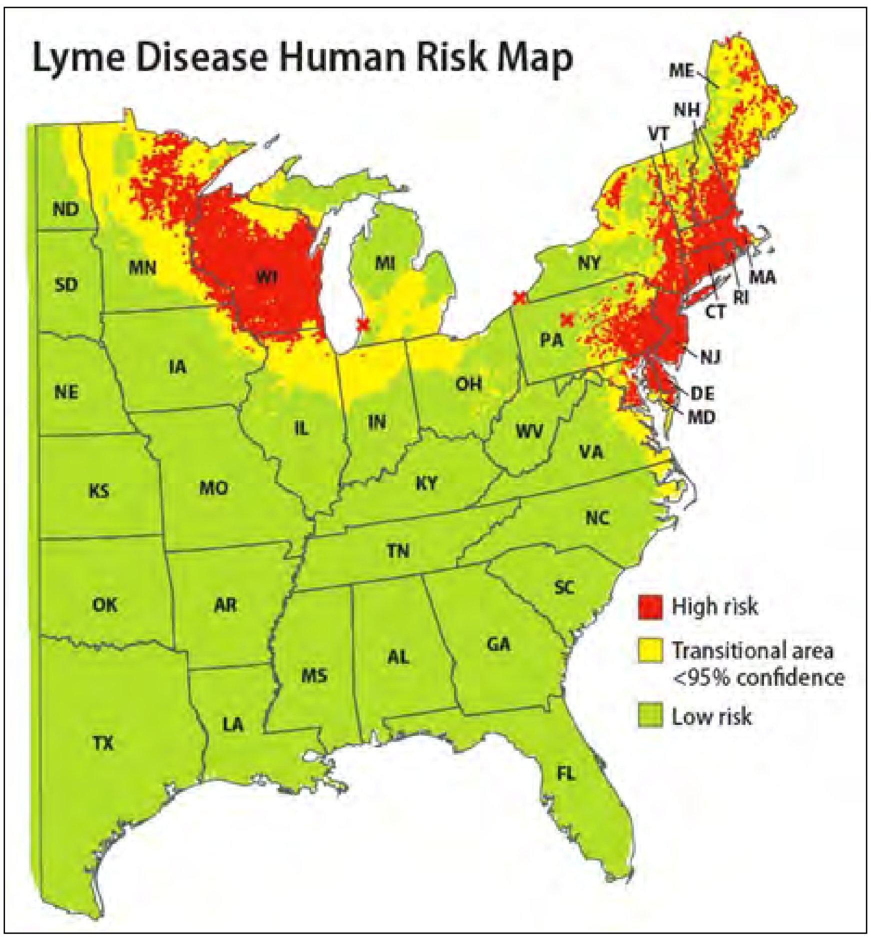
Figure 4.3.2-4. 2018 Reported Cases of Lyme Disease in the Northeast U.S.

Source: CDC 2019

Note: The red circle indicates the approximate location of Sussex County.

Figure 4.3.2-5 shows the risk of Lyme disease in the northeastern U.S. The figure indicates that Sussex County is located in a high-risk area.

Figure 4.3.2-5. Lyme Disease Human Risk Map in the Northeast U.S.



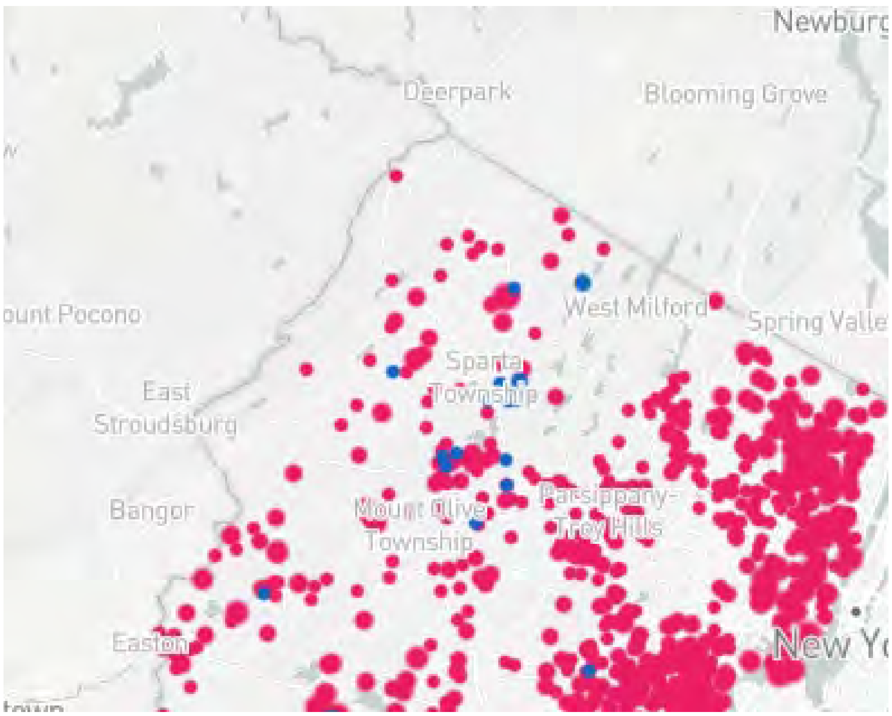
Source: Yale School of Public Health, 2013

Note (1): Sussex County is in a high risk or transitional area.

The CDC Division of Vector Borne Diseases (DVBD) indicated in 2018 that New Jersey was the state with the second-highest number of confirmed Lyme disease cases, totaling approximately 4,000 cases. For total number of cases between 2007 and 2017, New Jersey ranked third highest for the number of confirmed Lyme disease cases, totaling approximately 32,731 (12.4% of the total reported cases in the U.S.) New Jersey is also considered a High Incidence State for Lyme Disease, with the average incidence of at least 10 confirmed cases per 100,000 persons for three reporting years (CDC 2018).

Figure 4.3.2-6 below shows reports of arbovirus in Sussex County between January 2003 and October 2020. The red dots are for locations of mosquitos with West Nile Virus, whereas blue dots show the location of mosquitos carrying Eastern Equine Encephalitis.

Figure 4.3.2-6. Arbovirus Reports in Sussex County



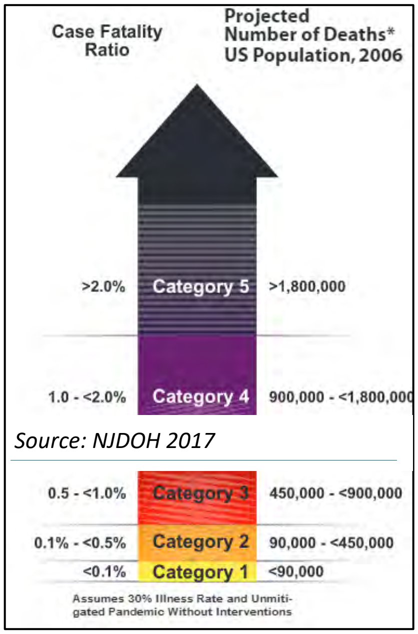
Source: VectorSurv Maps 2020

Influenza, Ebola and Coronavirus

The severity of a pandemic or infectious disease threat in New Jersey will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. Pandemics around the nation have the potential to affect New Jersey's populated areas.

The CDC and Prevention Community Strategy for Pandemic Influenza Mitigation guidance introduced a Pandemic Severity Index (PSI), which uses the case fatality ratio as the critical driver for categorizing the severity of a pandemic. The index is designed to estimate the severity of a pandemic on a population to allow better forecasting of the impact of a pandemic, and to enable recommendations on the use of mitigation interventions

Figure 4.3.2-7. Pandemic PSI



Source: NJDOH 2017

that are matched to the severity of influenza pandemic. Pandemics are assigned to one of five discrete categories of increasing severity (Category 1 to Category 5) (NJDOH, 2017). Figure 4.3.2-7 illustrates the five categories of the Pandemic Severity Index (PSI).

In 1999, the WHO Secretariat published guidance for pandemic influenza and defined the six phases of a pandemic. Updated guidance was published in 2005 to redefine these phases. This schema is designed to provide guidance to the international community and to national governments on preparedness and response for pandemic threats and pandemic disease. Compared with the 1999 phases, the new definitions place more emphasis on pre-pandemic phases when pandemic threats may exist in animals or when new influenza virus subtypes infect people but do not spread efficiently. Because recognizing that distinctions between the two interpandemic phases and the three pandemic alert phases may be unclear, the WHO Secretariat proposes that classifications be determined by assessing risk based on a range of scientific and epidemiological data (WHO 2009). The WHO pandemic phases are outlined in Table 4.3.2-1.

Table 4.3.2-1. WHO Global Pandemic Phases

Phase	Description
Preparedness	
Phase 1	No viruses circulating among animals have been reported to cause infections in humans.
Phase 2	An animal influenza virus circulating among domesticated or wild animals is known to have caused infection in humans, and is therefore considered a potential pandemic threat.
Phase 3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people, but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, for example, when there is close contact between an infected person and an unprotected caregiver. However, limited transmission under such restricted circumstances does not indicate that the virus has gained the level of transmissibility among humans necessary to cause a pandemic.
Response and Mitigation Efforts	
Phase 4	Human infection(s) are reported with a new subtype, but no human-to-human spread or at most rare instances of spread to a close contact.
Phase 5	Characterized by human-to-human spread of the virus into at least two countries in one WHO region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short.
Phase 6	The pandemic phase, is characterized by community level outbreaks in at least one other country in a different WHO region in addition to the criteria defined in Phase 5. Designation of this phase will indicate that a global pandemic is under way.

Source: WHO 2009

In New Jersey, health and supporting agency responses to a pandemic are defined by the WHO phases and federal pandemic influenza stages, and further defined by New Jersey pandemic situations. The State's situations are similar, but not identical to the United States Department of Homeland Security federal government response stages. Transition from one situation to another indicates a change in activities of one or more New Jersey agencies. Table 4.3.2-2 compares the federal and New Jersey pandemic influenza phases and situations.

Table 4.3.2-2. Federal and New Jersey Pandemic Phases and Situations

Federal Pandemic Influenza Stage		New Jersey Situations	
0	New domestic outbreak in at-risk country (WHO Phase 1, 2, or 3)	1 2	Novel (new) influenza virus in birds or other animals outside the U.S. Novel (new) influenza virus in birds or other animals in the U.S./NJ
1	Suspected human outbreak overseas (WHO Phase 3)	3	Human case of novel (new) influenza virus outside of the U.S.
2	Confirmed human outbreak overseas (WHO Phase 4 or 5)	4 5	Human-to-human spread of novel (new) influenza outside the U.S. (no widespread human transmission) Clusters of human cases outside the U.S.
3	Widespread human outbreak in multiple locations overseas (WHO Phase 6)		
4	First human case in North America (WHO Phase 6)	6	Human case of novel (new) influenza virus (no human spread) in the U.S./NJ
5	Spread in the U.S. (WHO Phase 6)	7 8 9	First case of human-to-human spread of novel (new) influenza in the U.S./NJ Clusters of cases of human spread in the U.S./NJ Widespread cases of human-to-human spread of novel (new) influenza outside the U.S./NJ
6	Recovery and preparation for subsequent waves (WHO Phase 5 or 6)	10	Reduced spread of influenza or end of pandemic

Source: NJOEM 2019
NJ New Jersey
U.S. United States
WHO World Health Organization

Previous Occurrences and Losses

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, Sussex County was included in two emergency declarations and one disaster declaration related to disease outbreak.

Table 4.3.2-3. Disease-Related Disaster (DR) and Emergency (EM) Declarations 1954-2020

Declaration	Event Date	Declaration Date	Event Description
EM-3156	May 30-November 1,2000	November 1, 2000	West Nile Virus
DR-4488 / EM-3451	January 20,2000 to present	March 25, 2020 and March 13, 2020	New Jersey COVID-19 Pandemic

Source: FEMA 2020

Disease Outbreak Events

Disease outbreak events that have impacted Sussex County between 2015 and 2020 are listed in Table 4.3.2-3. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Table 4.3.2-3. Previous Occurrences of Disease Outbreak Events, 2014-2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Description
2014	Influenza	N/A	N/A	In 2014, 65 cases of nfluenza were reported in Sussex County.
2014	Lyme Disease	N/A	N/A	In 2014, 258 cases of Lyme disease were reported in Sussex County.
2015	Influenza	N/A	N/A	In 2015, 43 cases of influenza were reported in Sussex County.
2015	Lyme Disease	N/A	N/A	In 2015, 309 cases of Lyme disease were reported in Sussex County.
2016	Influenza	N/A	N/A	In 2016, 54 cases of influenza were reported in Sussex County.
2016	Lyme Disease	N/A	N/A	In 2016, 260 cases of Lyme disease were reported in Sussex County.
2017	Influenza	N/A	N/A	In 2017, 151 cases of influenza were reported in Sussex County.
2017	Lyme Disease	N/A	N/A	In 2017, 331 cases of Lyme disease were reported in Sussex County.
2017	West Nile Virus	N/A	N/A	In 2017, one case of West Nile Virus was reported in Sussex County.
2017	Zika Virus	N/A	N/A	In 2017, one case of Zika virus was reported in Sussex County
2018	Influenza	N/A	N/A	In 2018, 306 cases of influenza were reported in Sussex County.
2018	Lyme Disease	N/A	N/A	In 2018, 246 cases of Lyme disease were reported in Sussex County.
2019	Influenza	N/A	N/A	In 2019, 251 cases of influenza were reported in Sussex County.
2019	Lyme Disease	N/A	N/A	In 2019, 246 cases of Lyme disease were reported in Sussex County.
2020	Coronavirus	DR-4488 / EM-3451	Yes	In early spring of 2020, the coronavirus pandemic began. High numbers of hospitalizations and deaths prompted masking and social distancing requirements and the closure of schools and non-essential businesses. At the time of this plan update, the pandemic continues as do many social distancing and masking requirements. By October 19, 2020, Sussex County had recorded 1,652 cases and 197 deaths.

Source: FEMA 2020; NJDOH 2021
Note: Not all events that have occurred in Sussex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
Reportable disease statistics in NJ were only available up to 2018 at the writing of this plan update.

Probability of Future Occurrences

It is difficult to predict when the next disease outbreak will occur and how severe it will be because viruses are always changing. The Department of Health and Human Services and others are developing supplies of vaccines and medicines. In addition, the United States has been working with the WHO and other countries to strengthen detection of disease and response to outbreaks. Preparedness efforts are ongoing at the national, State, and local level (NJOEM 2019). The Sussex County Division of Health is leading the effort in coordination with Sussex County DEM and other departments on the COVID-19 response.

In Sussex County, the probability for a future disease outbreak event is dependent on several factors. One factor that influences the spread of disease is population density. Populations that live close to one another are more likely to spread diseases. All of the critical components necessary to sustain the threat of mosquito-borne disease in Sussex County have been clearly documented. Instances of the WNV have been generally decreasing because of aggressive planning and eradication efforts, but some scientists suggest that as global temperatures rise and extreme weather conditions emerge from climate change, the range of the virus in the United States will grow (Epstein 2001). While instances of Zika have decreased since the outbreak in 2016, there is still the possibility of an outbreak occurring in the future. Therefore, based on all available information and available data regarding mosquito populations, it is anticipated that mosquito-borne diseases will continue to be a threat to Sussex County.

Disease-carrying ticks will continue to inhabit the northeast, including Sussex County, creating an increase in Lyme disease and other types of infections amongst the county population if not controlled or prevented. Ecological conditions favorable to Lyme disease, the steady increase in the number of cases, and the challenge of prevention predict that Lyme disease will be a continuing public health concern. Personal protection measures, including protective clothing, repellents or acaricides, tick checks, and landscape modifications in or near residential areas, may be helpful. However, these measures are difficult to perform regularly throughout the summer. Attempts to control the infection on a larger scale by the eradication of deer or widespread use of acaricides, which may be effective, have had limited public acceptance. New methods of tick control, including host-targeted acaricides against rodents and deer, are being developed and may provide help in the future (Steere, Coburn, and Glickstein, 2004).

Currently and in the future, control of Lyme disease will depend primarily on public and physician education about personal protection measures, signs and symptoms of the disease, and appropriate antibiotic therapy. Based on available information and the ongoing trends of disease-carrying tick populations, it is anticipated that Lyme disease infections will continue to be a threat to Sussex County.

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for disease outbreak in the County is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the disease outbreak hazard for individual municipalities is presented in the jurisdictional annexes (Section 9).

Climate Change Impacts

The relationship between climate change and increase in infectious diseases is difficult to predict with certainty, although there are scientific linkages between the two. Increased rainfall and heavy rainfalls increase the chances of standing water where mosquitos breed. As warm habitats that host insects such as mosquitoes increase, this may lead to an increase in individuals exposed to potential virus threats (The Washington Post, 2017). The notion that rising temperatures will increase the number of mosquitoes that can transmit diseases such as WNV and Zika among humans (rather than just shift their range) has been the subject of debate over the past decade. Some believe that climate change may affect the spread of disease, while others are not convinced. However, many researchers point out that climate is not the only force at work in increasing the spread of infectious diseases into the future (NJOEM 2019). Increased rainstorms contribute to flooding and poor drainage in Sussex County. As flooding events increase in the County owing to climate change, water-borne and vector-borne diseases (particularly those associated with mosquitos) may similarly increase owing to the prevalence of standing water over long periods (World Health Organization).

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Climate change includes changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard. The following discusses Sussex County's vulnerability, in a qualitative nature, to the disease outbreak hazard.

Impact on Life, Health and Safety

The entire population of Sussex County is vulnerable to the disease outbreak hazard. Due to a lack of quantifiable loss information, a qualitative assessment was conducted to evaluate the assets exposed to this hazard and the potential impacts associated with this hazard.

Maintaining certain key functions is important to preserve life and decrease societal disruption during pandemics. Heat, clean water, waste disposal, and corpse management all contribute to public health. Ensuring functional transportation systems also protects health by making it possible for people to access medical care and by transporting food and other essential goods. Critical infrastructure groups have a responsibility to maintain public health, provide public safety, transport medical supplies and food, implement a pandemic response, and maintaining societal functions. If these workers were absent due to pandemic outbreak, these systems will fail (CISA 2020).

Healthcare providers and first responders have an increased risk of exposure due to their frequent contact with infected populations. Areas with a higher population density also have an increased risk of exposure or transmission of disease due to their proximity to potentially infected people. Further, the elderly and immunocompromised individuals may have increased vulnerability to becoming infected or experience exacerbated impacts depending upon the disease. Refer to Section 3 (County Profile) for summary of the vulnerable populations in Sussex County.

Most recently with COVID-19, the Centers for Disease Control and Prevention (CDC) has indicated that persons over 65 years and older, persons living in a nursing home or long-term care facility, and persons with underlying medical conditions such as diabetes, severe obesity, serious heart conditions, etc. are at a higher risk of getting severely ill (CDC 2020). Population data from the 2018 5-year American Community Survey indicates that 22,889 persons over 65 years old in Sussex County would be considered at risk for getting severely ill from the COVID-19 virus. While the statistics of this virus are subject to change during the publication of this HMP, the New Jersey Covid-19 dashboard shows that Sussex County is within the lower quarter of the impacted Counties. Overall, persons over 65 make up approximately 16.3-percent of positive COVID-19 cases in the entire State (NJ DOH 2020).

Impact on General Building Stock

No structures are anticipated to be directly affected by disease outbreaks.

Impact on Critical Facilities and Lifelines

While the actual structures of County and municipal buildings, critical facilities, and infrastructure will not be impacted by a pandemic or disease outbreak, the effect of absenteeism on workers will impact local government services. The most significant impact on critical facilities would be the increase in hospitalization and emergency room visits that would take place as a result of the outbreak. This would create a greater demand on these critical facilities, their staff, and resources.

Mortuary services could be substantially impacted due to the anticipated increased numbers of deaths. The timely, safe, and respectful disposition of the deceased is an essential component of an effective response. Pandemic influenza may quickly rise to the level of a catastrophic incident that results in mass fatalities, which will place extraordinary demands (including religious, cultural, and emotional burdens) on local jurisdictions and the families of the victims (Homeland Security Council 2006).

The healthcare system will be severely taxed, if not overwhelmed, from the large number of illnesses and complications from influenza requiring hospitalization and critical care. Ventilators will be the most critical shortage if a pandemic were to occur (Homeland Security Council 2006). The 2020 coronavirus pandemic has led to overwhelmed hospitals in numerous hotspots.

Impact on Economy

Costs associated with the activities and programs implemented to conduct surveillance and address disease outbreaks have not been quantified for this plan update. However, numerous activities and programs have been implemented by the County and State to address this hazard. Such resources include the COVID-19 Housing Assistance Program to help residents pay for housing costs and the Executive Order, Extending Utility Shutoff Moratorium to prohibit cable and telecommunication providers from disconnecting internet services (Sussex County 2021). Further, there has been secondary economic impact of closing non-essential facilities to reduce the spread of the virus. The final costs of this virus are still to be determined.

Most recently, the Health Department has played an active role in maintaining and controlling COVID-19 protocols across the County. This activity requires additional costs from the State and County to manage COVID-19 in communities. In April 2020, the Sussex County Board of Chosen Freeholders approved a $117.4-

million County budget, which reallocated existing budget from other accounts to the Office of Emergency Management and the Office of Public Health Nursing. The updated budget also moved funding to the mosquito control unit of the Health Department in order to fund aerial spraying and the use of larvacides (New Jersey Harold 2020).

Impact on Environment

Disease outbreaks may have an impact on the environment if the outbreaks are caused by invasive species. Invasive species tend to be competitive with native species and their habitat. One study has shown that invasive mosquitos such as the Asian tiger mosquito, a common invasive mosquito found in New Jersey, have "desiccation-resistant eggs," which means that they have enhanced survival in inhospitable environments (Juliano and Lounibos 2005). This species is considered a competitive predator and will prey on other species of mosquitos and a range of insects disrupting the natural food chain. Invasive species of mosquitos can be the major transmitters of disease like Zika, dengue, and yellow fever (Placer Mosquito and Vector Control District 2019).

Secondary impacts from mitigating disease outbreaks could also have an impact on the environment. Pesticides used to control disease carrying insects like mosquitos have been reviewed by the EPA and department of health. If these sprays are applied in large concentrations, they could potentially leach into waterways and harm nearby terrestrial species. However, there is a law in New Jersey's Pesticide Regulations that states "no person shall distribute, sell, offer for sale, purchase, or use any pesticide which has been suspended or canceled by the EPA, except as provided for in the suspension of cancellation order" (New Jersey nd).

Further Changes that May Impact Vulnerability

Understanding future changes that may impact vulnerability in the county can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. The county considered the following factors that may affect hazard vulnerability:

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

Projected Development

Any areas of growth could be potentially impacted by the disease outbreak hazard because the entire planning area is exposed. As population counts change in the County, there may be at increased risk to certain diseases. Higher concentrations of persons traveling via public transportation may become more vulnerable to the exchange of disease through airborne transmission.

Projected Changes in Population

Changes in population density may influence the number of persons exposed to disease outbreaks. Higher density jurisdictions are not only at risk of greater exposure to disease outbreak, density may also reduce available basic services provided by critical facilities such as hospitals and emergency facilities for persons that are not affected by a disease. Further, as the population ages there may be increased risk to this demographic. Older adults and people who have severe underlying medical conditions like heart or lung disease or diabetes seem to be at higher risk for developing more serious complications from certain diseases, such as COVID-19.

Climate Change

As discussed earlier in this section, the relationship between climate change and increase in infectious diseases is difficult to predict with certainty, however there may be linkages between the two. Changes in the environment may create a more livable habitat for vectors carrying disease as suggested by the Centers for Disease Control and Prevention (CDC n.d.). Localized changes in climate and human interaction may also be a factor in the spread of disease.

The relationship between climate change and infectious diseases is somewhat controversial. The notion that rising temperatures will increase the number of mosquitoes that can transmit malaria among humans (rather than just shift their range) has been the subject of debate over the past decade. Some believe that climate change may affect the spread of disease, while others are not convinced. However, many researchers point out that climate is not the only force at work in increasing the spread of infectious diseases into the future. Other factors, such as expanded rapid travel and evolution of resistance to medical treatments, are already changing the ways pathogens infect people, plants, and animals. As climate change accelerates it is likely to work synergistically with many of these factors, especially in populations increasingly subject to massive migration and malnutrition (Harmon 2010).

Vulnerability Change Since the 2016 HMP

Overall, the County continues to remain vulnerable to the disease outbreak hazard. Any changes or perceived increase in vulnerability may be attributed to changes in population numbers and density or the emergence of new diseases.

4.3.3 DROUGHT

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 drought hazard in Sussex County.

2021 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2020.
- The County's 2017 5-year American Community Survey population was considered when determining its exposure and vulnerability to the drought hazard.

Profile

Hazard Description

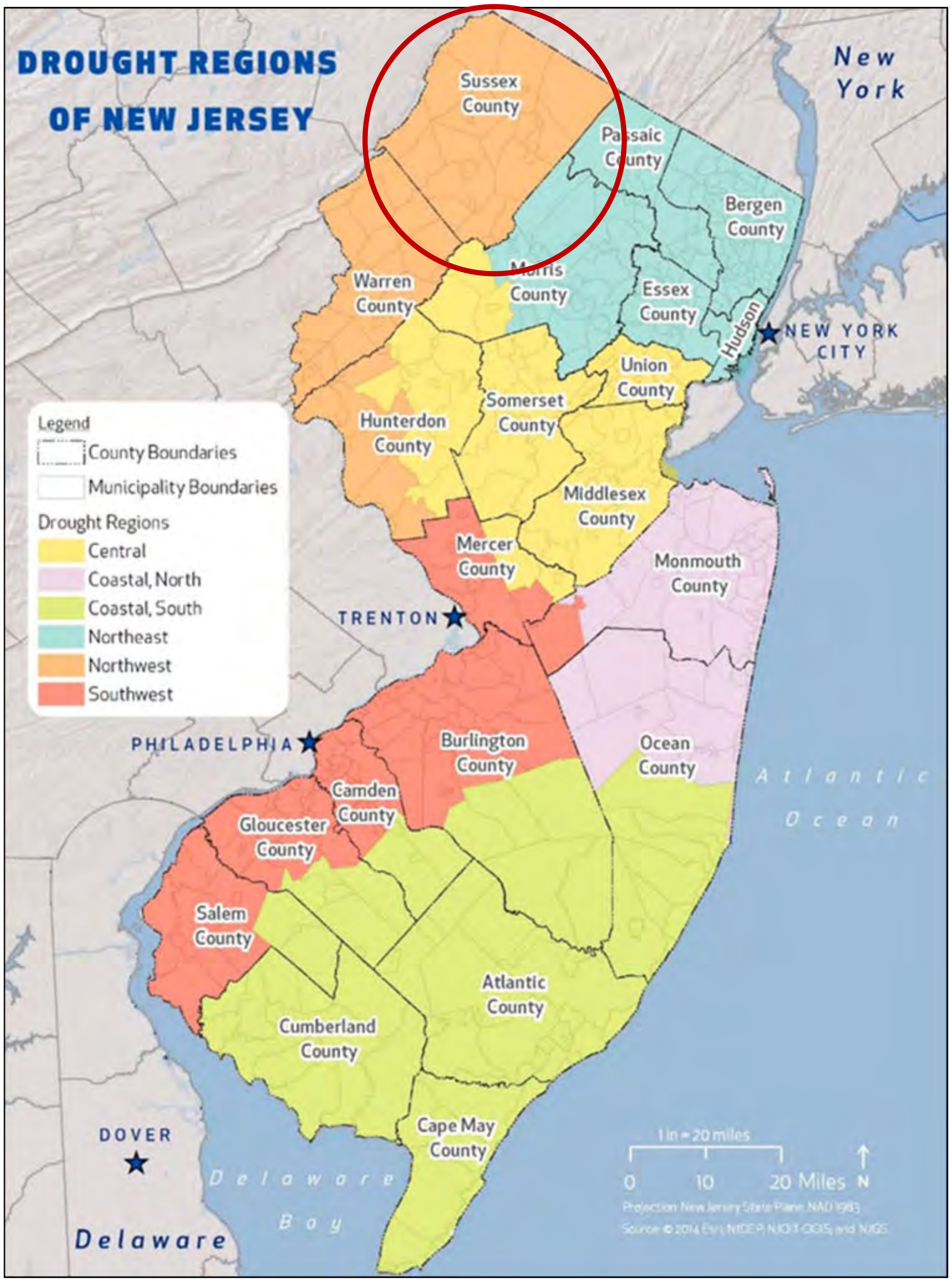
Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet characteristics of drought vary significantly from one region to another, relative to normal precipitation within respective regions. Drought can affect agriculture, water supply, aquatic ecology, wildlife, and plant life. Drought is a temporary irregularity in typical weather patterns and differs from aridity, which reflects low rainfall within a specific region and is a permanent feature of the climate of that area.

Location

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the U.S. into 359 climate divisions. The boundaries of these divisions typically coincide with the county boundaries, except in the western U.S., where they are based largely on drainage basins (U.S. Energy Information Administration, Date Unknown). According to NOAA, New Jersey is made up of three climate divisions: Northern, Southern, and Coastal; Sussex County is located in the Northern Climate Division (NOAA, 2012).

Drought regions allow New Jersey to respond to changing conditions without imposing restrictions on areas not experiencing water supply shortages. New Jersey is divided into six drought regions that are based on regional similarities in water supply sources and rainfall patterns (Hoffman and Domber, 2003). Sussex County is located in the Northwest Drought Region. Other counties in the Northwest Drought region include Hunterdon and Warren Counties (Hoffman and Domber, 2003) (see Figure 4.3.3-1). These regions were developed based upon hydro-geologic conditions, watershed boundaries, municipal boundaries, and water supply characteristics. Drought region boundaries are contiguous with municipal boundaries because during a water emergency, the primary enforcement mechanism for restrictions is municipal police forces.

Figure 4.3.3-1. Drought Regions of New Jersey

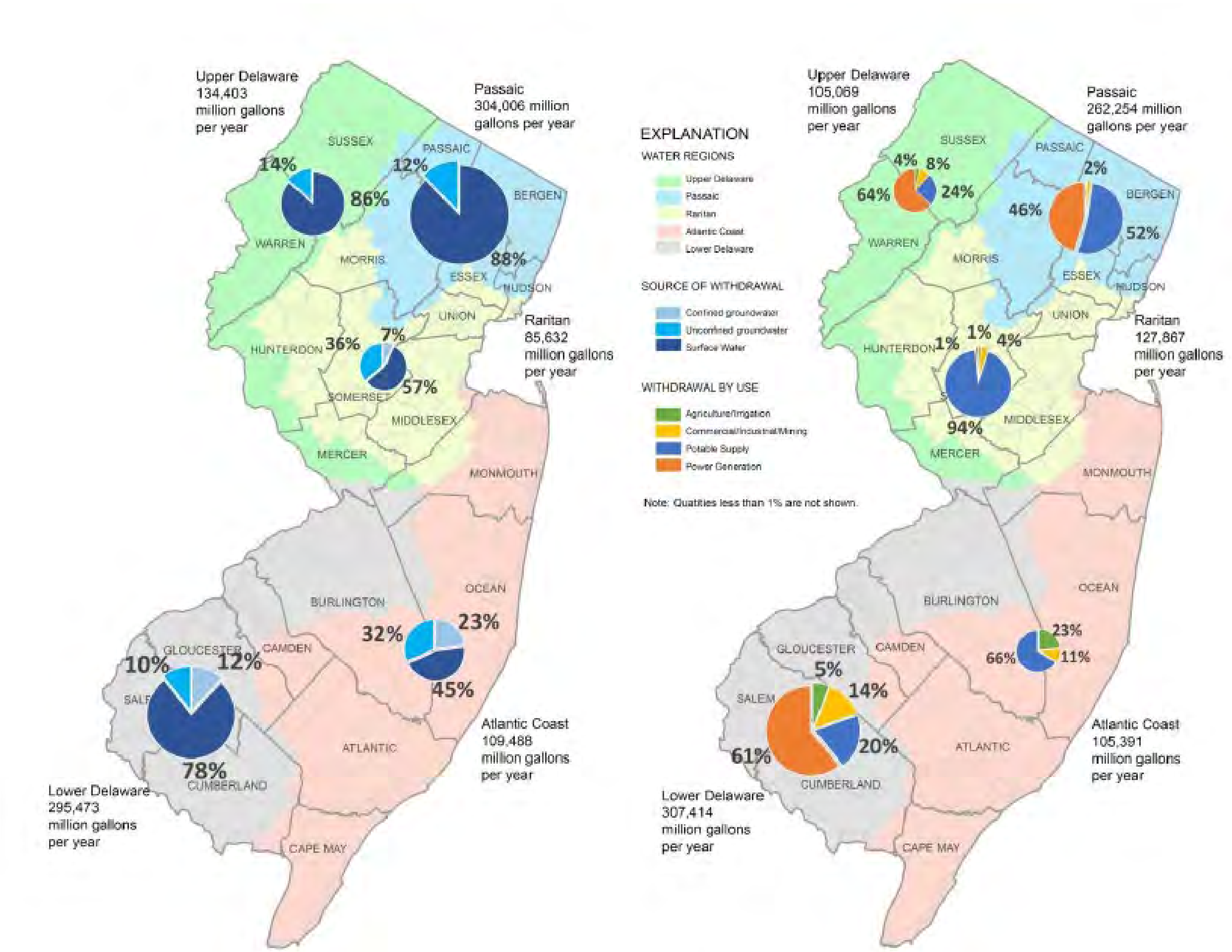


Source: NJHMP 2019

Note: The red circle indicates the location of Sussex County. The County is located within the Northwest Drought Region of New Jersey.

There are five water regions across the State (compiled from HUCH11 Watershed Management Areas). Sussex County is located in the Upper Delaware water region with a small area along the southeast border with Passaic County located in the Passaic water region; refer to Figure 4.3.3-2. The County's water supply sources are from surface water and unconfined groundwater sources. In terms of annual water withdrawal by sector, the majority is for power generation, followed by potable water supply, commercial/industrial/mining, and agriculture. Water use trends, similar to withdrawal trends, vary from month to month with water use typically peaking during summer months when outdoor and irrigation demands are high (NJDEP 2017).

Figure 4.3.3-2. Water Regions, Sources and Withdrawal by Sector in New Jersey



Source: NJDEP 2017

According to the 2017 Census of Agriculture, Sussex County is home to 1,008 farms covering 59,755 acres. Roughly 407 acres are irrigated (USDA 2017). Farms are considered to be at a higher risk for drought impacts than other types of land use. Table 4.3.3-1 shows the agricultural land use area within Sussex County jurisdictions.

Table 4.3.3-1. Agricultural Land Use Area by Jurisdiction

Jurisdiction	Total Area (Acres)	Agriculture	
		Area (Acres)	Percent of Total Area
Andover (B)	872	211	24.2%
Andover (Twp)	13,304	1,407	10.6%
Branchville (B)	383	7	1.9%
Byram (Twp)	14,536	74	0.5%
Frankford (Twp)	22,585	4,360	19.3%
Franklin (B)	2,833	188	6.6%

Jurisdiction	Total Area (Acres)	Agriculture	
		Area (Acres)	Percent of Total Area
Fredon (Twp)	11,464	2,619	22.8%
Green (Twp)	10,429	2,575	24.7%
Hamburg (B)	747	10	1.3%
Hampton (Twp)	16,305	1,959	12.0%
Hardyston (Twp)	20,892	985	4.7%
Hopatcong (B)	7,949	25	0.3%
Lafayette (Twp)	11,499	2,930	25.5%
Montague (Twp)	29,840	1,088	3.6%
Newton (T)	2,164	42	1.9%
Ogdensburg (B)	1,438	13	0.9%
Sandyston (Twp)	26,926	1,841	6.8%
Sparta (Twp)	24,828	1,007	4.1%
Stanhope (B)	1,341	0	0.0%
Stillwater (Twp)	18,076	1,509	8.3%
Sussex (B)	399	8	1.9%
Vernon (Twp)	44,769	1,756	3.9%
Walpack (Twp)	15,945	369	2.3%
Wantage (Twp)	43,175	9,761	22.6%
Sussex County (Total)	**342,701**	**34,745**	**10.1%**

Source: NJDEP, 2015
Note: B = Borough; T = Town; Twp = Township; % = Percent

Extent

The severity of a drought depends on the degree of moisture deficiency, the duration, and the size and location of the affected area. The longer the duration of the drought and the larger the area impacted, the more severe the potential impacts. The State of New Jersey uses a multi-index system that takes advantage of some of these indices to determine the severity of a drought or extended period of dry conditions.

Palmer Drought Severity Index

The Palmer Drought Severity Index is commonly used by drought monitoring agencies for drought reporting. The PDSI is primarily based on soil conditions. Soil with decreased moisture content is the first indicator of an overall moisture deficit. Table 4.3.3-2 lists the PDSI classifications. At the one end of the spectrum, 0 is used as normal and drought is indicated by negative numbers. For example, -2 is moderate drought, -3 is severe drought, and -4 is extreme drought. The PDSI also reflects excess precipitation using positive numbers; however, this is not shown in Table 4.3.3-2 (National Drought Mitigation Center [NDMC] 2013).

Table 4.3.3-2. Palmer Drought Category Descriptions

Category	Description	Possible Impacts	Palmer Drought Index
D0	Abnormally Dry	Going into drought: short-term dryness slowing	-1.0 to -1.99

Category	Description	Possible Impacts	Palmer Drought Index
		planting and growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered.	
D1	Moderate drought	Some damage to crops and pastures; fire risk high; streams, reservoirs, or wells low; some water shortages developing or imminent; voluntary water-use restrictions requested.	-2.0 to -2.99
D2	Severe drought	Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed.	-3.0 to -3.99
D3	Extreme drought	Major crop or pasture losses; extreme fire danger; widespread water shortages or restrictions.	-4.0 to -4.99
D4	Exceptional drought	Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells, creating water emergencies.	-5.0 or less

Source: NDMC 2013

The Division of Water Supply and Geoscience within the NJDEP, regularly monitors various water supply conditions within the state based on the different Water Supply Regions. The water supply conditions aid the Department in declaring the regions as being within one of the four stages of water supply drought, Normal, Drought Watch, Drought Warning, and Drought Emergency.

- A ***Drought Watch*** is an administrative designation made by the Department when drought or other factors begin to adversely affect water supply conditions. A Watch indicates that conditions are dry but not yet significantly so. During a drought Watch, the Department closely monitors drought indicators (including precipitation, stream flows and reservoir and ground water levels, and water demands) and consults with affected water suppliers.
- A ***Drought Warning*** represents a non-emergency phase of managing available water supplies during the developing stages of drought and falls between the Watch and Emergency levels of drought response. The aim of a Drought Watch is to avert a more serious water shortage that would necessitate declaration of a water emergency and the imposition of mandatory water use restrictions, bans on water use, or other potentially drastic measures.
- A ***Drought Emergency*** can only be declared by the governor. While drought warning actions focus on increasing or shifting the supply of water, efforts initiated under a water emergency focus on reducing water demands. During a water emergency, a phased approach to restricting water consumption is typically initiated. Phase I water use restrictions typically target non-essential, outdoor water use (NJDEP Division of Water Supply and Geoscience 2018).

Previous Occurrences and Losses

Precipitation variability, coupled with concentrated population centers, can produce wide fluctuations in water availability and demands. The State and County have experienced several episodes of drought that have resulted in water shortages of varying degrees (e.g., mid-1960's, early to mid-1980's and 2001-2002) (NJDEP 2017).

Federal Disaster Declarations

Between 1954 and 2020, the State of New Jersey experienced two FEMA declared drought-related major disasters (DR) or emergencies (EM) classified as a water shortage. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Of those two declarations, Sussex County has been included in both declarations (FEMA 2020).

Table 4.3.3-3. FEMA DR and EM Declarations Since 2008 for Drought Events in Sussex County

FEMA Declaration Number	Date(s) of Event	Declaration Date	Event Description
DR-205	August 18, 1965	August 18, 1965	Drought: Water Shortage
EM-3083	October 19, 1980	October 19, 1980	Drought: Water Shortage

Source: FEMA 2020

USDA Disaster Declarations

Agriculture-related drought disasters are quite common. The USDA Secretary of Agriculture 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. In 2015, Sussex County was included in declaration S3930 for excessive heat and drought with losses for all other crops totaling $47,315.10 (USDA 2020a, USDA 2020b).

Drought events identified for Sussex County between 2015 and 2020 are listed in Table 4.3.3-4. For this 2021 HMP update, known drought events that have impacted Sussex County prior to 2015 are identified in Appendix E (Risk Assessment Supplement).

Table 4.3.3-4. Drought Incidents in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Description
August 26, 2014 – June 29, 2015	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from August 26, 2014 – May 18, 2015; D1 or "moderate drought" status from May 19, 2015 – June 22, 2015; D0 or "abnormally dry" from June 23, 2015 – June 29, 2015. Residents around Lake Hopatcong, concerned about the lake level, sought a reduction in water release.
August 11, 2015 – January 11, 2016	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from August 11, 2015 – January 11, 2016. Boats were pulled early from Lake Hopatcong. Water restrictions were placed in Newton.
February 2-28, 2016	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from February 2-28, 2016.
March 29, 2016 – April 10, 2017	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from March 29, 2016 – June 13, 2016; D1 or "moderate drought" status from June 14, 2016 – August 15, 2016; D0 or "abnormally dry" status from August 16, 2016 – September 12, 2016; D1 or "moderate drought" status from September 13, 2016 – October 17, 2016; D2 or "severe drought" from October 18, 2016 – March 20,

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Description
				2017; D1 or "moderate drought" from– March 20, 2017 – April 10. Warm, low waters negatively impacted New Jersey trout. A drought watch was issued in July 2016. A drought warning was issued in October 2016. Water conservation was urged in northern New Jersey. The warning was lifted in April 2017.
October 3-30, 2017	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from October 3- 30, 2017.
November 28, 2017 – February 12, 2018	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from November 28, 2017 – February 12, 2018. Low reservoirs were reported in northern New Jersey.
September 24, 2019 – November 11, 2019	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from September 24, 2019 – November 11, 2019. A fire restriction was issued in northern New Jersey.
March 17-30, 2020.	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from March 17-30, 2020.
July 7-August 11, 2020	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Sussex County from July 7-August 11, 2020.

Source: USDA 2020, NDMC 2020, FEMA 2020, US Drought Monitor 2020
Please note that not all events that have occurred in Sussex County are included due to the extent of documentation and the fact that not all sources may have been identified or researched. Loss and impact information could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP update.

Probability of Future Occurrences

Based on the historical occurrences for drought, it is likely that droughts will occur across New Jersey and Sussex County in the future. Drought affects groundwater sources but not as quickly as surface water supplies. In addition, as temperatures increase (see climate change impacts), the probability for future droughts will likely increase as well.

It is estimated that Sussex County will continue to experience direct and indirect impacts of drought and its impacts on occasion, with the secondary effects causing potential disruption or damage to agricultural activities and creating shortages in water supply within communities.

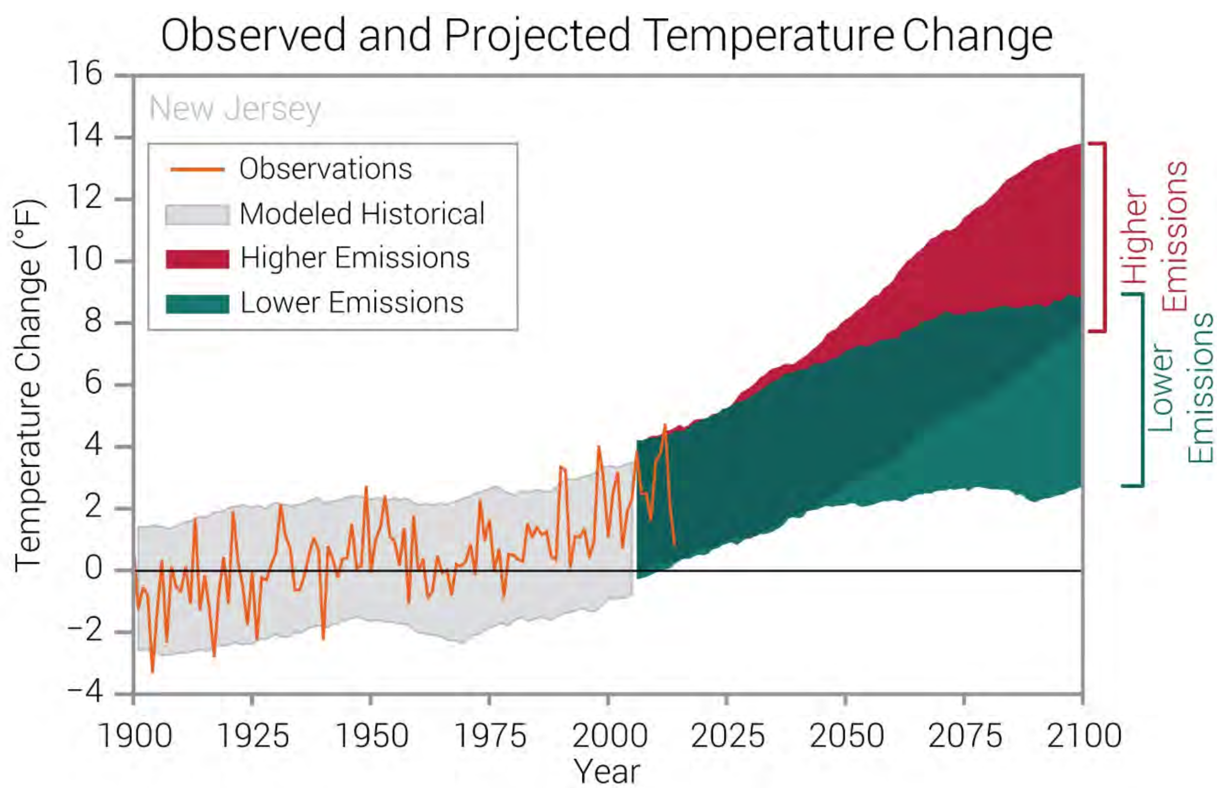
In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for drought is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the drought hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Water resources are important to both society and ecosystems. Humans depend on reliable, clean supply of drinking water to sustain their health. Water is also needed for agriculture, energy production, navigation, recreation, and manufacturing. These water uses put pressure on water resources and are most likely to be worsened by climate change in the future.

The climate of New Jersey is already changing and will continue to change over the course of this century. Since 1900, temperatures in New Jersey have increased an average of 3 degrees Fahrenheit (°F). Historically unprecedented warming is projected by the end of the 21st century. Heat waves are projected to be more intense while cold waves are projected to be less intense. (Office of the New Jersey State Climatologist [ONJSC] 2020). New Jersey has consistently been above the 1900-2014 mean during the 21st century with the highest 5-year average number occurring during 2010-2014 (NOAA NCICS 2020). Figure 4.3.3-3 depicts the observed and projected temperature change for New Jersey from 1900 to 2100.

Figure 4.3.3-3. Observed and Projected Temperature Change in New Jersey



Source: NOAA NCICS 2020

Either under a high or lower emissions pathway, historically unprecedented warming is projected by the end of the 21st century. Increases in the number of extremely hot days and decreases in the number of extremely cold days are projected to accompany the overall warming. According to state-level analysis, by the middle of the 21st century an estimated 70% of summers in this northeast region are anticipated to be hotter than what we now recognize as the warmest summer on record (NOAA NCICS 2020). These trends will certainly affect the probability and frequency of dry conditions that could lead to drought events in Sussex County.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable in the identified hazard area. The following discusses Sussex County's vulnerability, in a qualitative nature, to the drought hazard.

Impact on Life, Health and Safety

The entire population of Sussex County is exposed to drought events (population of 142,298 people, according to the 2014-2018 American Community Survey population estimates). Drought conditions can cause a shortage of potable water for human consumption, both in quantity and quality. A decrease in available water may also impact power generation and availability to residents.

Public health impacts may include an increase in heat-related illnesses, waterborne illnesses, recreational risks, limited food availability, and reduced living conditions. Vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts due to age, health conditions, and limited ability to mobilize to shelter, cooling and medical resources. Other possible impacts to health due to drought include increased recreational risks; effects on air quality; diminished living conditions related to energy, air quality, and sanitation and hygiene; compromised food and nutrition; and increased incidence of illness and disease. Health implications of drought are numerous. Some drought-related health effects are short-term while others can be long-term (CDC 2020).

Surface water supplies are affected more quickly during droughts than groundwater sources; however, groundwater supplies generally take longer to recover. According to the NJ Drinking Water Watch List, there are 490 suppliers of water to Sussex County (NJ Drinking Water Watch 2020). Of these suppliers, only two suppliers provide water from surface water sources. All other suppliers provide water from groundwater sources. The EPA classifies water suppliers into three major categories: community water systems, non-transient non-community water systems, transient non-community water systems.

- ***Community Water System* (CWS):** A public water system that supplies water to the same population year-round.
- ***Non-Transient Non-Community Water System* (NTNCWS)**: A public water system that regularly supplies water to at least 25 of the same people at least six months per year. Some examples are schools, factories, office buildings, and hospitals which have their own water systems.
- ***Transient Non-Community Water System* (TNCWS)**: A public water system that provides water in a place such as a gas station or campground where people do not remain for long periods of time (EPA 2020).

Overall, in Sussex County, 347 sources are transient non-community water suppliers, 78 are non-transient non-community suppliers, 63 are community suppliers, and 2 are non-public water supplies. Some County residents and organizations also rely on private wells for their water supply needs.

The CDC 2016 Social Vulnerability Index (SVI) ranks U.S. Census tracts on socioeconomic status, household composition and disability, minority status and language, and housing and transportation. Sussex County's overall score is 0.0325, indicating that its communities have very low social vulnerability (CDC 2016). Out of all the census tracts in the County, only one has very high vulnerability which is located in south central Sussex County.

Impact on General Building Stock

No structures are anticipated to be directly affected by a drought event. However, droughts contribute to conditions conducive to wildfires and reduce fire-fighting capabilities. Risk to life and property is greatest in those areas where forested areas adjoin urbanized areas (high density residential, commercial and industrial) also known as the wildfire urban interface (WUI) or where areas are made up of species that are highly susceptible to erupting into wildfire events. Therefore, all assets in and adjacent to the WUI zone and wildfire fuel hazard areas, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer to Section 4.3.13 for the Wildfire risk assessment.

Impact on Critical Facilities and Lifelines

As mentioned, drought events generally do not impact buildings; however, droughts have the potential to impact agriculture-related facilities, critical facilities and lifelines that are associated with water supplies such as potable water used with fire-fighting services. The impacts droughts cause to agricultural-related facilities is particularly important to Sussex County due to its high amount of acreage devoted to farmland. Critical facilities and lifelines in and adjacent to the wildfire hazard areas are also considered vulnerable to drought.

Water systems and thus distribution to the population may also be impacted by other hazards such as extreme weather events. A good example is Superstorm Sandy where storm surge damaged critical water supply infrastructure along the coast and high winds impacted energy distribution across the State which in turn impacted the ability to supply water. As a result, NJDEP has developed new guidance aimed to ensure that repairs, reconstruction, new facilities and operations/maintenance are focused on enhancing the resilience of critical infrastructure (NJDEP 2017).

Impact on the Economy

Drought can produce a range of impacts that span many economic sectors and can reach beyond an area experiencing physical drought. As previously discussed, water withdrawals are not only used for potable water but for use in the commercial/industrial/mining sectors and power generation. When a state of water emergency is declared by the Governor (when a potential or actual water shortage endangers the public health, safety and welfare), the NJDEP may impose mandatory water restrictions and require specific actions to be taken by water suppliers. According to the New Jersey Water Supply Plan, a water emergency seeks to cause as little disruption as possible to commercial activity and employment (NJDEP 2017).

A prolonged drought can have a serious economic impact on a community. When drought conditions persist with little to no relief, water restrictions may be put into place by local or state governments. These restrictions may include placing limitations on when or how frequent lawns can be watered, car washing services, or any other recreational/commercial outdoor use of water supplies. In exceptional drought conditions, watering of lawns and crops may not be an option. If crops are not able to receive water, farmland will dry out and crops will die. This can lead to crop shortages, which, in turn, increases the price of food.

Increased demand for water and electricity can also result in shortages and higher costs for these resources. Industries that rely on water for business could be impacted the most (e.g., landscaping businesses). Although most businesses will still be operational, they may be impacted aesthetically. These aesthetic impacts are most significant within the recreation and tourism industry. Moreover, droughts within another area could impact the food supply and price of food for residents within the County.

Direct impacts of drought include reduced crop yield, increased fire hazard, reduced water levels, and damage to wildlife and fish habitat. The many impacts of drought can be listed as economic, environmental, or social. Direct and indirect losses include the following:

- Damage to crop quality and crop losses.
- Insect infestation leading to crop and tree losses.
- Plant diseases leading to loss of agricultural crops and trees.
- Reduction in outdoor activities.
- Increased risk of brush fires and wildfires due to dried crops, grasses, and dying trees.

When a drought occurs, the agricultural industry is most at risk in terms of economic impact and damage. For example, crops may not mature leading to a lessened crop yield, wildlife and livestock may become undernourished, land values could decrease, and ultimately there could be a financial loss for the farmer. Based on the 2017 Census of Agriculture, Sussex County farms had a total market value of products sold of approximately $10.8-million in crop sales and $7.4-million in livestock sales. Table 4.3.3-5 summarizes the acreage of agricultural land exposed to the drought hazard.

Table 4.3.3-5. Agricultural Land in Sussex County in 2017

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Irrigated Land (acres)
1,008	59,766	25,671	20,441	407

Source: USDA 2017

Impact on the Environment

Droughts can impact the environment because these events can trigger wildfires, increase insect infestations, and exacerbate the spread of disease (NOAA 2020). Droughts will also impact water resources that are relied upon by aquatic and terrestrial species. Ecologically sensitive areas, such as wetlands, can be particularly vulnerable to drought periods because they are dependent on steady water levels and soil moisture availability to sustain growth. As a result, these types of habitats can be negatively impacted after long periods of dryness (NJDEP 2017).

Droughts also have the potential to lead to water pollution due to the lack of rainwater to dilute any chemicals in water sources. Contaminated water supplies may be harmful to plans and animals. If water is not getting into the soils, the ground will dry up and become unstable for plant species. Maintaining stability prevents erosion and treefall that is susceptible to catching fire and starting wildfire events (North Carolina State University 2020).

Future Changes That May Impact Vulnerability

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

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

Projected Development

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across Sussex County. The New Jersey Water Supply Plan indicates seasonal outdoor water use is rising statewide and is attributable to continued suburbanization and increases in residential and commercial lawn and landscape maintenance. Changes in water demands by commercial/industrial users will depend on future development of this water type use and how effectively efficiency techniques are implemented (NJDEP 2017).

Projected Changes in Population

Potable water use is the second largest water use sector and largest consumptive use in New Jersey. As such, population projections, per capital water use and percent non-residential water use by water system are important factors to consider when assessing future water needs. According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the distribution of the population can impact the source of water resources required to sustain the user demand of each household, agricultural operation, and business operation.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures. Additionally, the State is projected to experience more frequency droughts which may affect the availability of water supplies, primarily placing an increased stress on the population and their available potable water. Agricultural needs may increase if the climate grows warmer but may decrease if more efficient irrigation techniques are adopted broadly or if precipitation increases. A decrease in water supply, or increase in water supply demand, may increase the County's vulnerability to structural fire and wildfire events. Critical water-related service sectors may need to adjust management practices and actively manage resources to accommodate for future changes.

Vulnerability Change Since the 2016 HMP

When examining the change in the County's vulnerability to drought events from the 2016 HMP to this update, it is important to look at each entity that is exposed and vulnerable. The total population across the County has experienced a slight decrease, which can place less stress on the water supply during a drought event. However, the number of farm operations has increased since the 2012 USDA report by over 10-percent, which may increase the overall stress on the water supply during a drought event.

4.3.4 EARTHQUAKE

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 earthquake hazard in Sussex County.

2021 HMP Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2015 and 2020.
- The New Jersey Geologic and Water Survey (NJGWS) updated liquefaction data was included in the vulnerability assessment.
- Updated Hazus-MH probabilistic modeling using v4.2 was conducted using updated inventory data.
- Impacts on the environment are summarized in the vulnerability assessment.

Profile

Hazard Description

An earthquake is the sudden movement of the Earth's surface caused by the release of stress accumulated within or along the edge of the Earth's tectonic plates, a volcanic eruption, or by a manmade explosion (Federal Emergency Management Agency [FEMA] 2001; Shedlock and Pakiser 1997). Most earthquakes occur at the boundaries where the Earth's tectonic plates meet (faults); less than 10% of earthquakes occur within plate interiors. New Jersey is in an area where the rarer plate interior-related earthquakes occur. As plates continue to move and plate boundaries change geologically over time, weakened boundary regions become part of the interiors of the plates. These zones of weakness within the continents can cause earthquakes in response to stresses that originate at the edges of the plate or in the deeper crust (Shedlock and Pakiser 1997).

The location of an earthquake is commonly described by its focal depth and the geographic position of its epicenter. The focal depth of an earthquake is the depth from the Earth's surface to the region where an earthquake's energy originates, also called the focus or hypocenter. The epicenter of an earthquake is the point on the Earth's surface directly above the hypocenter (Shedlock and Pakiser 1997). Earthquakes usually occur without warning and their effects can impact areas of great distance from the epicenter (FEMA 2001).

According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, an earthquake hazard is any disruption associated with an earthquake that may affect residents' normal activities. This includes surface faulting, ground shaking, landslides, liquefaction, tectonic deformation, tsunamis, and seiches; each of these terms is defined below; however, not all occur within the Sussex County planning area:

- *Surface faulting*: Displacement that reaches the earth's surface during a slip along a fault. Commonly occurs with shallow earthquakes—those with an epicenter less than 20 kilometers.
- *Ground motion (shaking):* The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by a sudden slip on a fault or sudden pressure at the explosive source and travel through the Earth and along its surface.
- *Landslide*: A movement of surface material down a slope.
- *Liquefaction*: A process by which water-saturated sediment temporarily loses strength and acts as a fluid, like the wet sand near the water at the beach. Earthquake shaking can cause this effect.
- *Tectonic Deformation*: A change in the original shape of a material caused by stress and strain.
- *Tsunami*: A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major sub-marine slides, or exploding volcanic islands.

- *Seiche*: The sloshing of a closed body of water, such as a lake or bay, from earthquake shaking (USGS 2012a).

Earthquakes can cause large and sometimes disastrous landslides and mudslides. Any steep slope is vulnerable to slope failure, often as a result of loss of cohesion in clay-rich soils. Unless properly secured, hazardous materials can be released, causing significant damage to the environment and people. Earthen dams and levees are highly susceptible to seismic events and the impacts of their eventual failures can be considered secondary risks for earthquakes. Landslides are further discussed in Section 5.4.5 (Geologic Hazards) of this HMP update.

Earthquakes can also cause dam failures. The most common mode of earthquake-induced dam failure is slumping or settlement of earth-fill dams where the fill has not been property compacted. If the slumping occurs when the dam is full, then overtopping of the dam, with rapid erosion leading to dam failure is possible. Dam failure is also possible if strong ground motions heavily damage concrete dams. Earthquake-induced landslides into reservoirs have also caused dam failures.

Another secondary effect of earthquakes that is often observed in low-lying areas near water bodies is ground liquefaction. Liquefaction is the conversion of water-saturated soil into a fluid-like mass. This can occur when loosely packed, waterlogged sediments lose their strength in response to strong shaking. Liquefaction effects may occur along the shorelines of the ocean, rivers, and lakes and they can also happen in low-lying areas away from water bodies in locations where the ground water is near the earth's surface.

Tsunamis are formed as a result of earthquakes, volcanic eruptions, or landslides that occur under the ocean. When these events occur, huge amounts of energy are released as a result of quick, upward bottom movement. A wave is formed when huge volumes of ocean water are pushed upward. A large earthquake can lift large portions of the seafloor, which will cause the formation of huge waves (U.S. Search and Rescue Task Force Date Unknown).

Location

Earthquakes are most likely to occur in the northern parts of New Jersey, which includes Sussex County, where significant faults are concentrated; however, low-magnitude events can and do occur in many other areas of the State. The National Earthquake Hazard Reduction Program (NEHRP) 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, as noted in Table 4.3.4-1, 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.

Table 4.3.4-1. NEHRP Soil Classifications

Soil Classification	Description
A	Hard Rock
B	Rock
C	Very dense soil and soft rock
D	Stiff soils
E	Soft soils

Source: FEMA 2013

The New Jersey Department of Transportation (NJDOT) compiled a report on seismic design consideration for bridges in New Jersey, dated March 2012. In the report, NJDOT classifies the seismic nature of soils according to the American Association of State Highway and Transportation Officials (AASHTO) Guide Specifications for Bridge Seismic Design (SGS). For the purpose of seismic analysis and design, sites can be classified into

Soil Classes A, B, C, D, E and F, ranging from hard rock to soft soil and special soils (similar to the NEHRP soil classifications with an additional class F); refer to Table 4.3.4-2.

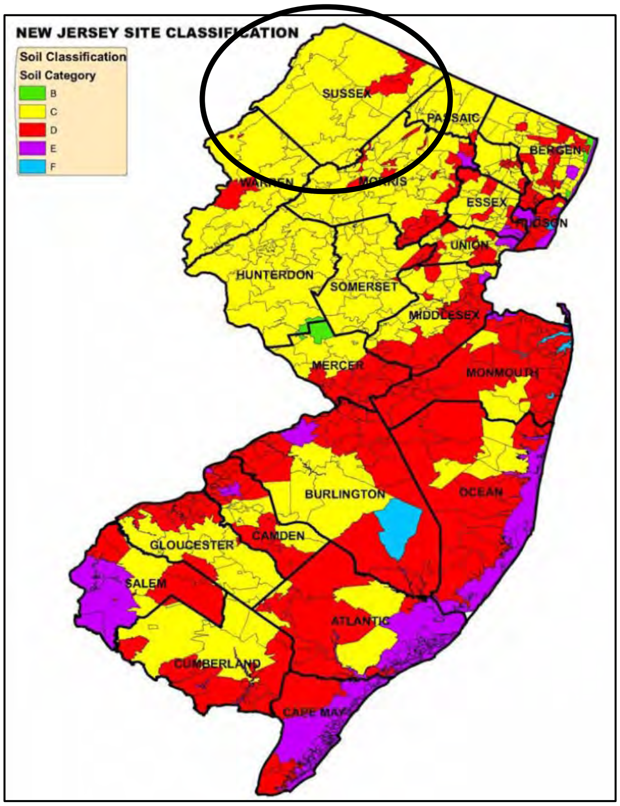
Table 4.3.4-2. NJDOT Soil Classifications

Soil Classification	Description
A-B	Rock sites
C	Very dense soil
D	Dense soil
E	Soft soil
F	Special soil requiring site-specific analysis

Source: NJDOT 2012

NJDOT also developed a Geotechnical Database Management System, which contains soil boring data across New Jersey. The soil boring logs were then used to classify soil sites. Through this analysis, NJDOT developed a map of soil site classes according to ZIP codes in New Jersey where each ZIP code was assigned a class based on its predominant soil condition. In Sussex County, most ZIP codes were rated as a Category C, and a few were rated as Category D; refer to Figure 4.3.4-1.

Figure 4.3.4-1. ZIP Code-Based Soil Site Class Map



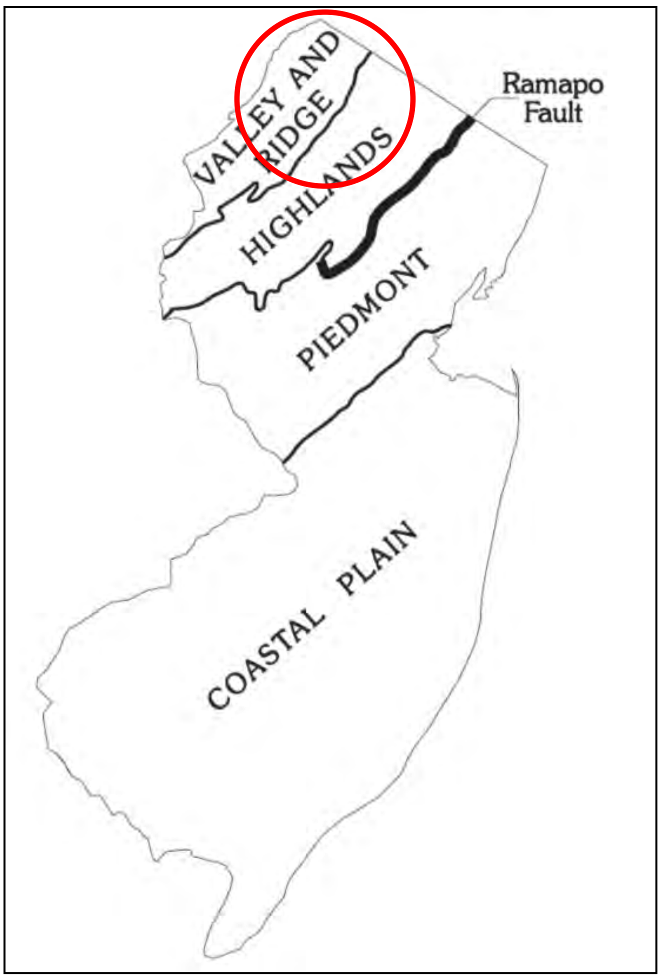
Source: NJDOT 2012
Note: Sussex County is indicated by the black circle.
Soil Classes A and B are rock sites
Soil Class C is very dense soil
Soil Class D is dense soil
Soil Class E is soft soil
Soil Class F is special soil requiring site-specific analysis

Liquefaction has been responsible for tremendous amounts of damage in historical earthquakes around the world. Shaking behavior and liquefaction susceptibility of soils are determined by their grain size, thickness, compaction, and degree of saturation. These properties, in turn, are determined by the geologic origin of the soils and their topographic position.

Liquefaction occurs in saturated soils and when it occurs, the strength of the soil decreases and the ability of a soil deposit to support foundations for buildings and bridges is reduced. Shaking from earthquakes often triggers an increase in water pressure which can trigger landslides and the collapse of dams. For information regarding dam failures, refer to Section 4.3.1 (Dam Failure) and for landslides refer to Section 4.3.6 (Geologic). Earthquakes can also contribute to landslide hazards. Earthquakes create stresses that make weak slopes fail. Earthquakes of magnitude 4.0 or greater have been known to trigger landslides.

There are many faults in New Jersey; however, the Ramapo Fault, which separates the Piedmont and Highlands Physiographic Provinces, is best known. As indicated in Figure 4.3.4-2, Sussex County might feel the effects of an earthquake along the Ramapo Fault; however, the fault itself is not located within County borders. The Reservoir Fault, which borders the Green Pond Mountain region, is another major faultline in New Jersey and is closer to Sussex County borders than the Ramapo Fault (Volkert and Witte 2015).

Figure 4.3.4-2. Physiographic Provinces of New Jersey and the Ramapo Fault Line



Source: Dombroski 1973 (revised 2005)

Note: The red circle indicates the approximate location of Sussex County. The County is part of Piedmont Province.

Extent

An earthquake's magnitude and intensity are used to describe the size and severity of the event. Magnitude describes the size at the focal point of an earthquake, and intensity describes the overall severity of shaking felt during the event. The earthquake's magnitude is a measure of the energy released at the source of the earthquake. Magnitude was formerly expressed by ratings on the Richter scale but is now most commonly expressed using the moment magnitude (Mw) scale. This scale is based on the total moment release of the earthquake (the product of the distance a fault moved and the force required to move it). The scale is as follows:

- Great Mw > 8
- Major Mw = 7.0 – 7.9
- Strong Mw = 6.0 – 6.9
- Moderate Mw = 5.0 – 5.9
- Light Mw = 4.0 – 4.9
- Minor Mw = 3.0 – 3.9
- Micro Mw = 3.0 – 3.9

The most commonly used intensity scale is the modified Mercalli intensity scale. Ratings of the scale, as well as the perceived shaking and damage potential for structures, are shown in Table 4.3.4-3. The modified Mercalli intensity scale is generally represented visually using shake maps, which show the expected ground shaking at any given location produced by an earthquake with a specified magnitude and epicenter An earthquake has only one magnitude and one epicenter, but it produces a range of ground shaking at sites throughout the region, depending on the distance from the earthquake, the rock and soil conditions at sites, and variations in the propagation of seismic waves from the earthquake due to complexities in the structure of the earth's crust. A USGS shake map shows the variation of ground shaking in a region immediately following significant earthquakes. Table 4.3.4-4 displays the MMI scale and its relationship to the areas peak ground acceleration (PGA).

Table 4.3.4-3. Modified Mercalli Intensity Scale

Mercalli Intensity	Description
I	Felt by very few people; barely noticeable.
II	Felt by few people, especially on upper floors.
III	Noticeable indoors, especially on upper floors, but may not be recognized as an earthquake.
IV	Felt by many indoors, few outdoors. May feel like passing truck.
V	Felt by almost everyone, some people awakened. Small objects move; trees and poles may shake.
VI	Felt by everyone; people have trouble standing. Heavy furniture can move; plaster can fall off walls. Chimneys may be slightly damaged.
VII	People have difficulty standing. Drivers feel their cars shaking. Some furniture breaks. Loose bricks fall from buildings. Damage is slight to moderate in well-built buildings; considerable in poorly built buildings.
VIII	Well-built buildings suffer slight damage. Poorly built structures suffer severe damage. Some walls collapse.
IX	Considerable damage to specially built structures; buildings shift off their foundations. The ground cracks. Landslides may occur.
X	Most buildings and their foundations are destroyed. Some bridges are destroyed. Dams are seriously damaged. Large landslides occur. Water is thrown on the banks of canals, rivers, and lakes. The ground cracks in large areas.
XI	Most buildings collapse. Some bridges are destroyed. Large cracks appear in the ground. Underground pipelines are destroyed.

Mercalli Intensity	Description
XII	Almost everything is destroyed. Objects are thrown into the air. The ground moves in waves or ripples. Large amounts of rock may move.

Source: Michigan Tech University n.d.

Table 4.3.4-4. Modified Mercalli Intensity and PGA Equivalents

Modified Mercalli Intensity	Acceleration (%g) (PGA)	Perceived Shaking	Potential Damage
I	< .17	Not Felt	None
II	.17 – 1.4	Weak	None
III	.17 – 1.4	Weak	None
IV	1.4 – 3.9	Light	None
V	3.9 – 9.2	Moderate	Very Light
VI	9.2 – 18	Strong	Light
VII	18 – 34	Very Strong	Moderate
VIII	34 – 65	Severe	Moderate to Heavy

Source: Freeman et al. 2004
Note: PGA Peak Ground Acceleration

The ground experiences acceleration as it shakes during an earthquake. The peak ground acceleration (PGA) is the largest acceleration recorded by a monitoring station during an earthquake. PGA is a measure of how hard the earth shakes in a given geographic area. It is expressed as a percentage of the acceleration due to gravity (%g). Horizontal and vertical PGA varies with soil or rock type. Earthquake hazard assessment involves estimating the annual probability that certain ground accelerations will be exceeded, and then summing the annual probabilities over a time period of interest. Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures, as noted in Table 4.3.4-5.

Table 4.3.4-5. Damage Levels Experienced in Earthquakes

Ground Motion Percentage	Explanation of Damages
1-2%g	Motions are widely felt by people; hanging plants and lamps swing strongly, but damage levels, if any, are usually very low.
Below 10%g	Usually causes only slight damage, except in unusually vulnerable facilities.
10 - 20%g	May cause minor-to-moderate damage in well-designed buildings, with higher levels of damage in poorly designed buildings. At this level of ground shaking, only unusually poor buildings would be subject to potential collapse.
20 - 50%g	May cause significant damage in some modern buildings and very high levels of damage (including collapse) in poorly designed buildings.
≥50%g	May causes higher levels of damage in many buildings, even those designed to resist seismic forces.

Source: NJOEM 2019
Note: %g Peak Ground Acceleration

National maps of earthquake shaking hazards provide information for creating and updating seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities, and land use planning. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al. 2001). The USGS updated the National Seismic Hazard Maps in 2014. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2014 map represents the best available data, as determined by the USGS.

Figures 4.3.4-3 and Figure 4.3.4-4 illustrate geographic distributions of the Modified Mercalli Scale based on PGAs (%*g*) across Sussex County for 100- and 500-year MRP events at the census-tract level. A 100-year mean return period (MRP) event is an earthquake with 1-percent chance that mapped ground motion levels (PGA) will be exceeded in any given year. A 500-year MRP is an earthquake with 0.2 percent chance that mapped PGAs will be exceeded in any given year.

Figure 4.3.4-3. Peak Ground Acceleration 100-Year Mean Return Period for Sussex County

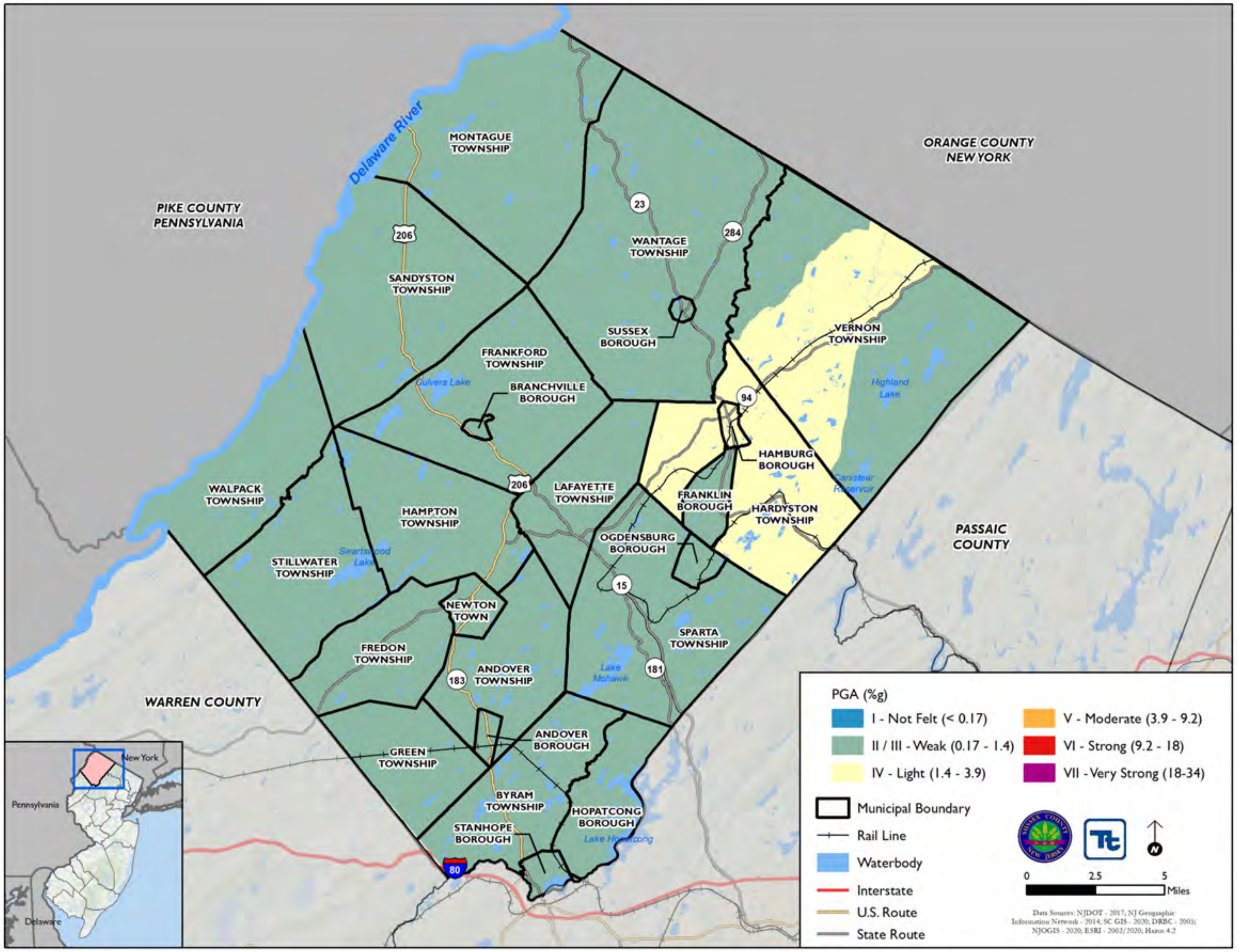
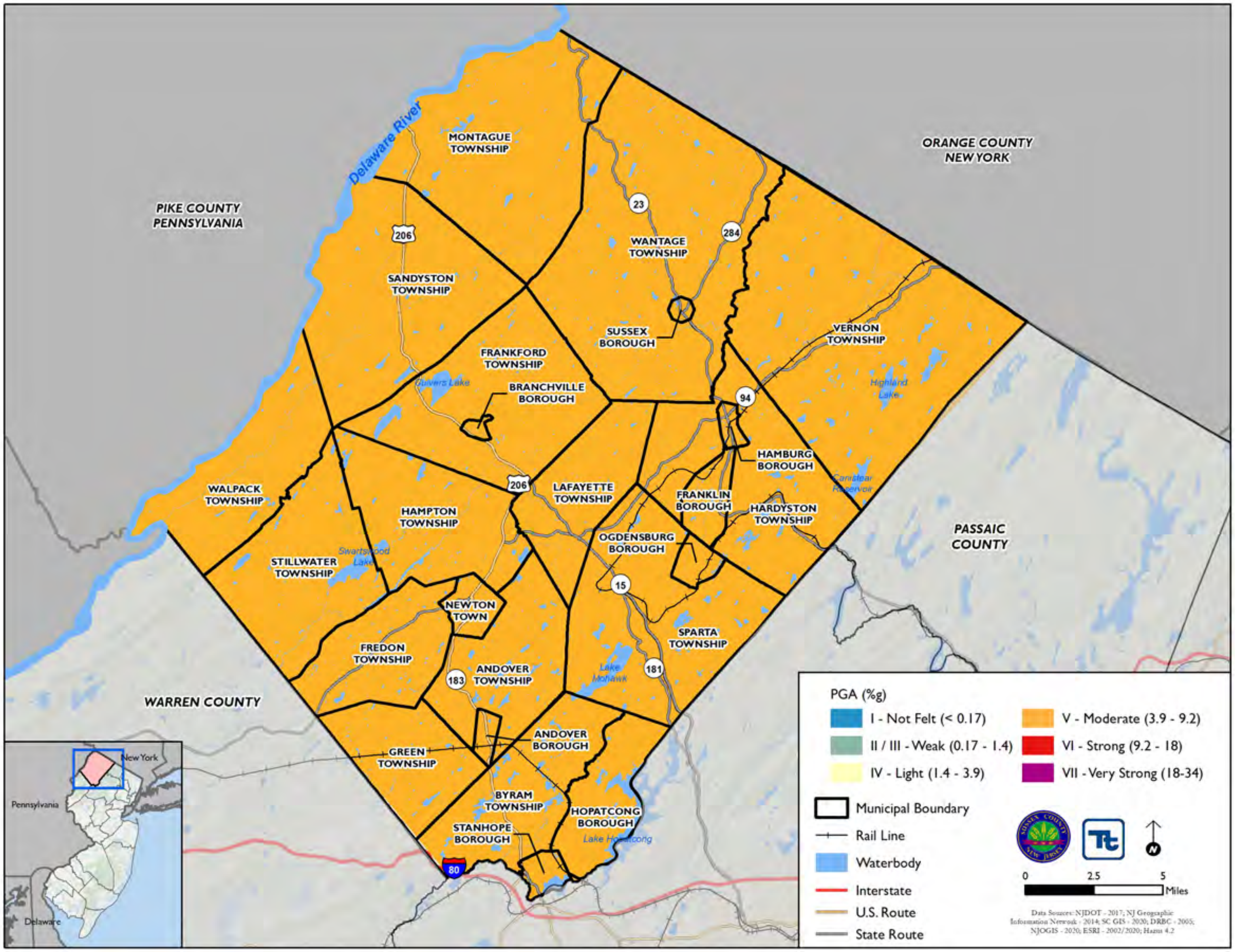


Figure 4.3.4-4. Peak Ground Acceleration 500-Year Mean Return Period for Sussex County



Previous Occurrences and Losses

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, Sussex County has not been included in any declarations associated with earthquakes.

U.S. Department of Agriculture Disaster 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 2015 and 2020, Sussex County was not included in any USDA declarations associated with earthquakes.

Earthquake Events

Earthquake events that have impacted Sussex County between 2015 and 2020 are identified in Table 4.3.4-6. With earthquake documentation for New Jersey and Sussex County being so extensive, not all sources have been identified or researched. Therefore, Table 4.3.4-6 may not include all events that have occurred in the County. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

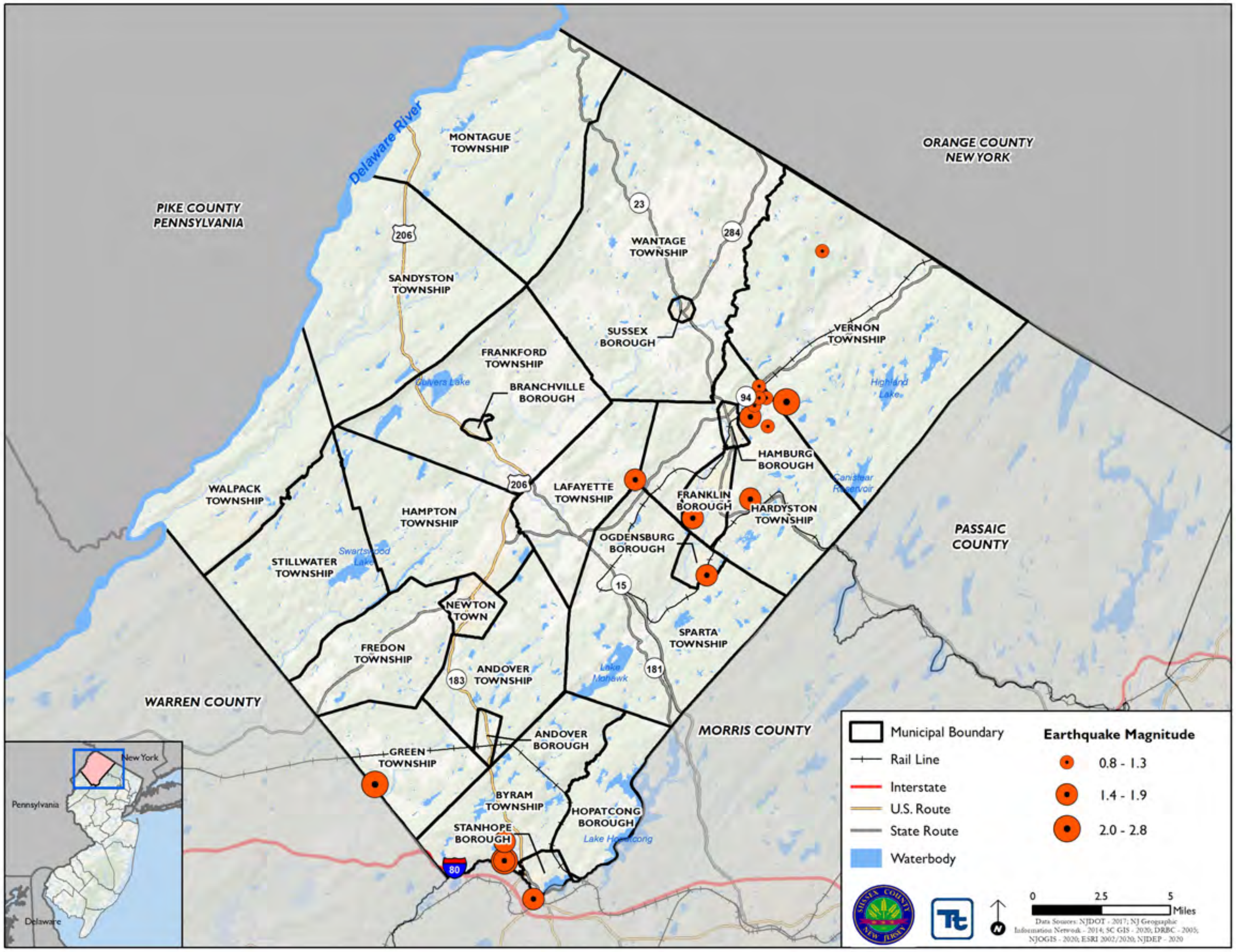
Table 4.3.4-6. Earthquake Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
January 2, 2016	Earthquake	N/A	N/A	Ringwood, NJ	A magnitude 2.1 earthquake in Ringwood, NJ was faintly felt in eastern areas of Sussex County.
November 30, 2017	Earthquake	N/A	N/A	Dover, DE	A magnitude 4.1 earthquake in Dover, DE was felt throughout the mid-Atlantic region. The quake was felt from central Virginia to Massachusetts.
September 9, 2020	Earthquake	N/A	N/A	Marlboro, NJ	A magnitude 3.1 earthquake in Marlboro, NJ was faintly felt in Sussex County.

Source: FEMA 2020; NOAA-NCEI 2020; NWS 2020; SPC 2020; NJOEM 2019
Note: Not all events that have occurred in Sussex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
DR Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
N/A Not Applicable

Historically, Sussex County has not experienced a major earthquake. However, there have been a number of earthquakes of relatively low intensity. The majority of earthquakes that have occurred in New Jersey have occurred along faults in the central and eastern Highlands, with the Ramapo fault being the most seismically active fault in the region (Volkert and Witte 2015); Sussex County can be impacted by earthquakes in the New Jersey Highlands. Small earthquakes may occur several times a year and generally do not cause significant damage. The largest earthquake to impact Sussex County was a magnitude 5.3 earthquake that was epicentered west of New York City. It was felt from New Hampshire to Pennsylvania (Stover and Coffman 1993; NJGWS 2015). Figure 4.3.4-5 illustrates earthquake events where the epicenters were located in New Jersey.

Figure 4.3.4-5. Earthquakes with Epicenters in Sussex County



Probability of Future Occurrences

Earthquakes cannot be predicted and may occur any time of the day or year. Major earthquakes are infrequent in the State and County and may occur only once every few hundred years or longer, but the consequences of major earthquakes may potentially be very high. Based on the historic record, the future probability of damaging earthquakes impacting Sussex County is low.

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for earthquake in the County is considered 'rare' (between 1 and 10 percent annual probability of a hazard event occurring, as presented in Table 4.4-1). The ranking of the earthquake hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

The potential impacts of global climate change on earthquake probability are unknown. Some scientists feel that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the Earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes (NJOEM 2019).

Secondary impacts of earthquakes could be magnified by future climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity because of the increased saturation. Dams storing increased volumes of water from changes in the hydrograph could fail during seismic events. There are currently no models available to estimate these impacts (NJOEM 2019).

Vulnerability Assessment

A probabilistic assessment was conducted for the 100-year and 500-year MRP events through a Level 2 analysis in Hazus v4.2 to analyze the earthquake hazard and provide a range of loss estimates. Refer to Section 4.2 (Methodology) for additional details on the methodology used to assess earthquake risk.

Impact on Life, Health, and Safety

The entire County may experience an earthquake. However, the degree of impact is dependent on many factors including the age and type of construction people live in, the soil types their homes are located on, and the intensity of the earthquake. Whether directly or indirectly impacted, residents could be faced with business closures, road closures that could isolate populations, and loss of function of critical facilities and utilities.

Overall, risk to public safety and loss of life from an earthquake in the County is minimal for low magnitude events. However, there is a higher risk to public safety for those inside buildings due to structural damage or people walking below building ornamentations and chimneys that may be shaken loose and fall because of an earthquake. NEHRP Soil Classes D and E amplify ground shaking to damaging levels even during a moderate earthquake, and thus increase risk to the population. As Figure 4.3.4-1 demonstrates, softer soils are more prevalent in the northeast portion of the County, making the population in this area more vulnerable to an earthquake event.

Populations considered most vulnerable are those located in/near the built environment, particularly those near unreinforced masonry construction. Of these most vulnerable populations, socially vulnerable populations, including the elderly (persons over age 65) and individuals living below the poverty threshold, are most susceptible. Factors leadings to this higher susceptibility include decreased mobility and financial ability to react or respond during a hazard, and the location and construction quality of their housing. According to the 2014 – 2018 5-year American Community Survey (ACS) estimates, there are 7,191 total persons living below the poverty level and 22,889 persons over the age of 65 years in Sussex County.

As a result of an earthquake event, residents may be displaced or require temporary to long-term sheltering. The number of people requiring shelter is generally less than the number displaced as some displaced persons use hotels or stay with family or friends following a disaster event. Hazus estimates that there will be zero displaced households and zero persons seeking short-term sheltering caused by the 100-year and 500-year MRP events.

According to the 1999-2003 NYCEM Summary Report (*Earthquake Risks and Mitigation in the New York / New Jersey / Connecticut Region*), a strong correlation exists between structural building damage and number of injuries and casualties from an earthquake event. Further, the time of day also exposes different sectors of the community to the hazard. For example, Hazus considers the residential occupancy at its maximum at 2:00 a.m., where the educational, commercial, and industrial sectors are at their maximum at 2:00 p.m., with peak commute time at 5:00 p.m. Whether directly impacted or indirectly impact, the entire population will have to deal with the consequences of earthquakes to some degree. Business interruption could prevent people from working, road closures could isolate populations, and loss of functions of utilities could impact populations that suffered no direct damage from an event itself. Overall, Hazus estimates that there are no injuries or casualties caused by the 100-year MRP event and seven injuries caused by the 500-year MRP event (i.e., one injury during the 2AM commute, four injuries during the 2PM commute, and two injuries during the 5PM commute).

Impact on General Building Stock

The entire County's general building stock is considered at risk and exposed to this hazard. Soft soils (NEHRP Soil Classes D and E) can amplify ground shaking to damaging levels even during a moderate earthquake.

Therefore, buildings located on NEHRP Classes D (Figure 4.3.4-1) soils are at increased risk of damage from an earthquake.

There is a strong correlation between PGA and damage a building might undergo (New Jersey 2019). The Hazus model is based on best available earthquake science and aligns with these statements. The Hazus probabilistic earthquake model was applied to analyze effects from the earthquake hazard on general building stock in Sussex County. Refer to Figures 4.3.4-3 and 4.3.4-4 earlier in this profile which illustrates the geographic distribution of PGA (g) across the County for 100-year and 500-year MRP events at the Census-tract level.

A building's construction determines how well it can withstand the force of an earthquake. Unreinforced masonry buildings are most at risk during an earthquake because the walls are prone to collapse outward, whereas steel and wood buildings absorb more of the earthquake's energy. Additional attributes that affect a building's capability to withstand an earthquake's force include its age, number of stories, and quality of construction. Hazus considers building construction and age of building as part of the analysis. Because a custom general building stock was used for this Hazus analysis, the building ages and building types from the inventory were incorporated into the Hazus model.

Potential building damage was evaluated by Hazus across the following damage categories: none, slight, moderate, extensive, and complete. Table 4.3.4-7 provides definitions of these five categories of damage for a light wood-framed building. Definitions for other building types are included in the Hazus technical manual documentation. The results of potential damage states for buildings in Sussex County categorized by general occupancy classes (i.e., residential, commercial, industrial, etc.) from Hazus are summarized in Table 4.3.4-8 for the 500-year MRP event. Hazus estimates that there are zero damages to structures caused by the 100-year MRP event.

Table 4.3.4-7 Example of Structural Damage State Definitions for a Light Wood-Framed Building

Damage Category	Description
Slight	Small plaster or gypsum-board cracks at corners of door and window openings and wall-ceiling intersections; small cracks in masonry chimneys and masonry veneer.
Moderate	Large plaster or gypsum-board cracks at corners of door and window openings; small diagonal cracks across shear wall panels exhibited by small cracks in stucco and gypsum wall panels; large cracks in brick chimneys; toppling of tall masonry chimneys.
Extensive	Large diagonal cracks across shear wall panels or large cracks at plywood joints; permanent lateral movement of floors and roof; toppling of most brick chimneys; cracks in foundations; splitting of wood sill plates and/or slippage of structure over foundations; partial collapse of room-over-garage or other soft-story configurations.
Complete	Structure may have large permanent lateral displacement, may collapse, or be in imminent danger of collapse due to cripple-wall failure or the failure of the lateral load resisting system; some structures may slip and fall off the foundations; large foundation cracks.

Source: Hazus Technical Manual

Table 4.3.4-8. Estimated Buildings Damaged by General Occupancy for the 500-Year MRP Earthquake Event

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	500-Year MRP Event	
			Building Count	Percent Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	62,429	None	61,844	99.1%
		Minor	535	0.9%
		Moderate	49	0.1%
		Severe	1	0.0%

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	500-Year MRP Event	
			Building Count	Percent Buildings in Occupancy Class
		Complete Destruction	0	0.0%
Commercial Buildings	3,304	None	3,266	98.8%
		Minor	30	0.9%
		Moderate	7	0.2%
		Severe	1	0.0%
		Complete Destruction	0	0.0%
Industrial Buildings	258	None	249	96.5%
		Minor	7	2.7%
		Moderate	2	0.8%
		Severe	0	0.0%
		Complete Destruction	0	0.0%
Government, Religion, Agricultural, and Education Buildings	6,030	None	5,974	99.1%
		Minor	50	0.8%
		Moderate	6	0.1%
		Severe	0	0.0%
		Complete Destruction	0	0.0%

Source: Sussex County GIS 2020; Hazus; NJDOT 2012

Building damage as a result of the 100-year and 500-year MRP earthquakes were estimated for each municipality using Hazus. Hazus estimates that zero damages will occur to buildings and contents during the 100-year MRP event. Table 4.3.4-9 estimates total building and content losses caused by the 500-year MRP event by jurisdiction. This table also summarizes losses for structures categorized as residential, commercial, and all other occupancy classes. Less than 0.1-percent of the County's structures are impacted by the 500-year MRP event (i.e., approximately $22.1 million in replacement cost value). A majority of the losses are estimated to occur in the Township of Sparta ($3.2 million).

Table 4.3.4-9. Estimated Building Damages (Structure and Contents) from the 500-year MRP Earthquake Event

Jurisdiction	Replacement Cost Value (RCV)	500-Year MRP				
		Estimated Total Damage	Percent of Total Building and Contents Replacement Cost Value	Estimated Residential Damage	Estimated Commercial Damage	Estimated Damages for All Other Occupancies
Andover (B)	$628,463,030	$138,206	<0.1%	$41,366	$75,478	$21,362
Andover (Twp)	$3,609,679,724	$1,211,956	<0.1%	$295,663	$687,218	$229,075
Branchville (B)	$532,377,368	$137,604	<0.1%	$40,001	$50,678	$46,924
Byram (Twp)	$2,746,550,446	$912,777	<0.1%	$379,598	$409,542	$123,637
Frankford (Twp)	$3,129,888,305	$849,244	<0.1%	$315,353	$291,281	$242,610
Franklin (B)	$1,921,211,856	$733,079	<0.1%	$274,199	$299,511	$159,369
Fredon (Twp)	$1,372,050,934	$373,196	<0.1%	$167,578	$34,723	$170,895
Green (Twp)	$1,598,635,804	$464,353	<0.1%	$221,292	$36,158	$206,903
Hamburg (B)	$1,588,049,291	$1,375,141	0.1%	$300,503	$768,323	$306,315
Hampton (Twp)	$2,196,131,598	$648,121	<0.1%	$239,795	$212,162	$196,163
Hardyston (Twp)	$3,183,033,542	$1,619,332	0.1%	$613,578	$678,706	$327,048
Hopatcong (B)	$2,888,571,676	$1,055,355	<0.1%	$651,629	$239,749	$163,977
Lafayette (Twp)	$1,958,174,065	$568,466	<0.1%	$149,711	$145,237	$273,518
Montague (Twp)	$1,459,611,020	$382,419	<0.1%	$154,030	$112,671	$115,718
Newton (T)	$5,093,275,807	$1,781,932	<0.1%	$409,696	$931,264	$440,971
Ogdensburg (B)	$819,879,629	$332,147	<0.1%	$116,702	$126,672	$88,773
Sandyston (Twp)	$1,212,626,664	$311,623	<0.1%	$87,694	$74,144	$149,785
Sparta (Twp)	$9,070,094,285	$3,166,510	<0.1%	$1,095,870	$1,556,912	$513,728
Stanhope (B)	$1,051,183,581	$434,431	<0.1%	$181,702	$107,122	$145,606
Stillwater (Twp)	$1,417,579,398	$345,260	<0.1%	$181,040	$53,910	$110,310
Sussex (B)	$1,945,578,916	$696,643	<0.1%	$145,135	$463,241	$88,267

Jurisdiction	Replacement Cost Value (RCV)	500-Year MRP				
		Estimated Total Damage	Percent of Total Building and Contents Replacement Cost Value	Estimated Residential Damage	Estimated Commercial Damage	Estimated Damages for All Other Occupancies
Vernon (Twp)	$5,658,971,163	$3,107,545	0.1%	$1,679,595	$649,630	$778,320
Walpack (Twp)	$63,691,550	$10,401	<0.1%	$2,927	$2,475	$4,999
Wantage (Twp)	$4,877,543,885	$1,488,367	<0.1%	$539,289	$365,878	$583,200
Sussex County (Total)	**$60,022,853,539**	**$22,144,106**	**<0.1%**	**$8,283,949**	**$8,372,687**	**$5,487,470**

Source: Sussex County GIS 2020; RS Means 2020; Hazus; NYS n.d.
Notes: B – Borough; T – Town; Twp. – Township; % - Percent

Historically, Building Officials Code Administration (BOCA) regulations in the northeast states were developed to address local concerns, including heavy snow loads and wind. Seismic requirements for design criteria are not as stringent as those of the west coast of the United States, which rely on the more seismically focused Uniform Building Code. As such, a smaller earthquake in the northeast can cause more structural damage than if it would occur in the west.

Impact on Critical Facilities

All critical facilities in Sussex County are considered exposed to the earthquake hazard. Refer to subsection "Critical Facilities" in Section 3 (County Profile) of this HMP for a complete inventory of critical facilities in Sussex County.

The Hazus earthquake model was used to assign the range or average probability of each damage state category to the critical facilities in Sussex County for the 100-year and 500-year MRP events. In addition, Hazus estimates the time to restore critical facilities to fully functional use. Results are presented as a probability of being functional at specified time increments (days after the event). For example, Hazus might estimate that a facility has 5% chance of being fully functional at Day 3, and a 95% chance of being fully functional at Day 90. For percent probability of sustaining damage, the minimum and maximum damage estimated value for that facility type is presented.

As a result of a 100-year MRP event, Hazus estimates that critical facilities will be nearly 100-percent functional with negligible damages. Therefore, the impact to critical facilities is not significant for the 100-year MRP event. Whereas, for the 500-year MRP events, functionality can approximately decrease as low as 4.2-percent. Table 4.3.4-10 summarizes the damage state probabilities for critical facilities during the 500-year MRP event.

Table 4.3.4-10. Estimated Damage and Loss of Functionality for Critical Facilities and Utilities in Sussex County for the 500-Year MRP Earthquake Event

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Critical Facilities									
EOC	99.1-99.3%	0.8%	0.1%	0.0%	0.0%	99.2%	99.9%	99.9%	99.9%
Medical	99.2%	0.8%	0.0%	0.0%	0.0%	99.1%	99.9%	99.9%	99.9%
Police	95.9-97.7%	1.4-2.4%	0.8-1.5%	0.1-0.3%	0.0%	95.9-97.6%	98.1-99.0%	99.8%	99.9%
Fire	95.9-97.9%	1.2-2.4%	0.7-1.5%	0.1-0.3%	0.0%	95.9-97.9%	98.1-99.1%	99.8%	99.9%
Schools	97.4-98.6%	1.0-1.8%	0.3-0.8%	0.1%	0.0%	97.3-98.6%	99.5%	99.9%	99.9%
Utilities									
Potable Water	95.9-98.0%	1.2-2.3%	0.7-1.5%	0.1-0.3%	0.0%	97.7-99.2%	99.8%	99.9%	99.9%
Waste Water	96.1-97.7%	1.4-2.3%	0.8-1.4%	0.1-0.3%	0.0%	96.9-98.2%	99.8%	99.9%	99.9%
Communication	95.8-99.2%	0.7-2.8%	0.0-1.2%	0.0%-0.1%	0.0%	99.9%	99.9%	99.9%	99.9%
Electric Power	96.1-98.0%	1.2-2.3%	0.7-1.4%	0.1-0.3%	0.0%	97.3-98.6%	99.9%	99.9%	99.9%
Natural Gas Facility	97.2%	0.1%	0.0%	0.0%	0.0%	98.9%	99.9%	99.9%	99.9%
Transportation									
Airport Facility	99.2%	0.8%	0.0%	0.0%	0.0%	99.9%	99.9%	99.9%	99.9%

Source: Hazus; Sussex County GIS 2020
Notes: EOC = Emergency Operations Center; MRP = Mean Return Period; % - Percent

Impact on Economy

Earthquakes also have impacts on the economy, including loss of business function, damage to inventory, relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. Hazus estimates building-related economic losses, including income losses (wage, rental, relocation, and capital-related losses) and capital stock losses (structural, non-structural, content, and inventory losses). Economic losses estimated by Hazus are summarized in Table 4.3.4-11.

Table 4.3.4-11. Economic Losses for Earthquake MRP Events

Mean Return Period (MRP)	Inventory Loss	Relocation Loss	Building and Content Losses	Wages Losses	Rental Losses	Capital-Related Loss
100-year MRP	$0	$0	$0	$0	$0	$0
500-year MRP	$172,600	$1,213,800	$22,143,500	$551,600	$643,000	$322,700

Source: Hazus; RS Means 2020

Although the Hazus analysis did not compute damage estimates for individual roadway segments and railroad tracks, assumedly these features would undergo damage due to ground failure, resulting in interruptions of regional transportation and of distribution of materials. Losses to the community that would result from damage to lifelines could exceed costs of repair. Earthquake events can also significantly affect road bridges, many of which provide the only access to certain neighborhoods. Because softer soils generally follow floodplain boundaries, bridges that cross watercourses should be considered vulnerable. Another key factor in degree of vulnerability is age of facilities and infrastructure, which correlates with standards in place at times of construction.

Hazus also estimates the volume of debris that may be generated as a result of an earthquake event to enable the study region to prepare and rapidly and efficiently manage debris removal and disposal. Debris estimates are divided into two categories: (1) reinforced concrete and steel that require special equipment to break it up before it can be transported, and (2) brick, wood, and other debris that can be loaded directly onto trucks with bulldozers (Hazus-MH Earthquake User's Manual 2020).

For the 100-year MRP event, Hazus estimates that zero tons of debris will be generated. For the 500-year MRP event, Hazus estimates a total of 3,596 tons of debris will be generated county-wide. Table 5.4.4-4.3.5-6 and Table 5.4.4-4.3.5-6 summarizes the estimated debris generated as a result of these events by municipality.

Table 4.3.4-12. Estimated Debris Generated by the 500-Year MRP Earthquake Events

Jurisdiction	500-Year	
	Brick/Wood (tons)	Concrete/Steel (tons)
Andover (B)	11	9
Andover (Twp)	97	69
Branchville (B)	11	4
Byram (Twp)	71	37
Frankford (Twp)	77	25
Franklin (B)	126	23
Fredon (Twp)	34	15
Green (Twp)	67	10

Jurisdiction	500-Year	
	Brick/Wood (tons)	Concrete/Steel (tons)
Hamburg (B)	209	82
Hampton (Twp)	85	26
Hardyston (Twp)	157	71
Hopatcong (B)	113	31
Lafayette (Twp)	57	11
Montague (Twp)	47	16
Newton (T)	313	100
Ogdensburg (B)	67	10
Sandyston (Twp)	48	10
Sparta (Twp)	363	68
Stanhope (B)	62	42
Stillwater (Twp)	42	6
Sussex (B)	101	36
Vernon (Twp)	423	75
Walpack (Twp)	2	0
Wantage (Twp)	159	78
Sussex County (Total)	**2,741**	**855**

Source: Hazus
Notes: B – Borough; T – Town; Twp. – Township

Impact on the Environment

According to USGS, earthquakes can cause damage to the surface of the Earth in various forms depending on the magnitude and distribution of the event (USGS 2020). Surface faulting is one of the major seismic components to earthquakes that can create wide ruptures in the ground. Ruptures can have a direct impact on the landscape and natural environment because it can disconnect habitats for miles isolating animal species or tear apart plant roots.

Furthermore, ground failure as a result of soil liquefaction can have an impact on soil pores and retention of water resources (USGS 2020). The greater the seismic activity and liquefaction properties of the soil, the more likely drainage of groundwater can occur which depletes groundwater resources. In areas where there is higher pressure of groundwater retention, the pores can build up more pressure and make soil behave more like a fluid rather than a solid increasing risk of localized flooding and deposition or accumulation of silt.

Future Growth and Development

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

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

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Development built in areas with softer NEHRP soil classes, liquefaction, and landslide-susceptible areas may experience shifting or cracking in the foundation during earthquakes because of the loose soil characteristics of these soil classes. However, current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts than older, existing construction that may have been built to lower construction standards. Refer to Section 3, and Volume II Section 9 for more information about the potential new development in Sussex County.

Projected Changes in Population

Sussex County has experienced population decline since 2010. According to the U.S. Census Bureau, the County's population has decreased 4.7-percent between 2010 and 2018 (U.S. Census Bureau 2020). The Township of Walpack and the Borough of Sussex have experienced the greatest decline with a decrease of 62.5-percent and 13.0-percent, respectively. The population is expected to continue to decrease as residents move away from the suburbs and towards urban centers (Stirling 2018). Even though the population has decreased, any changes in the density of population can impact the number of persons exposed to the earthquake hazard. Persons that move into older buildings may increase their overall vulnerability to earthquakes. As noted earlier, if moving into new construction, current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts.

Climate Change

Because the impacts of climate change on earthquakes are not well understood, a change in the County's vulnerability as the climate continues to change is difficult to determine. However, climate change has the potential to magnify secondary impacts of earthquakes. As a result of the climate change projections discussed above, the County's assets located on areas of saturated soils and on or at the base of steep slopes, are at a higher risk of landslides/mudslides because of seismic activity. Refer to Section 4.3.6 for additional discussion of the geological hazard.

Vulnerability Change Since the 2016 HMP

Overall, the entire County continues to be vulnerable to earthquakes. For the 2021 HMP, the exposure analyses were conducted using 2014-2018 American Community Survey 5-year population estimates. The building inventory was updated using RS Means 2020 values, which is more current and reflects replacement cost versus the building stock improvement values reported in the 2016 HMP. Additional building stock updates include updates to the critical facility inventory provided by Sussex County. Furthermore, since the 2016 HMP, an updated version of Hazus was released (v4.2). This updated model includes longer historical records to pull from to generate probabilistic events. Further, a NEHRP boundary was created for NEHRP soil class D using the NJDOT Soil Classification map (Figure 4.3.4-1).

4.3.5 FLOOD

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 Sussex County.

2021 HMP Changes

- All subsections have been updated using best available data.
- The urban flooding discussion and problem areas was expanded.
- Previous events between 2015 and 2020 are listed with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).
- The vulnerability assessment was updated utilizing updated and expanded building, critical facility and community lifeline inventories.

Profile

Hazard Description

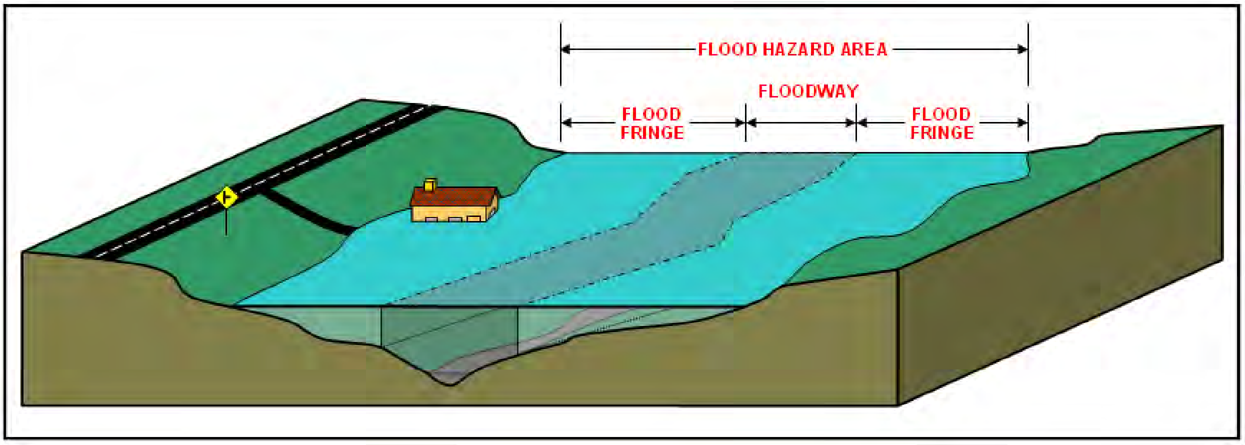
A flood is the inundation of normally dry land resulting from the rising and overflowing of a body of water. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, coastlines and multiple counties or states) (FEMA 2007). Floods are frequent and costly natural hazards in New Jersey in terms of human hardship and economic loss, particularly to communities that lie within flood-prone areas or floodplains of a major water source.

The flood-related hazards most likely to impact Sussex County are riverine (inland) flooding, ice jam flooding, and flooding as a result of a dam failure. Dam failure is discussed in Section 4.3.1 (Dam Failure). In addition, Sussex County also experiences urban flooding which is the result of precipitation and insufficient drainage.

Riverine (Inland) Flooding

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 Sussex 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 4.3.5-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.

Figure 4.3.5-1. Floodplain



Source: New Jersey Department of Environmental Protection (NJDEP) Date Unknown

Ice Jam Flooding

As per the Northeast States Emergency Consortium and FEMA, an ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams occur when warm temperatures and heavy rains cause rapid snowmelt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding (FEMA 2015a). Ice jams may also be caused by frazil ice, which forms when mist freezes and then floats down a river, stream, or creek.

There are two different types of ice jams: freeze-up and breakup. Freeze-up jams occur in the early to mid-winter when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Breakup jams occur during periods of thaw, generally in late winter and early spring. The ice cover breakup is usually associated with a rapid increase in runoff and corresponding river discharge due to a heavy rainfall, snowmelt, or warmer temperatures (White 2013).

Urban Flooding

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 coastal flooding is mapped and studied by FEMA, urban flooding is not.

NOAA defines urban flooding as the flooding of streets, underpasses, low lying areas, or storm drains. (NOAA 2009). Urban drainage flooding is caused by increased water runoff due to urban development and inadequate drainage systems. Drainage systems are designed to remove surface water from developed areas as quickly as possible to prevent localized flooding on streets and other urban areas. The systems make use of a closed conveyance system that channels water away from an urban area to surrounding streams. This bypasses the natural processes of water filtration through the ground, containment, and evaporation of excess water. 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 (Harris 2008).

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 (FEMA 1997).

Location

Flooding potential is influenced by climatology, meteorology and topography. Extensive development can impact flooding potential as it leaves fewer natural surfaces available to absorb rainwater, forcing water directly into streams, rivers, and existing drainage systems swelling them more than when more natural surface buffered the runoff rate.

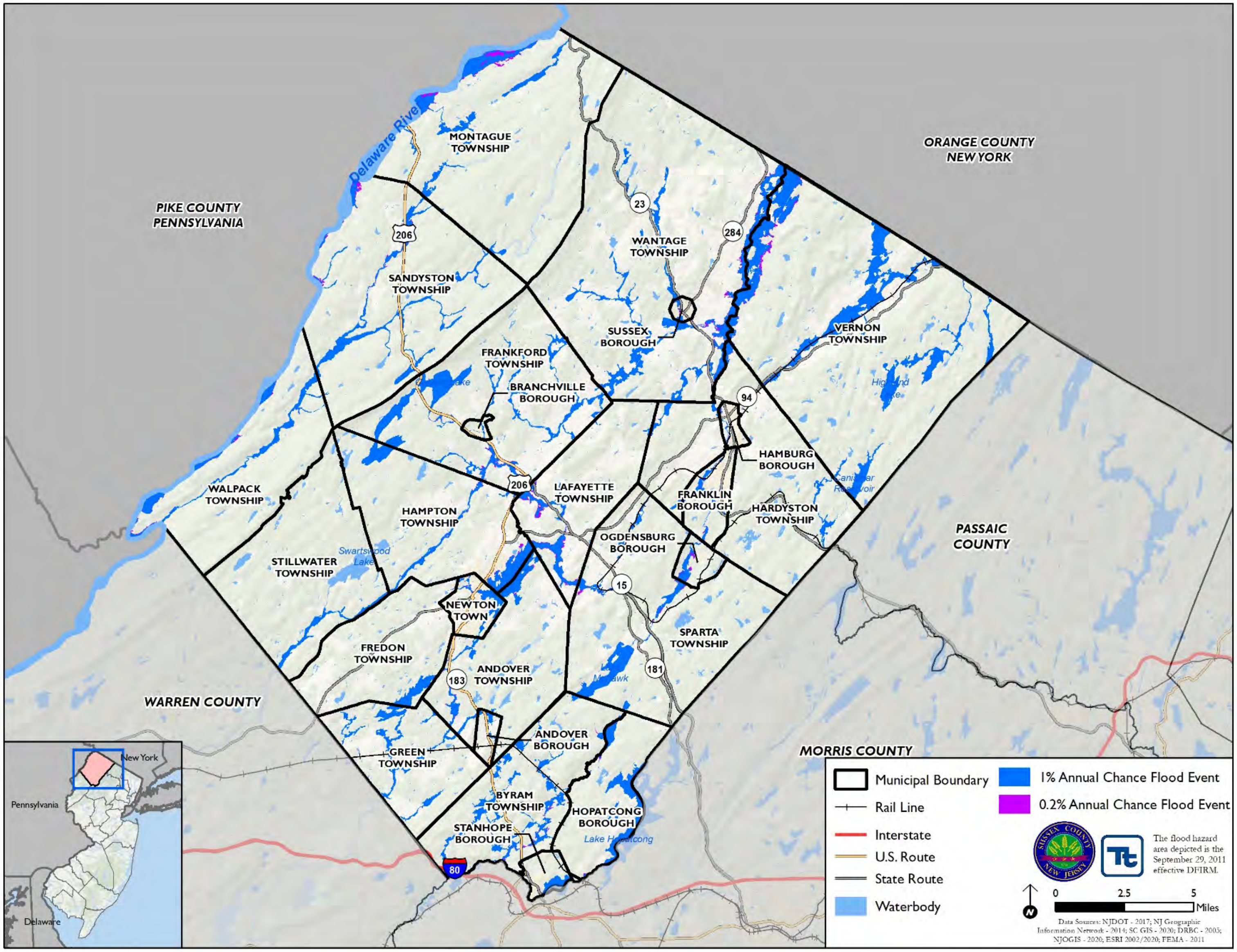
Flooding in Sussex County is often the direct result of frequent weather events such as thunderstorms, heavy rains, tropical storms, and hurricanes. Floods can happen almost anywhere in County, although they do tend to occur in and around areas near existing bodies of water, such as rivers and streams. The most damaging floods (particularly riverine floods) in New Jersey appear to occur in the northern half of the State, which includes Sussex County. This is a function of several physiographic and physical features of the landscape. Greater geographic relief in the northern half results in flowing water moving down steeper gradients and being naturally or artificially channelized through valleys and gullies.

Sussex County has primarily a mountainous terrain, with significant exposure to water and vulnerability to the flood hazard. Sussex County has several large waterways, including the Musconetcong River and Paulins Kill, as well as the Delaware River, which has a total drainage area of over 14,000 square miles. Larger lakes and reservoirs include Lake Hopatcong, Lake Musconetcong and Lake Mohawk (FEMA FIS 2011). Over the years, Sussex County has been impacted by flooding, especially in the municipalities situated adjacent to these bodies of water.

Development patterns have resulted in denser development in northern New Jersey. In addition, proximity to New York City boosts property values and therefore increases damage dollar totals. Extensive development also leaves fewer natural surfaces available to absorb rainwater, forcing water directly into streams and rivers, swelling them more than when more natural surface buffered the runoff rate. Since the Delaware, Raritan, and Passaic Rivers drain more than 90 percent of the northern New Jersey counties, these rivers and their tributaries are common locations for flooding.

The 1-percent annual chance flood hazard zones are widely dispersed in Sussex County, generally following riverine corridors as shown in Figure 4.3.5-2. A significant concentration of 1 percent annual chance flood hazard zones is located in the northeastern portion of the County, around the Wallkill River, and the Pochuck and Wawayanda Creeks, especially as they near the New York State border in Wantage and Vernon Townships, respectively. Additional 1-percent annual chance flood hazard zones exist along Lake Hopatcong as it forms the southeastern Sussex County boundary with Morris County, around Lake Mohawk in Sparta Township, and along Moore's Brook in Andover and Hampton Townships. In addition, 1-percent annual chance floodplains are scattered throughout the County tracing the footprints of numerous other creeks, rivers, and bodies of water, as shown in Figure 4.3.5-2 below.

Figure 4.3.5-2. FEMA 2011 Flood Hazard Areas in Sussex County



Flood-Prone Areas in Sussex County

Watersheds in New Jersey are referred to as the name of the water body to which the land area drains and the corresponding Hydrologic Unit Code (HUC). The HUC can range from 2 to 16 digits long- the longer the numeric code, the smaller the watershed area. NJDEP also has divided the state into 21 Watershed Management Areas (WMAs) based on large scale drainage pattern. Each WMA encompasses a particular group of major rivers. Sussex County falls within parts of 4 regions: WMA 01: Upper Delaware - Northwest Region; WMA 02: Wallkill - Northwest Region; WMA 03: Pompton, Pequannock, Wanaque, Ramapo - Northeast Region; and WMA 06: Middle Passaic, Whippany – Northeast Region. These areas delineate the principal stream systems that drain the county's land area. WMA 1, the Upper Delaware River Watershed, is the largest watershed in the county by area, with waters draining west and southwest to the Delaware River. The second largest is WMA 2, the Wallkill River Watershed. The Wallkill, which flows north into Orange County, New York, drains the north-central and northeastern section of Sussex County. WMA 3 (Pequannock River Watershed) and WMA 6 (Rockaway River Watershed) both drain to the southeast, and comprise small parts of the county.

Please refer to Section 9 for information regarding specific areas of flooding within each municipality.

Watershed Management Area 01 – Upper Delaware River

Located in the western and southern sections of Sussex County, the Upper Delaware River Watershed comprises greater than half of the County's land area, and includes the following principal waterways: the Flat Brook; the Paulins Kill; the Pequest River and a short stretch of the Musconetcong River. Waterways in WMA 01 run southwesterly, roughly parallel to one another, towards the Delaware River. Montague and Sandyston townships contain a large amount of these waterways, most of which are streams part of the Big and Little Flat Brook systems. The upper half of the Big Flat Brook flows through High Point State Park and Stokes State Forest. Clove Brook and Mill Brook also run through Montague Township. Walpack Township contains tributaries of the Flat Brook draining the west slope of the Kittatinny Ridge. Other waterways in this area include several stretches and tributaries of the Paulins Kill, Pequest River and Musconetcong River in Stillwater, Fredon, Green and Byram Townships, as well as parts of Kymer Brook and Lubbers Run (Sussex County 2015).

Watershed Management Area 02 – Wallkill River

The Wallkill River watershed occupies the northern and northeastern parts of Sussex County, extending south through Sparta and northern Byram Townships. The Wallkill River flows northeast across the NJ state border and lets out on the Hudson River near Kingston, NY. Major tributaries of the Wallkill River that pass through Sussex County include Papakating Creek, which begins its run in Frankford Township, and Clove Brook, the upper reaches of which flow south from northern Wantage Township. Pochuck Creek drains parts of Vernon and Hardyston Townships east of Pochuck Mountain before merging with the Wallkill several miles over the NJ-NY border. Several branches of the Black Creek flow through Vernon Township (Sussex County 2015).

Watershed Management Area 03 – Pequannock River

A small area of eastern Sussex County is drained by the Pequannock River, which flows south out of Vernon Township continuing into Hardyston Township where it turns southeast, forming the border between Morris and Passaic Counties, before ultimately converging with the Passaic River in Essex County. Tributaries of the Pequannock in Sussex County include a stretch of the upper Pacack Brook and an unnamed tributary located in Hardyston Township (Sussex County 2015).

Watershed Management Area 6 – Rockaway River

The Rockaway River itself does not pass through Sussex County, but the system's upper reaches includes many tributaries in eastern Sparta Township, where several streams merge to form Russia Brook. Russia Brook flows into Jefferson Township (Morris County) where it meets the Rockaway River (Sussex County 2015).

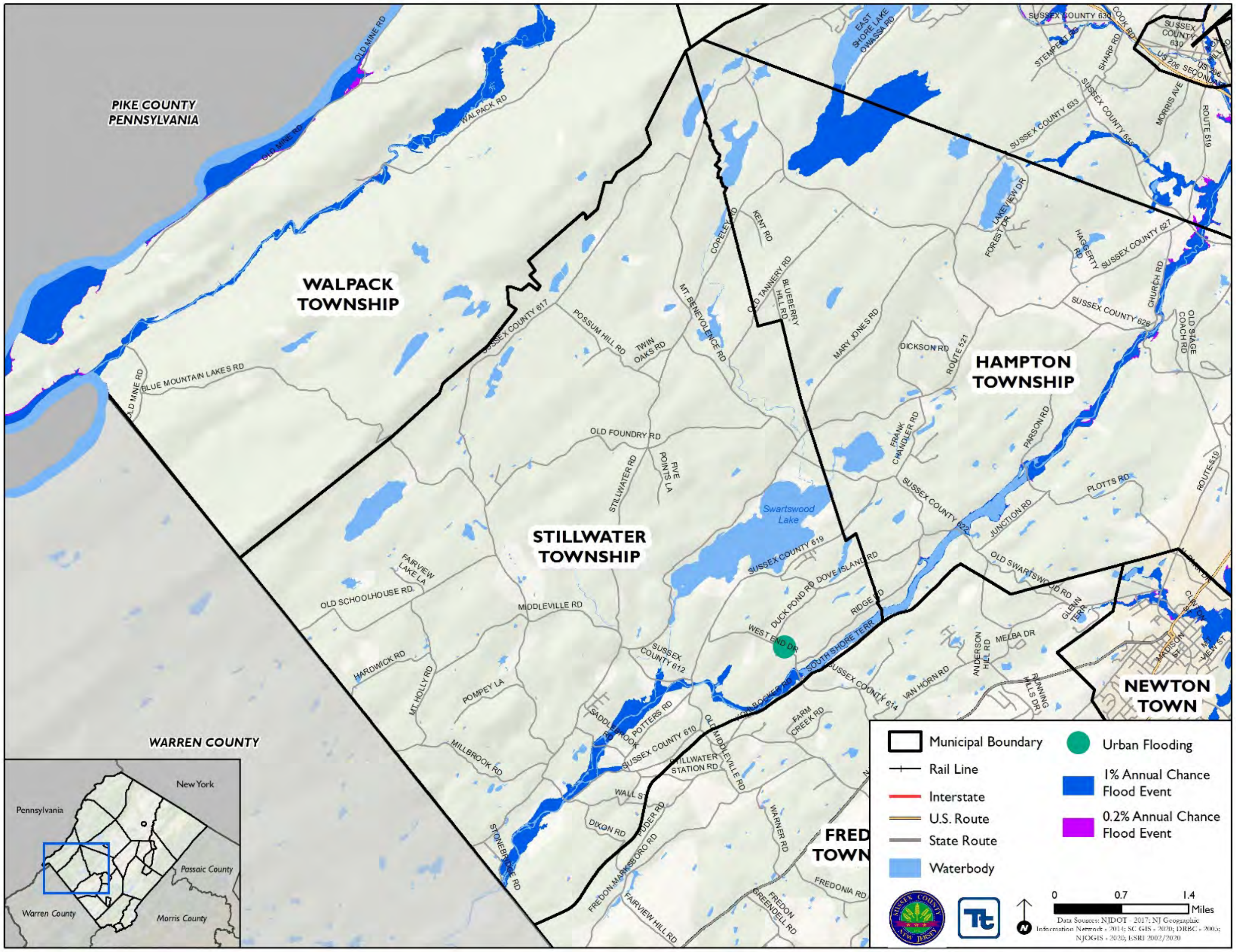
Ice Jams

Ice jams can occur along rivers and creeks. In Sussex County, ice jams have historically occurred along the Delaware River (USACE CRREL 2020).

Urban Flooding

Throughout Sussex County, low-lying surface flooding and interior shallow ponding occurs as a result of heavy rainfall and inadequate capacity of stormwater systems. While riverine flooding is mapped by FEMA, urban flooding is not. Stillwater Township identified one urban flooding location where a low-lying area floods. Figure 4.3.5-3 illustrates this urban flood location.

Figure 4.3.5-3. Urban Flood Areas Identified in Sussex County



Natural and Beneficial Floodplain Areas

Although typically associated as a hazard area, floodplains also serve beneficial and natural functions (on ecological/environmental, social, and economic levels). Disruption of these natural systems can have long-term consequences on entire regions; however, this potential impact has only recently been noted. Some of the more well-known water-related functions for floodplains include:

- Natural flood and erosion control
  - Provide flood storage and conveyance
  - Reduce flood velocities
  - Reduce flood peaks
  - Reduce sedimentation
- Surface water quality maintenance
  - Filter nutrients and impurities from runoff
  - Process organic wastes
  - Moderate temperatures of water
- Groundwater recharge
  - Promote infiltration and aquifer recharge
  - Reduce frequency and duration of low surface flows (FEMA)

Areas in the floodplain that typically provide these natural functions are wetlands, riparian areas, sensitive areas, and habitats for rare and endangered species. According to NJ DEP 2015 Land-Use Land-Cover data, the County has several floodplain areas that could serve natural and beneficial functions (Landscape Project contains the endangered species data). This information is summarized in Tables 4.3.5-1 and 4.3.5-2.

Table 4.3.5-1. Acreage of Wetlands by Jurisdiction

Jurisdiction	Total Area (Acres)	Wetlands	
		Area (Acres)	Percent of Total Area
Andover (B)	872	76	8.7%
Andover (Twp)	13,304	1,847	13.9%
Branchville (B)	383	5	1.3%
Byram (Twp)	14,536	1,218	8.4%
Frankford (Twp)	22,585	3,222	14.3%
Franklin (B)	2,833	370	13.1%
Fredon (Twp)	11,464	1,314	11.5%
Green (Twp)	10,429	1,175	11.3%
Hamburg (B)	747	80	10.8%
Hampton (Twp)	16,305	2,738	16.8%
Hardyston (Twp)	20,892	3,475	16.6%
Hopatcong (B)	7,949	569	7.2%
Lafayette (Twp)	11,499	2,172	18.9%
Montague (Twp)	29,840	3,730	12.5%
Newton (T)	2,164	337	15.6%

Jurisdiction	Total Area (Acres)	Wetlands Area (Acres)	Wetlands Percent of Total Area
Ogdensburg (B)	1,438	258	17.9%
Sandyston (Twp)	26,926	2,170	8.1%
Sparta (Twp)	24,828	2,987	12.0%
Stanhope (B)	1,341	113	8.4%
Stillwater (Twp)	18,076	2,066	11.4%
Sussex (B)	399	34	8.5%
Vernon (Twp)	44,769	7,846	17.5%
Walpack (Twp)	15,945	744	4.7%
Wantage (Twp)	43,175	8,254	19.1%
Sussex County (Total)	**342,701**	**46,797**	**13.7%**

Source: NJDEP 2015
B – Borough; T – Town; Twp – Township; % - Percent

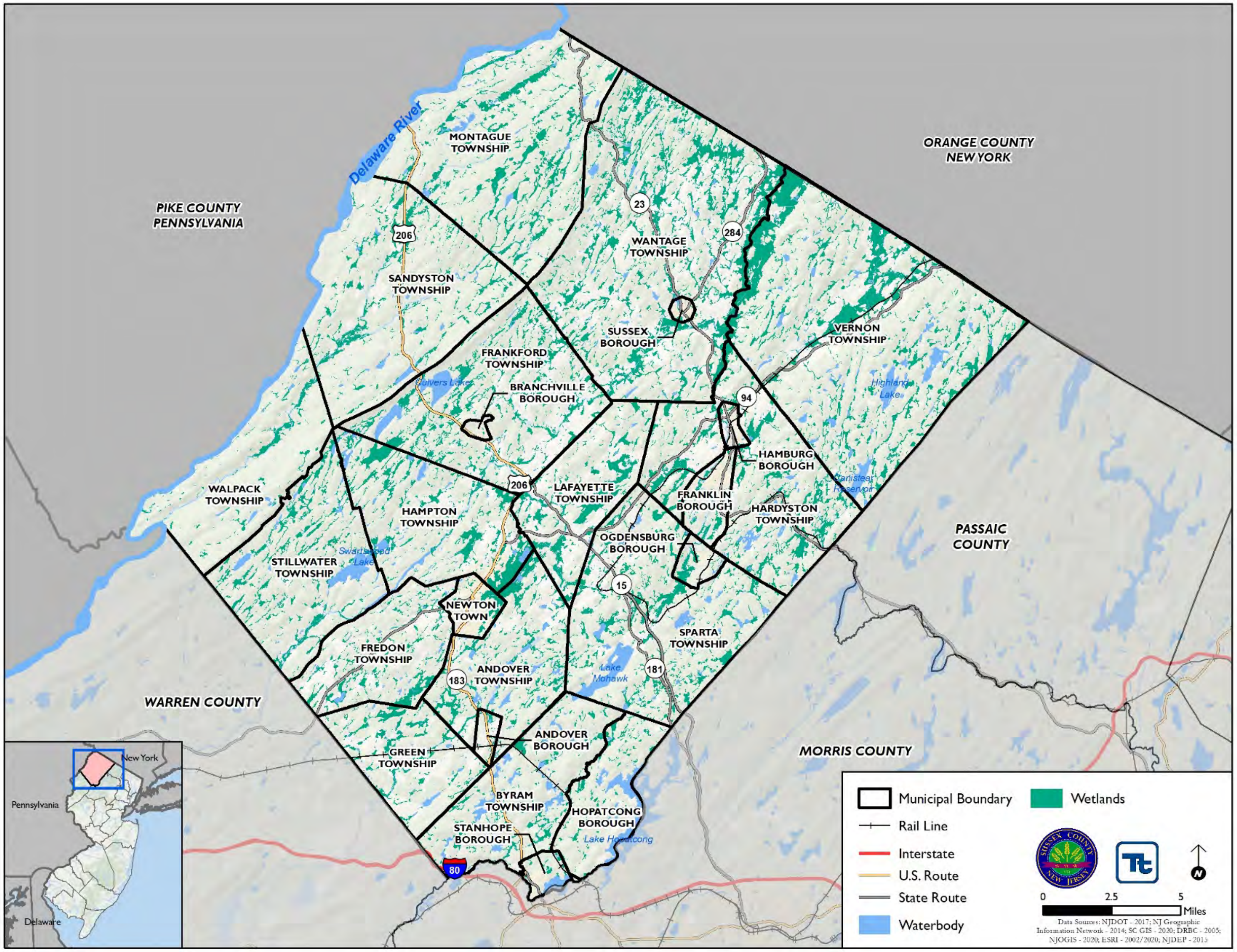
Table 4.3.5-2 Natural and Beneficial Land in Sussex County

Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Agricultural Wetlands (Modified)	4,109	Coniferous Brush/Shrubland	1,402	State Threatened	7,735
Atlantic White Cedar Wetlands	31	Coniferous Forest (>50% Crown Closure)	5,814	State Endangered	100,568
Cemetery on Wetland	1	Coniferous Forest (10-50% Crown Closure)	935	Federally Listed	164,667
Coniferous Scrub/Shrub Wetlands	126	Deciduous Brush/Shrubland	4,772		
Coniferous Wooded Wetlands	858	Deciduous Forest (>50% Crown Closure)	133,379		
Deciduous Scrub/Shrub Wetlands	5,816	Deciduous Forest (10-50% Crown Closure)	7,817		
Deciduous Wooded Wetlands	24,741	Mixed Deciduous/Coniferous Brush/Shrubland	4,801		
Disturbed Wetlands (Modified)	100	Mixed Forest (>50% Coniferous With >50% Crown Closure)	8,545		
Former Agricultural Wetland (Becoming Shrubby, Not Built-Up)	643	Mixed Forest (>50% Coniferous With 10-50% Crown Closure)	1,025		
Freshwater Tidal Marshes	1	Mixed Forest (>50% Deciduous With >50% Crown Closure)	14,151		
Herbaceous Wetlands	7,194	Mixed Forest (>50% Deciduous With 10-50% Crown Closure)	1,503		
Managed Wetland In Built-Up Maintained Rec Area	137	Old Field (< 25% Brush Covered)	6,038		

Wetlands	Area (acres)	Forest	Area (acres)	Endangered Species	Area (acres)
Managed Wetland In Maintained Lawn Greenspace	125	Phragmites Dominate Old Field	13		
Mixed Scrub/Shrub Wetlands (Coniferous Dom.)	226	Plantation	948		
Mixed Scrub/Shrub Wetlands (Deciduous Dom.)	528				
Mixed Wooded Wetlands (Coniferous Dom.)	750				
Mixed Wooded Wetlands (Deciduous Dom.)	771				
Phragmites Dominate Interior Wetlands	400				
Unvegetated Flats	40				
Wetland Rights-Of-Way	203				

Source: NJDEP 2015/2019

Figure 4.3.4-4. Wetlands in Sussex County



Extent

The frequency and severity of riverine 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.

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

The NJDEP is mandated to delineate and regulate flood hazard areas pursuant to N.J.S.A. 58:16A-50 et seq., the Flood Hazard Area Control Act. This Act authorizes the NJDEP to adopt land use regulations for development within the flood hazard areas, to control stream encroachments and to integrate the flood control activities of the municipal, county, state and federal governments. The State’s Flood Hazard Area delineations are defined by the New Jersey Flood Hazard Area Design Flood which is equal to a design flood discharge 25% greater in flow than the 1-percent annual chance flood. In addition, the floodway shall be based on encroachments that produce no more than a 0.2-foot water surface rise above the 1-percent annual chance flood.

The USGS National Water Information System (NWIS) collects surface water data from more than 850,000 stations across the country. The time-series data describes stream levels, streamflow (discharge), reservoir and lake levels, surface water quality, and rainfall. The data is collected by automatic recorders and manual field measurements at the gage locations. Sussex County has numerous active USGS stream gages; in addition, stream gauges are located upstream in neighboring counties.

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

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

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

Currently, there is no measurement used to further define the frequency and severity of urban flooding.

Previous Occurrences and Losses

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (NCEI) Storm Events database records and defines flood events as follows:

- Flash Flood is reported in the NOAA-NCEI database for a life-threatening, rapid rise of water into a normally dry area beginning within minutes to multiple hours of the causative event (e.g., intense rainfall, dam failure, ice jam).
- Flood is reported in the NOAA-NCEI database for any high flow, overflow, or inundation by water which causes damage. In general, this would mean the inundation of a normally dry area caused by an increased water level in an established watercourse, or ponding of water, that poses a threat to life or property.

Between 1954 and 2020, Sussex County was included in seven flood-related disaster declarations; refer to Table 4.3.5-3. Flood events that have impacted Sussex County between 2015 and 2020 are identified in Table 4.3.5-4 with associated impacts. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality. For events prior to 2015, refer to the Appendix E (Risk Assessment Supplement).

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 2015 and 2020, Sussex County was included in two flood-related agricultural disaster declarations. In 2019, Sussex County was included in declaration S4479 for excessive precipitation and S4455 for the combined effects of excessive rainfall, moisture, and storm-force winds from Hurricane Florence. In 2019, indemnities for moisture/precipitation/rain for all other crops totaled $43,692.

Table 4.3.5-3 Flood-Related Disaster (DR) and Emergency (EM) Declarations 1954-2020

Declaration	Event Date	Declaration Date	Event Description
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-477	July 23, 1975	July 23, 1975	Flood: Heavy Rains, High Winds, Hail & Tornadoes
DR-1337	August 12-21, 2000	August 17, 2000	Severe Storms, Flooding and Mudslides
DR-1563	September 18-October 1, 2004	October 1, 2004	Severe Storms and Flooding
DR 1588	April 1-3, 2005	April 19, 2005	Severe Storm(s): Severe Storms and Flooding
DR-1653	June 23-July 10, 2006	July 7, 2006	Severe Storms and Flooding
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s): Severe Storms and Inland and Coastal Flooding

Source: FEMA 2020

Table 4.3.5-4 Flooding Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
July 26, 2015	Flash Flood	N/A	N/A	Montague	A cold front over the Finger Lakes region of New York State helped trigger a cluster of showers and thunderstorms with very heavy rain that moved over northwest New Jersey mainly during the evening of the 26th. The heaviest rain fell over western parts of Warren County and especially in far northwest Sussex County. Doppler Radar storm total estimates exceeded 4 inches in the latter. A cluster of thunderstorms with torrential rain caused poor drainage and small creek flash flooding in the Shimers Brook

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					Basin in Montague Township. Event precipitation totals included 4.74 inches in Montague. A mesonet site within Montague measured 2.57 inches of rain in 70 minutes.
February 24, 2016	Flood	N/A	N/A	Flatbrookville through Wallpack Center	A strong low pressure system moving north through the Great Lakes region, combined with its associated warm front and cold front, copious amounts of moisture, and low level jet, produced strong to severe thunderstorms, heavy rain, flash flooding, and stream flooding in New Jersey late Wednesday afternoon and evening, February 24th, with stream flooding continuing into Thursday, February 25th. Thousands were without power for a period across the state, focused in South Jersey. Route 615 was closed due to flooding between Pompey Ridge Road and Flatbrook Bridge on the morning of 2/25.
October 2, 2018	Flash Flood	N/A	N/A	Newton, Hampton Township	Thunderstorms brought locally heavy rain to northern New Jersey on the evening of October 2. Sections of US Route 206 and NJ Route 94 were closed in Newton and in Hampton Township due to flooding.

Source: FEMA 2020; NOAA-NCEI 2020; NWS 2020; SPC 2020; NJOEM 2019
Note: Not all events that have occurred in Sussex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
DR Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
N/A Not Applicable

Ice Jam Events

Based on review of the CRREL database, 12 ice-jam events have occurred in or near Sussex County between 1780 and 2020. Events that occurred outside of the County were included because they were close enough to the borders to cause possible flooding impacts in Sussex County. Information regarding losses associated with these reported ice jams was limited. According to this database, there have been no ice jam events since 2015 in Sussex County along the Delaware River (CRREL 2020).

Probability of Future Occurrences

Sussex County is expected to continue experiencing direct and indirect impacts of flooding events in the future. These impacts 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.

According to NOAA and the CRREL database, Sussex County experienced 52 flood events between 1950 and 2020, including 23 floods, 27 flash floods, and two ice jams as summarized in Table 4.3.5-5. The table summarizes data regarding the probability of occurrences of flood events in Sussex County based on the historic record. The information used to calculate the probability of occurrence is based solely on NOAA-NCEI storm events database results (NOAA NCEI 2020).

Table 4.3.5-5 Probability of Future Flood Events

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Flood	23	0.33	3.1	0.32	32.4
Flash Flood	27	0.39	2.6	0.38	38.0
Ice Jams	2	0.03	35.5	0.03	2.8
Total	**52**	**0.74**	**1.4**	**0.73**	**73.2**

Source: NOAA-NCEI 2020; CRREL 2020

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for flood events in the County is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the flood hazard for individual municipalities is presented in the jurisdictional annexes (Section 9).

Climate Change Impacts

Climate change includes changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation. Changes in winter temperatures could result in a change in the frequency of ice jam events.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017).

Vulnerability Assessment

To assess Sussex County's risk to the flood hazard, a spatial analysis was conducted using the FEMA Risk Map products dated September 2011. The 1- and 0.2-percent annual chance flood events were examined to determine the assets located in the hazard areas and to estimate potential loss using the FEMA Hazus riverine flood 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 is dependent upon several factors including the severity of the event and whether or not adequate warning time is provided to residents. Hazard exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. Additionally, exposure should not be limited to only those who reside in a defined hazard zone, but all individuals who may be affected by the hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact will vary and is not strictly measurable.

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 2,182 residents living in the Special Flood Hazard Area (SFHA, or 1-percent annual chance floodplain), or 1.5% of the County's total population. There are an estimated 2,433 residents living in the 0.2-percent annual chance floodplain, or 1.7% of the County's total population. The Borough of Hopatcong has the greatest number of residents living in the floodplain with approximately 333 residents living in the SFHA. The Township of Byram has the greatest number of residents living in the 0.2-percent annual chance flood area—approximately 374 people. Table 4.3.5-6 summarizes the population exposed to the flood hazard by jurisdiction.

Table 4.3.5-6. Estimated Sussex County Population Exposed to the 1-percent and 0.2-percent Flood Hazard Area

Jurisdiction	Total Population	Population Exposed to the 1-Percent Annual Chance Flood Event Hazard Area		Population Exposed to the 0.2-Percent Annual Chance Flood Event Hazard Area	
		Number of People	Percent Total	Number of People	Percent Total
Andover (B)	594	13	2.1%	13	2.1%
Andover (Twp)	5,996	6	0.1%	6	0.1%
Branchville (B)	896	26	2.9%	34	3.8%
Byram (Twp)	8,010	292	3.6%	374	4.7%
Frankford (Twp)	5,361	281	5.2%	287	5.4%
Franklin (B)	4,807	29	0.6%	29	0.6%
Fredon (Twp)	3,214	0	0.0%	0	0.0%
Green (Twp)	3,495	51	1.5%	51	1.5%

Jurisdiction	Total Population	Population Exposed to the 1-Percent Annual Chance Flood Event Hazard Area		Population Exposed to the 0.2-Percent Annual Chance Flood Event Hazard Area	
		Number of People	Percent Total	Number of People	Percent Total
Hamburg (B)	3,152	2	0.1%	2	0.1%
Hampton (Twp)	4,916	36	0.7%	41	0.8%
Hardyston (Twp)	7,886	2	0.0%	2	0.0%
Hopatcong (B)	14,362	333	2.3%	333	2.3%
Lafayette (Twp)	2,390	50	2.1%	70	2.9%
Montague (Twp)	3,716	123	3.3%	149	4.0%
Newton (T)	7,895	84	1.1%	106	1.3%
Ogdensburg (B)	2,314	8	0.3%	64	2.8%
Sandyston (Twp)	1,925	114	5.9%	127	6.6%
Sparta (Twp)	18,841	281	1.5%	281	1.5%
Stanhope (B)	3,377	14	0.4%	19	0.6%
Stillwater (Twp)	3,936	54	1.4%	56	1.4%
Sussex (B)	1,854	10	0.5%	17	0.9%
Vernon (Twp)	22,369	256	1.1%	256	1.1%
Walpack (Twp)	6	1	18.2%	1	18.2%
Wantage (Twp)	10,986	116	1.1%	119	1.1%
Sussex County (Total)	**142,298**	**2,182**	**1.5%**	**2,433**	**1.7%**

Sources: American Community Survey 2018 5-year estimates; FEMA 2011
Note: B – Borough; T - Town; Twp – Township

Research has shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. This is due to many factors including their physical and financial ability to react or respond during a hazard. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. There are 7,191 persons below the poverty level and 22,889 persons that are over 65 years old in the County. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is more vulnerable because they are more likely to seek or need medical attention which may not be available due to isolation during a flood event and they may have more difficulty evacuating. Special consideration should be taken when planning for disaster preparation, response, and recovery for these vulnerable groups.

The Hazus riverine model estimates the potential sheltering needs as a result of a 1-percent annual chance flood event. The demographic data in Hazus has not been updated and the estimated sheltering needs are based on 2010 U.S. Census data. Hazus estimates 2,150 households may be displaced and 51 people may seek short-term sheltering. These statistics, by jurisdiction, are presented in Table 4.3.5-7. The estimated displaced population and number of persons seeking short-term sheltering differs from the number of persons exposed to the 1-percent annual chance flood, because the displaced population numbers take into consideration that not all residents will be significantly impacted enough to be displaced or to require short-term sheltering during a flood event.

Table 4.3.5-7. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-percent Annual Chance Flood Event

Jurisdiction	Population (ACS 5-Year 2014 - 2018)	1-Percent Annual Chance Flood Event Hazard Area	
		Displaced Population	Persons Seeking Short-Term Sheltering
Andover (B)	594	31	0
Andover (Twp)	5,996	15	0
Branchville (B)	896	33	0
Byram (Twp)	8,010	225	1
Frankford (Twp)	5,361	176	2
Franklin (B)	4,807	86	0
Fredon (Twp)	3,214	2	0
Green (Twp)	3,495	105	0
Hamburg (B)	3,152	0	0
Hampton (Twp)	4,916	14	0
Hardyston (Twp)	7,886	8	0
Hopatcong (B)	14,362	26	0
Lafayette (Twp)	2,390	82	0
Montague (Twp)	3,716	196	5
Newton (T)	7,895	335	39
Ogdensburg (B)	2,314	24	0
Sandyston (Twp)	1,925	57	0
Sparta (Twp)	18,841	85	0
Stanhope (B)	3,377	7	0
Stillwater (Twp)	3,936	61	0
Sussex (B)	1,854	30	0
Vernon (Twp)	22,369	328	4
Walpack (Twp)	6	5	0
Wantage (Twp)	10,986	219	0
Sussex County (Total)	**142,298**	**2,150**	**51**

Sources: Hazus; FEMA 2011
Note: B – Borough; T - Town; Twp – Township

The total number of injuries and casualties resulting from flooding is generally limited based on advance weather forecasting, blockades, and warnings. 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.

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 24-48 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:

- 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.

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 zone. Potential damage is the modeled loss that could occur to the exposed inventory, including structural and content replacement cost values. Table 4.3.5-8 summarizes these results county-wide.

There are 1,267 buildings located in the 1-percent annual chance flood hazard area with an estimated $2.2 billion of replacement cost value (i.e., building and content replacement costs). In total, this represents approximately 1.8-percent of the County's total general building stock inventory. In addition, there are 1,400 buildings located in the 0.2-percent annual chance flood boundary with an estimated $2.3 billion of building stock and contents exposed. This represents approximately 1.9-percent of the County's total general building stock inventory.

The Hazus flood model estimated potential damages to the buildings in Sussex County at the structure level using the custom structure inventory developed for this HMP and the depth grid generated using the effective 2011 DFIRM data. The potential damage estimated by Hazus to the general building stock inventory associated with the 1-percent annual chance flood is approximately $137.7 million or 0.2-percent of the total building replacement cost value. The Township of Vernon has the greatest estimated building loss—approximately $21.5 million (i.e. 0.4-percent of the total replacement cost value). Refer to Table 4.3.5-9 for the estimated losses by jurisdiction, which also shows the estimated losses for residential, commercial, and other occupancy structures, respectively.

Table 4.3.5-8 Estimated General Building Stock Located in the FEMA Flood Zones - All Occupancies

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposure - Total (All Occupancies)							
			1-Percent Annual Chance Flood Event Hazard Area				0.2-Percent Annual Chance Flood Event Hazard Area			
			Number of Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total	Number of Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total
Andover (B)	328	$628,463,029.95	14	4.3%	$174,979,627	27.8%	14	4.3%	$174,979,627	27.8%
Andover (Twp)	2,584	$3,609,679,724.39	5	0.2%	$36,001,962	1.0%	5	0.2%	$36,001,962	1.0%
Branchville (B)	426	$532,377,368.38	14	3.3%	$14,360,449	2.7%	18	4.2%	$20,126,263	3.8%
Byram (Twp)	3,676	$2,746,550,445.88	136	3.7%	$59,432,969	2.2%	171	4.7%	$70,866,182	2.6%
Frankford (Twp)	3,537	$3,129,888,304.60	179	5.1%	$266,202,978	8.5%	186	5.3%	$284,523,862	9.1%
Franklin (B)	2,061	$1,921,211,856.14	20	1.0%	$35,297,163	1.8%	22	1.1%	$42,004,974	2.2%
Fredon (Twp)	1,615	$1,372,050,934.47	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Green (Twp)	1,698	$1,598,635,803.93	29	1.7%	$18,997,556	1.2%	29	1.7%	$18,997,556	1.2%
Hamburg (B)	1,594	$1,588,049,291.35	3	0.2%	$68,017,193	4.3%	4	0.3%	$71,157,825	4.5%
Hampton (Twp)	2,763	$2,196,131,598.39	21	0.8%	$13,488,730	0.6%	23	0.8%	$15,725,292	0.7%
Hardyston (Twp)	4,403	$3,183,033,541.83	1	<0.1%	$302,627	<0.1%	1	<0.1%	$302,627	<0.1%
Hopatcong (B)	8,040	$2,888,571,675.73	188	2.3%	$153,787,091	5.3%	188	2.3%	$153,787,091	5.3%
Lafayette (Twp)	1,462	$1,958,174,065.00	30	2.1%	$37,074,106	1.9%	44	3.0%	$56,651,230	2.9%
Montague (Twp)	2,175	$1,459,611,020.48	68	3.1%	$62,615,830	4.3%	82	3.8%	$69,659,154	4.8%
Newton (T)	2,679	$5,093,275,807.16	53	2.0%	$321,219,681	6.3%	60	2.2%	$330,994,913	6.5%
Ogdensburg (B)	992	$819,879,628.63	4	0.4%	$64,763,950	7.9%	26	2.6%	$68,977,030	8.4%
Sandyston (Twp)	1,528	$1,212,626,664.22	78	5.1%	$95,822,091	7.9%	91	6.0%	$101,399,933	8.4%
Sparta (Twp)	8,132	$9,070,094,285.30	128	1.6%	$149,119,235	1.6%	129	1.6%	$150,249,278	1.7%
Stanhope (B)	1,557	$1,051,183,581.21	9	0.6%	$141,434,869	13.5%	12	0.8%	$144,564,976	13.8%
Stillwater (Twp)	2,493	$1,417,579,397.87	31	1.2%	$8,960,900	0.6%	32	1.3%	$9,108,181	0.6%
Sussex (B)	678	$1,945,578,915.70	20	2.9%	$194,803,769	10.0%	24	3.5%	$200,856,377	10.3%
Vernon (Twp)	12,039	$5,658,971,163.02	153	1.3%	$127,448,710	2.3%	154	1.3%	$136,976,734	2.4%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposure - Total (All Occupancies)							
			1-Percent Annual Chance Flood Event Hazard Area				0.2-Percent Annual Chance Flood Event Hazard Area			
			Number of Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total	Number of Buildings	Percent Total	Replacement Cost Value (RCV)	Percent Total
Walpack (Twp)	51	$63,691,550.30	9	17.6%	$25,116,984	39.4%	9	17.6%	$25,116,984	39.4%
Wantage (Twp)	5,510	$4,877,543,884.74	74	1.3%	$81,399,036	1.7%	76	1.4%	$82,105,518	1.7%
Sussex County (Total)	**72,021**	**$60,022,853,538.68**	**1,267**	**1.8%**	**$2,150,647,504**	**3.6%**	**1,400**	**1.9%**	**$2,265,133,569**	**3.8%**

Source: FEMA 2011; Sussex County GIS 2020; RS Means 2020
Note: B – Borough; T – Town; Twp – Township

Table 4.3.5-9 Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Jurisdiction	Total Replacement Cost Value	All Occupancies 1-Percent Annual Chance Flood Event		Residential Losses Only 1-Percent Annual Chance Flood Event		Commercial Losses Only 1-Percent Annual Chance Flood Event		All Other Occupancies Total Losses 1-Percent Annual Chance Flood Event	
		Estimated Loss (Replacement Cost Value)	Percent of Total	Estimated Loss (Replacement Cost Value)	Percent of Total Residential Value	Estimated Loss (Replacement Cost Value)	Percent of Total Commercial Value	Estimated Loss (Replacement Cost Value)	Percent of Total Other Occupancies Value
Andover (B)	$628,463,030	$18,269,210	2.9%	$256,824	0.2%	$18,012,386	3.9%	$0	0.0%
Andover (Twp)	$3,609,679,724	$4,158,644	0.1%	$10,153	<0.1%	$4,148,492	0.2%	$0	0.0%
Branchville (B)	$532,377,368	$13,442	<0.1%	$13,442	<0.1%	$0	0.0%	$0	0.0%
Byram (Twp)	$2,746,550,446	$5,020,306	0.2%	$641,380	0.1%	$1,067,569	0.1%	$3,311,356	1.1%
Frankford (Twp)	$3,129,888,305	$7,604,867	0.2%	$2,345,629	0.2%	$1,132,760	0.1%	$4,126,478	0.4%
Franklin (B)	$1,921,211,856	$525,746	<0.1%	$449,981	0.1%	$75,765	<0.1%	$0	0.0%
Fredon (Twp)	$1,372,050,934	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Green (Twp)	$1,598,635,804	$3,953,072	0.2%	$424,189	0.1%	$0	0.0%	$3,528,884	0.5%
Hamburg (B)	$1,588,049,291	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%

Jurisdiction	Total Replacement Cost Value	All Occupancies 1-Percent Annual Chance Flood Event		Residential Losses Only 1-Percent Annual Chance Flood Event		Commercial Losses Only 1-Percent Annual Chance Flood Event		All Other Occupancies Total Losses 1-Percent Annual Chance Flood Event	
		Estimated Loss (Replacement Cost Value)	Percent of Total	Estimated Loss (Replacement Cost Value)	Percent of Total Residential Value	Estimated Loss (Replacement Cost Value)	Percent of Total Commercial Value	Estimated Loss (Replacement Cost Value)	Percent of Total Other Occupancies Value
Hampton (Twp)	$2,196,131,598	$202,871	<0.1%	$76,105	<0.1%	$0	0.0%	$126,766	<0.1%
Hardyston (Twp)	$3,183,033,542	$182,343	<0.1%	$182,343	<0.1%	$0	0.0%	$0	0.0%
Hopatcong (B)	$2,888,571,676	$1,074,057	<0.1%	$73,491	<0.1%	$0	0.0%	$1,000,566	0.3%
Lafayette (Twp)	$1,958,174,065	$8,157,067	0.4%	$365,595	0.1%	$768,384	0.2%	$7,023,088	0.7%
Montague (Twp)	$1,459,611,020	$2,007,280	0.1%	$1,822,040	0.3%	$0	0.0%	$185,239	<0.1%
Newton (T)	$5,093,275,807	$3,528,378	0.1%	$211,423	<0.1%	$727,209	<0.1%	$2,589,746	0.3%
Ogdensburg (B)	$819,879,629	$10,265,826	1.3%	$61,283	<0.1%	$10,204,543	3.1%	$0	0.0%
Sandyston (Twp)	$1,212,626,664	$3,885,891	0.3%	$493,390	0.1%	$2,487	<0.1%	$3,390,014	0.6%
Sparta (Twp)	$9,070,094,285	$13,918,398	0.2%	$1,298,468	<0.1%	$12,204,611	0.3%	$415,320	<0.1%
Stanhope (B)	$1,051,183,581	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Stillwater (Twp)	$1,417,579,398	$56,587	<0.1%	$4,088	<0.1%	$0	0.0%	$52,499	<0.1%
Sussex (B)	$1,945,578,916	$72,932	<0.1%	$0	0.0%	$0	0.0%	$72,932	<0.1%
Vernon (Twp)	$5,658,971,163	$21,538,532	0.4%	$1,944,482	0.1%	$17,592,777	1.8%	$2,001,273	0.2%
Walpack (Twp)	$63,691,550	$15,594,172	24.5%	$59,321	2.1%	$0	0.0%	$15,534,851	34.0%
Wantage (Twp)	$4,877,543,885	$17,621,344	0.4%	$2,555,710	0.1%	$8,860,280	1.0%	$6,205,354	0.3%
Sussex County (Total)	**$60,022,853,539**	**$137,650,964**	**0.2%**	**$13,289,334**	**0.1%**	**$74,797,262**	**0.3%**	**$49,564,367**	**0.4%**

Source: Hazus; FEMA 2011; Sussex County GIS 2020; RS Means 2020
Note: B – Borough; T – Town; Twp – Township

NFIP Statistics

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

Table 4.3.5-10, Table 4.3.5-11, and Table 4.3.5-12 summarize the NFIP policies, claims, and repetitive loss statistics for Sussex County. A majority of the repetitive loss properties are single family residential homes (87.5-percent). There are no SRL properties reported for the County. This information is current as of September 2019.

The locations of repetitive flooding were geocoded and mapped. Figure 4.3.5-3 illustrates these properties with the understanding that there are varying tolerances between how closely the longitude and latitude coordinates correspond to the location of the property address.

Table 4.3.5-10. Occupancy Class of Repetitive Loss Structures in Sussex County

Occupancy Class	Total Number of NFIP Repetitive Loss (RL) Properties
Single Family	14
2-4 Family	1
Non-Residential	1
Sussex County (Total)	**16**

Source: FEMA Region 2 2019; JUDEX 2020
Note: Repetitive loss statistics provided by FEMA Region 2 and are current as of September 2019.

Table 4.3.5-11. Occupancy Class of Repetitive Loss Structures in Sussex County, by Jurisdiction

Jurisdiction	NFIP Repetitive Loss Properties		
	Single Family	2-4 Family	Non-Residential
Andover (B)	0	0	0
Andover (Twp)	0	0	0
Branchville (B)	1	1	0
Byram (Twp)	3	0	0
Frankford (Twp)	1	0	0
Franklin (B)	0	0	0
Fredon (Twp)	0	0	0
Green (Twp)	0	0	0
Hamburg (B)	0	0	0
Hampton (Twp)	0	0	0
Hardyston (Twp)	0	0	0
Hopatcong (B)	1	0	0
Lafayette (Twp)	1	0	0
Montague (Twp)	2	0	0
Newton (T)	0	0	0

Jurisdiction	NFIP Repetitive Loss Properties		
	Single Family	2-4 Family	Non-Residential
Ogdensburg (B)	2	0	0
Sandyston (Twp)	1	0	0
Sparta (Twp)	0	0	0
Stanhope (B)	0	0	0
Stillwater (Twp)	0	0	0
Sussex (B)	0	0	1
Vernon (Twp)	2	0	0
Walpack (Twp)	0	0	0
Wantage (Twp)	0	0	0
Sussex County (Total)	14	1	1

Source: FEMA Region 2 2019; JUDEX 2020
B – Borough; T – Town; Twp – Township NFIP = National Flood Insurance Program
Notes: Repetitive loss statistics provided by FEMA Region 2 and are current as of September 2019. The statistics were summarized using the Community Name provided by FEMA Region 2.

Table 4.3.5-12. Repetitive Loss Properties and NFIP Data for Sussex County

Jurisdiction	Number of NFIP Policies	Number of Write Your Own Policies	Total Number of Policies	Number of NFIP Claims	Number of Write Your Own Claims	Total Claims	Total NFIP Payments	Total Write Your Own Payments	Total Payments	Number of NFIP Repetitive Loss (RL) Properties	Number of NFIP Severe Repetitive Loss (SRL)
Andover (B)	1	2	3	0	1	1	$0	$4,314	$4,314	0	0
Andover (Twp)	2	2	4	0	2	2	$0	$304	$304	0	0
Branchville (B)	1	3	4	3	6	9	$24,016	$33,573	$57,589	2	0
Byram (Twp)	5	17	22	2	12	14	$6,831	$123,046	$129,878	3	0
Frankford (Twp)	0	20	20	1	10	11	$0	$61,459	$61,459	0	0
Franklin (B)	2	9	11	3	8	11	$14,871	$61,017	$75,888	1	0
Fredon (Twp)	1	2	3	0	2	2	$0	$6,937	$6,937	0	0
Green (Twp)	1	8	9	0	2	2	$0	$11,652	$11,652	0	0
Hamburg (B)	0	4	4	0	0	0	$0	$0	$0	0	0
Hampton (Twp)	0	7	7	0	1	1	$0	$0	$0	0	0
Hardyston (Twp)	0	8	8	0	2	2	$0	$60,787	$60,787	0	0
Hopatcong (B)	1	10	11	4	8	12	$1,151	$53,042	$54,193	1	0
Lafayette (Twp)	0	3	3	0	7	7	$0	$24,566	$24,566	1	0
Montague (Twp)	6	13	19	7	10	17	$7,470	$170,778	$178,248	2	0
Newton (T)	2	22	24	0	8	8	$0	$295,505	$295,505	0	0
Ogdensburg (B)	1	10	11	4	5	9	$4,185	$44,937	$49,122	2	0
Sandyston (Twp)	1	7	8	0	5	5	$0	$209,806	$209,806	1	0
Sparta (Twp)	2	44	46	3	11	14	$628	$32,371	$32,999	0	0
Stanhope (B)	0	3	3	1	1	2	$6,052	$10,205	$16,257	0	0
Stillwater (Twp)	0	7	7	1	4	5	$0	$87,323	$87,323	0	0
Sussex (B)	0	4	4	0	4	4	$0	$65,202	$65,202	1	0
Vernon (Twp)	2	24	26	8	10	18	$36,310	$82,702	$119,012	2	0
Walpack (Twp)	0	0	0	0	1	1	$0	$7,076	$7,076	0	0
Wantage (Twp)	0	14	14	3	7	10	$21,511	$159,452	$180,963	0	0
Sussex County (Total)	**28**	**243**	**271**	**40**	**127**	**167**	**$123,025**	**$1,606,054**	**$1,729,080**	**16**	**0**

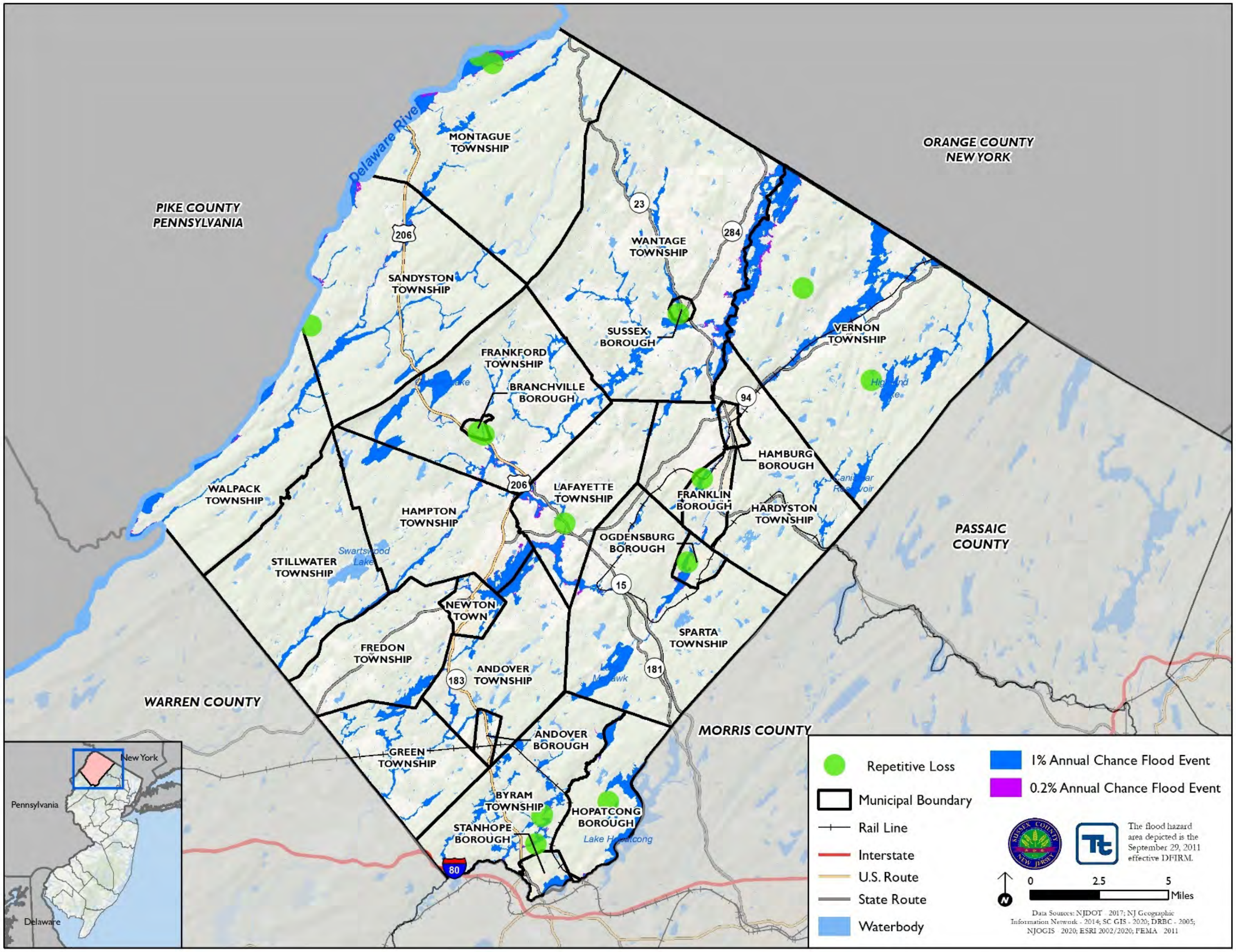
Source: FEMA Region 2 2019; JUDEX 2020

B – Borough; T – Town; Twp – Township NFIP = National Flood Insurance Program

1 - Policies, claims, repetitive loss, and severe repetitive loss statistics provided by FEMA Region 2 and HUDEX and are current as September 2019 and 2020, respectively. The total number of repetitive loss properties includes the severe repetitive loss properties.

2 - Total building and content losses from the claims file provided by HUDEX.

Figure 4.3.5-5. NFIP Repetitive Loss Areas – Sussex County



Impact on Critical Facilities and Lifelines

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

Critical facility and community lifeline exposure to the flood hazard was examined. Table 4.3.5-13 and Table 4.3.5-14 list critical facilities in the 1- and 0.2-percent annual chance flood event boundaries. Of the 66 critical facilities located in the 1-percent annual chance flood event boundary, the greatest number are dams because they are located in the waterway. Additionally, there are 69 critical facilities located in the 0.2-percent annual chance flood event boundary, 57 of which are dams. A majority of the critical facilities located in the 1-percent and 0.2-percent annual chance flood event boundaries are built in the Township of Byram. Critical facility types that are not listed in the tables were not exposed to the flood hazard.

Table 4.3.5-15 summarizes the critical facilities categorized by the FEMA lifelines that are exposed to the 1-percent and 0.2-percent flood inundation areas. 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.

Approximately 1.5-percent of all roadways are in the 1-percent annual chance flood event. Table 4.3.5-16 summarizes the total number of miles of exposed roadways. Figure 4.3.5-6 displays the major roadways that may be impacted by the 1-percent annual chance flood event. The major highways exposed to the 1-percent annual chance flood extent include portions of: I-80, NJ 181, NJ 23, NJ 15, NJ 94, NJ 183, and US 206.

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.

Table 4.3.5-13. Distribution of Critical Facilities within the 1-percent Annual Chance Flood Boundary

		Facility Types				
Jurisdiction	Dam	DPW	Hazardous Material Facility	Potable Water Treatment	Shelter	Wastewater Pump
Andover (B)	0	0	0	1	0	0
Andover (Twp)	0	0	0	0	0	0
Branchville (B)	0	0	0	0	0	0
Byram (Twp)	9	0	0	0	2	2
Frankford (Twp)	4	0	0	0	1	0
Franklin (B)	1	0	0	0	0	0
Fredon (Twp)	0	0	0	0	0	0
Green (Twp)	3	0	0	0	0	0
Hamburg (B)	2	0	0	0	0	0

Jurisdiction	Dam	Facility Types				
		DPW	Hazardous Material Facility	Potable Water Treatment	Shelter	Wastewater Pump
Hampton (Twp)	2	0	0	0	0	0
Hardyston (Twp)	1	0	0	0	0	0
Hopatcong (B)	2	0	0	0	0	0
Lafayette (Twp)	1	0	0	0	0	0
Montague (Twp)	4	0	0	0	0	0
Newton (T)	2	0	0	0	0	0
Ogdensburg (B)	0	0	0	0	0	0
Sandyston (Twp)	8	0	0	0	0	0
Sparta (Twp)	7	0	1	0	0	0
Stanhope (B)	0	0	0	0	0	0
Stillwater (Twp)	3	0	0	0	0	0
Sussex (B)	1	1	0	0	0	0
Vernon (Twp)	4	0	0	0	1	0
Walpack (Twp)	2	0	0	0	0	0
Wantage (Twp)	1	0	0	0	0	0
Sussex County (Total)	**57**	**1**	**1**	**1**	**4**	**2**

Source: FEMA 2011; Sussex County GIS 2020
Note: B – Borough; T – Town; Twp – Township
Only Critical Facility types that are exposed to the flood hazard appear in the table.

Table 4.3.5-14. Distribution of Critical Facilities within the 0.2-percent Annual Chance Flood Boundary

Jurisdiction	Dam	Facility Types						
		DPW	Electrical Substation	Hazardous Material Facility	Post Office	Potable Water Treatment	Shelter	Wastewater Pump
Andover (B)	0	0	0	0	0	1	0	0
Andover (Twp)	0	0	0	0	0	0	0	0
Branchville (B)	0	0	0	0	0	0	0	0
Byram (Twp)	9	0	0	0	0	0	2	2
Frankford (Twp)	4	0	0	0	0	0	1	0
Franklin (B)	1	0	0	0	0	0	0	0
Fredon (Twp)	0	0	0	0	0	0	0	0
Green (Twp)	3	0	0	0	0	0	0	0
Hamburg (B)	2	0	0	0	0	0	0	0

Jurisdiction	Facility Types							
	Dam	DPW	Electrical Substation	Hazardous Material Facility	Post Office	Potable Water Treatment	Shelter	Wastewater Pump
Hampton (Twp)	2	0	0	0	0	0	0	0
Hardyston (Twp)	1	0	0	0	0	0	0	0
Hopatcong (B)	2	0	0	0	0	0	0	0
Lafayette (Twp)	1	1	0	0	0	0	0	0
Montague (Twp)	4	0	0	0	0	0	0	0
Newton (T)	2	0	0	0	0	0	0	0
Ogdensburg (B)	0	0	0	0	0	0	0	0
Sandyston (Twp)	8	0	0	0	1	0	0	0
Sparta (Twp)	7	0	0	1	0	0	0	0
Stanhope (B)	0	0	0	0	0	0	0	0
Stillwater (Twp)	3	0	0	0	0	0	0	0
Sussex (B)	1	1	1	0	0	0	0	0
Vernon (Twp)	4	0	0	0	0	0	1	0
Walpack (Twp)	2	0	0	0	0	0	0	0
Wantage (Twp)	1	0	0	0	0	0	0	0
Sussex County (Total)	**57**	**2**	**1**	**1**	**1**	**1**	**4**	**2**

Source: FEMA 2011; Sussex County GIS 2020
Note: B – Borough; T – Town; Twp – Township
DPW – Department of Public Works
Only Critical Facility types that are exposed to the flood hazard appear in the table.

Table 4.3.5-15. Estimated Number of Community Lifelines Categorized by FEMA Lifeline Categories Exposed to the Flood Hazard Areas

FEMA Lifeline Category	Total Number of Lifelines Identified in Sussex County	Number of Lifelines Exposed to 1-Percent Annual Chance Flood Event Hazard	Number of Lifelines Exposed to 0.2-Percent Annual Chance Flood Event Hazard
Communications	9	0	0
Energy	12	0	1
Food, Water, Shelter	75	6	6
Hazardous Materials	20	0	0
Health and Medical	15	0	0
Safety and Security	463	60	62
Transportation	2	0	0
Sussex County (Total)	**596**	**66**	**69**

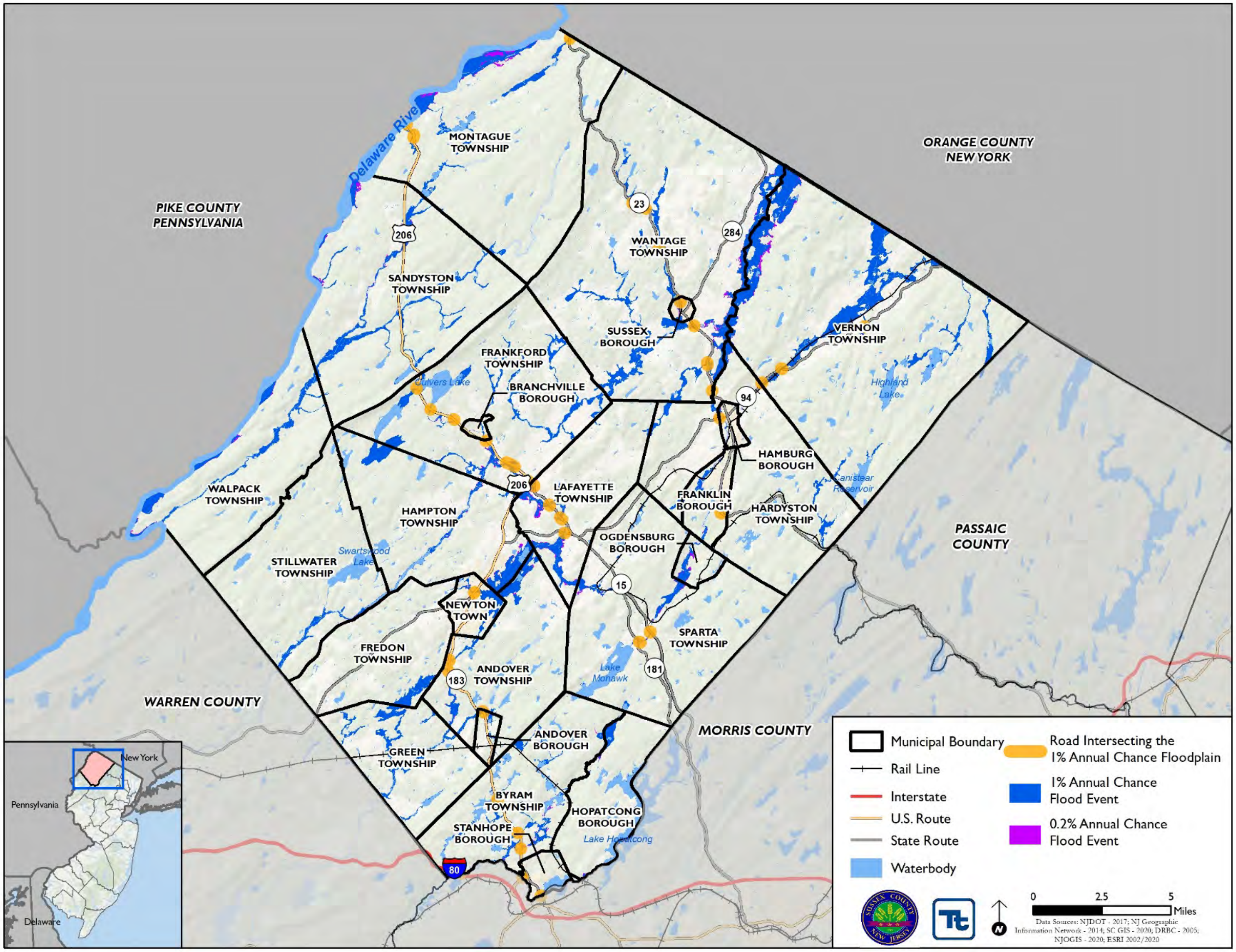
Sources: FEMA 2011/2020; Sussex County GIS 2020

Table 4.3.5-16. Major Transportation Routes Exposed to the Flood Hazard Areas

Road Type	Total Miles in the County	1-Percent Annual Chance Flood Event	
		Miles Located in the Hazard Area	Percent of Total
Local and Private Roads	1,337	19	1.4%
County Roads	313	5	1.6%
State Routes	86	1	1.2%
US Highways	34	1	2.9%
Interstate	1	<0.1	<0.1%
Sussex County (Total)	**1,771**	**26**	**1.5%**

Sources: Sussex County GIS 2020; NJDOT 2019; FEMA 2011

Figure 4.3.5-6. Major Roadways Located in the 1-percent Annual Chance Floodplain



Critical facilities and community lifelines that are near an area where frequent urban flooding occurs are even more vulnerable to flood damages. Urban flooding is defined by FEMA as flooding caused by rain that falls on densely populated areas that have increased amounts of impervious surfaces, which overwhelms the capacity of drainage systems (Natural Resources Defense Council 2019). This type of flooding can be exacerbated by riverine flooding within the County.

Debris from flood events may also affect culverts and sewer systems by creating bottlenecks in the wastewater system, which could not only cause or exacerbate localized urban flooding, but also cause wastewater to spill into homes and neighborhoods or contaminate local rivers and streams. As a result, contamination of drinking water supplies can be a significant secondary event created by major flood events.

Impact on the Economy

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

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 4.3.5-17 summarizes the debris Hazus estimates for these events. As a result of the 1-percent annual chance event, Hazus estimates approximately 10,855 tons of debris will be generated in total. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding.

Table 4.3.5-17. Estimated Debris Generated from the 1-percent Annual Chance Flood Event

Jurisdiction	1-Percent Annual Chance Flood Event Hazard Area			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Andover (B)	145	145	0	0
Andover (Twp)	38	38	0	0
Branchville (B)	65	65	0	0
Byram (Twp)	405	385	11	9
Frankford (Twp)	477	361	67	49
Franklin (B)	264	188	46	30
Fredon (Twp)	2	1	1	1
Green (Twp)	159	115	26	18
Hamburg (B)	0	0	0	0

Jurisdiction	1-Percent Annual Chance Flood Event Hazard Area			
	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Hampton (Twp)	27	27	0	0
Hardyston (Twp)	33	16	10	7
Hopatcong (B)	50	49	1	0
Lafayette (Twp)	138	130	4	3
Montague (Twp)	850	386	265	199
Newton (T)	371	336	22	14
Ogdensburg (B)	36	36	0	0
Sandyston (Twp)	259	174	50	35
Sparta (Twp)	3,564	698	1,765	1,101
Stanhope (B)	59	27	18	13
Stillwater (Twp)	152	127	15	10
Sussex (B)	284	209	43	32
Vernon (Twp)	1,411	955	276	180
Walpack (Twp)	1,227	52	675	500
Wantage (Twp)	837	532	179	127
Sussex County (Total)	**10,855**	**5,052**	**3,474**	**2,329**

Source: Hazus; FEMA 2011
Note: B – Borough; T – Town; Twp – Township

Impact on the Environment

As Sussex County communities grow, 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 and 0.2-percent annual flood events will continue to evolve alongside natural occurrences such as climate change and/or severity of storms. These flood events will impact Sussex County's natural and local environment.

Table 4.3.5-18 lists the number of acres exposed to the 1- and 0.2-percent annual chance flood extents by land use type. Non-residential land use types include forested and open space areas.

Table 4.3.5-18. Land Use Types in Sussex County Exposed to 1% and 0.2% Flood Extents

Land Use Type	Total Acres for County	1-Percent Annual Chance Flood Event		0.2-Percent Annual Chance Flood Event	
		Acres	Percent of Total	Acres	Percent of Total
Residential Land	54,839	811	1.5%	910	1.7%
Non-Residential Land	274,695	19,847	7.2%	20,701	7.5%
Natural Land	237,942	18,441	7.8%	19,138	8.0%
Total County Land	**342,701**	**27,961**	**8.2%**	**28,920**	**8.4%**

Source: NJDEP 2015, FEMA 2011
Notes: Area listed does not include water

Cascading Impacts on Other Hazards

Flood events can exacerbate the impacts of other hazards such as disease outbreak and landslides. After a flooding event, runoff can pick up and transport pollutants from wildlife and soils. Such organisms can then appear in water drinking facilities and transmit illnesses water-borne and vector diseases to the population (WHO, 2020). Flooding can also put additional strain on dams, which may lead to dam failure. More information about these hazards of concern can be found in Section 4.3.1 (Dam Failure) and Section 4.3.2 (Disease Outbreak).

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

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. The New Jersey Highlands Council has identified areas of potential growth (Existing Community Zones [where both in-fill of new development and/or re-development may occur], Designated Centers, as well as Sewer Service Areas) that may provide insight as to where potential new development may occur in Sussex County. In addition, each community was requested to provide potential major new development and infrastructure over the next five years; summarized in Section 9 (Jurisdictional Annexes).

An exposure analysis was conducted using the input from the communities as displayed in Figure 4.3.5-7 to determine if new development may be located in the floodplain. Based on the analysis, there is one potential new development located in the 1-percent and 0.2-percent annual chance floodplains, which is located in the Borough of Hamburg. The results of this analysis were shared with all jurisdictions. Being aware of these flood extents and requirements of protection will be critical for all future projects. The Sussex County Planning Board (SCPB) is responsible for review or approval of site plan and subdivision applications, and implementing the Sussex County Land Development Standards. Further, a site plan review process is done at the municipal level to ensure compliance with local ordinances.

Projected Changes in Population

Sussex County has experienced population decline since 2010. According to the U.S. Census Bureau, the County's population has decreased 4.7-percent between 2010 and 2018 (U.S. Census Bureau 2020). The Township of Walpack and the Borough of Sussex have experienced the greatest decline with a decrease of 62.5-percent and 13.0-percent, respectively. The population is expected to continue to decrease as residents move away from the suburbs and towards urban centers (Stirling 2018). Even though the population has decreased over the past decade, any changes in the density of population can impact the number of persons exposed to hurricanes and tropical storms. As the population changes, so will the number of people impacted by this hazard.

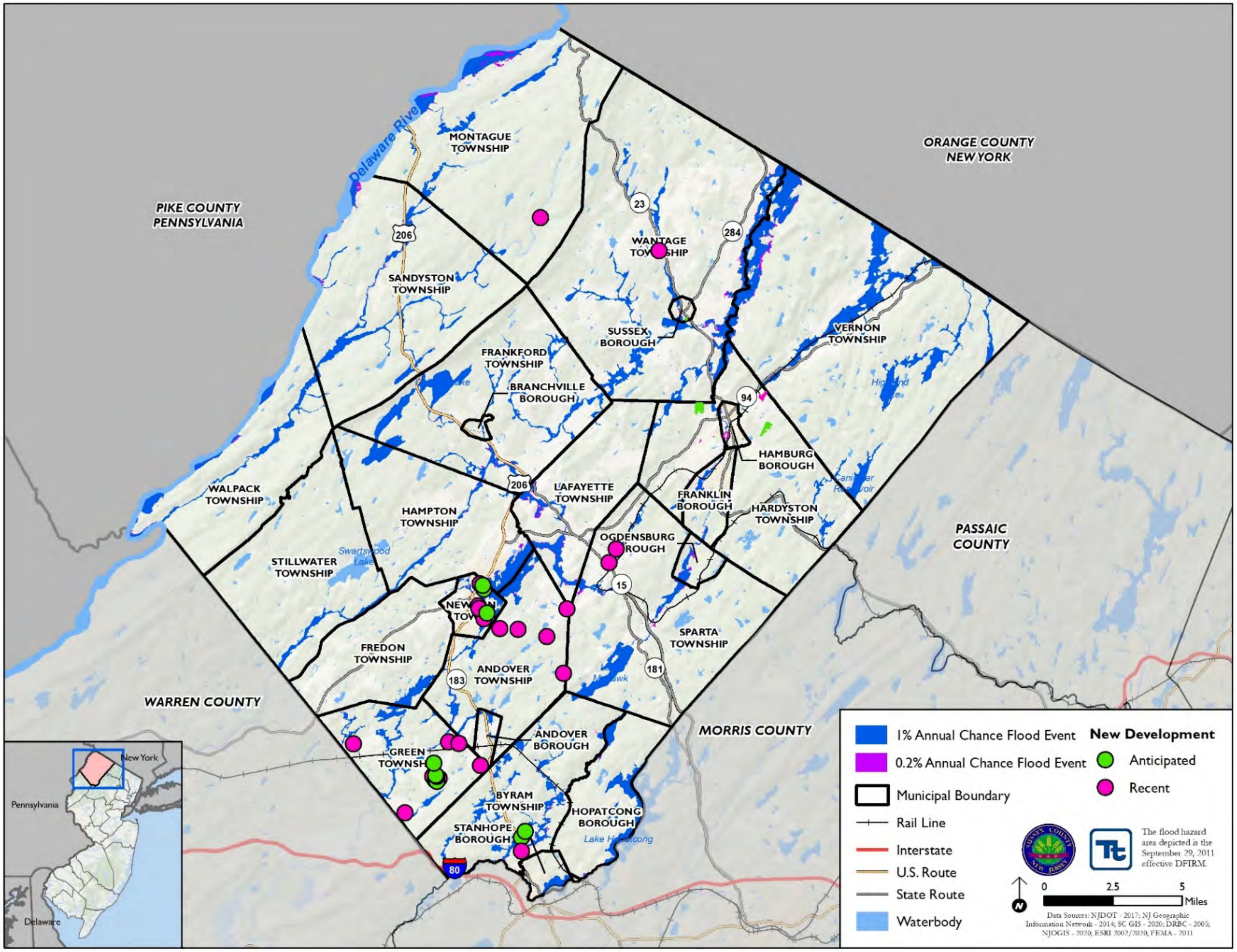
Climate Change

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

Vulnerability Change Since 2016 HMP

The entire County continues to be vulnerable to the flood hazard. Since the 2016 analysis, population statistics have been updated using the 2014-2018 American Community Survey. The general building stock was also updated using RS Means 2020 building valuations that estimated replacement cost value for each building in the inventory. This provides an up-to-date look at the entire building stock for Sussex County and gives more accurate results for the exposure and loss estimation analysis. Additionally, the 2016 critical facility dataset was updated by the County and now includes FEMA community lifelines. A Hazus v4.2 riverine flood analysis of Sussex County was based on the most current and best available data, including building and critical facility inventories, and the FEMA 2011 effective DFIRM that was used in the last HMP to develop the 1-percent annual chance flood event depth grid and boundary as well as the 0.2-percent annual chance flood event boundary.

Figure 4.3.5-7. New Development in the Floodplain



4.3.6 GEOLOGIC

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 geological hazards in Sussex County.

2021 HMP Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2015 and 2020.
- Slopes greater than 15% were utilized to evaluate the potential for landslide; a higher resolution analysis compared to the Radbruch et al. Landslide Incidence and Susceptibility GIS layer from the National Atlas.

Profile

Hazard Description

For the purpose of Sussex County's HMP update, only landslides and land subsidence/sinkholes are discussed for the geological hazard.

Landslides

According to the U.S. Geological Survey (USGS), the term landslide includes a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over steepened slope is the primary reason for a landslide, there are other contributing factors (NJGWS 2013). Among the contributing factors are: (1) erosion by rivers, glaciers, or ocean waves which create over-steepened slopes; (2) rock and soil slopes weakened through saturation by snowmelt or heavy rains; (3) earthquakes which create stresses making weak slopes fail; and (4) excess weight from rain/snow accumulation, rock/ore stockpiling, waste piles, or man-made structures. Scientists from the USGS also monitor stream flow, noting changes in sediment load in rivers and streams that may result from landslides. All of these types of landslides are considered aggregately in USGS landslide mapping.

In New Jersey, there are four main types of landslides: slumps, debris flows, rockfalls, and rockslides. Slumps are coherent masses that move downslope by rotational slip on surfaces that underlie and penetrate the landslide deposit (Briggs et al 2001). A debris flow, also known as a mudslide, is a form of rapid mass movement in which loose soil, rock, organic matter, air, and water mobilize as slurry that flows downslope. Debris flows are often caused by intense surface water from heavy precipitation or rapid snow melt. This precipitation loosens surface matter, thus triggering the slide. Rockfalls are common on roadway cuts and steep cliffs. These landslides are abrupt movements of geological material such as rocks and boulders. Rockfalls happen when these materials become detached. Rockslides are the movement of newly detached segments of bedrock sliding on bedrock, joint, or fault surfaces (Delano and Wilshusen 2001).

Landslides can cause several types of secondary effects, such as blocking access to roads, which can isolate residents and businesses and delay commercial, public, and private transportation. This could result in economic losses for businesses. Other potential problems resulting from landslides are power and communication failures. Vegetation or poles on slopes can be knocked over, resulting in possible losses to power and communication lines. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary loss for residents. They also can damage rivers or streams, potentially harming water quality, fisheries, and spawning habitat.

Subsidence/Sinkholes

Land subsidence can be defined as the sudden sinking or gradual downward settling of the earth's surface with little or no horizontal motion, owing to the subsurface movement of earth materials (USGS 2000). Subsidence often occurs through the loss of subsurface support in karst terrain, which may result from a number of natural- and human-caused occurrences. Karst describes a distinctive topography that indicates dissolution of underlying carbonate rocks (limestone and dolomite) by surface water or groundwater over time. The dissolution process causes surface depressions and the development of sinkholes, sinking stream, enlarged bedrock fractures, caves, and underground streams (NJOEM 2019).

Sinkholes, the type of subsidence most frequently seen in New Jersey, are a natural and common geologic feature in areas with underlying limestone, carbonate rock, salt beds, or other rocks that are soluble in water. Over periods of time, measured in thousands of years, the carbonate bedrock can be dissolved through acidic rain water moving in fractures or cracks in the bedrock. This creates larger openings in the rock through which water and overlying soil materials will travel. Over time the voids will enlarge until the roof over the void is unable to support the land above at which time it will collapse, forming a sinkhole. In this example the sinkhole occurs naturally, but in other cases the root causes of a sinkhole are anthropogenic. These anthropogenic causes can include changes to the water balance of an area such as: over-withdrawal of groundwater; diverting surface water from a large area and concentrating it in a single point; artificially creating ponds of surface water; and drilling new water wells. These actions can accelerate the natural processes of creation of soil voids, which can have a direct impact on sinkhole creation (NJOEM 2019).

The State's susceptibility to subsidence is also due in part to the number of abandoned mines throughout New Jersey. The mining industry in New Jersey dates back to the early 1600s when cooper was first mined by Dutch settlers along the Delaware River in Warren County. There are approximately 588 abandoned mines in New Jersey. Although mines have closed in New Jersey, continued development in the northern part of the State has been problematic because of the extensive mining there which has caused widespread subsidence. One problem is that the mapped locations of some of the abandoned mines are not accurate. Another issue is that many of the surface openings were improperly filled in, and roads and structures have been built adjacent to or on top of these former mine sites (NJOEM 2019).

Both natural and man-made sinkholes can occur without warning. Slumping or falling fence posts, trees, or foundations, sudden formation of small ponds, wilting vegetation, discolored well water, and/or structural cracks in walls and floors, are all specific signs that a sinkhole is forming. Sinkholes can range in form from steep-walled holes, to bowl, or cone-shaped depressions. When sinkholes occur in developed areas they can cause severe property damage, disruption of utilities, damage to roadways, injury, and loss of life (NJOEM 2019).

Location

Landslides

Landslides are common in New Jersey, primarily in the northern region of the State. Expansion of urban and recreational developments into hillside areas exposes more people to the threat of landslides each year. According to the USGS, Sussex County has low landslide potential. For a figure displaying the landslide potential of the conterminous United States, please refer to http://pubs.usgs.gov/fs/2005/3156/2005-3156.pdf (USGS 2005). Other resources, specifically the National Landslide Hazard Program (NLHP), provide a more detailed level of susceptibility analysis for the State.

The Highland's Steep Stope Protection Area separates steep slopes into four classifications that are not only defined by percent of slope, but also by riparian areas, type of soils, and forestation (NJ Highlands Council 2020). In summary, any slopes above 15-percent fall into one of the four steep slope classifications. For geological hazards, slopes above 15-percent were selected using the NJDEP contour lines. As displayed in Figure 4.3.6-1, there are slopes greater than 15-percent located throughout the County.

Figure 4.3.6-2 illustrates the historic landslide locations in Sussex County. According to the figure, landslides (particularly debris flows) have occurred throughout Sussex County with a large number occurring in Vernon and Sparta. Many of the landslide incidents documented are the result of Hurricane Irene and storm damage destabilizing roads and causing debris flows. This demonstrates how landslides can be an unexpected secondary hazard during another disaster event. More information on the Hurricane Irene-related landslides can be found later in this profile or in Appendix E (Risk Assessment Supplement).

Subsidence/Sinkholes

New Jersey is susceptible to the effects of subsidence and sinkholes, primarily in the northwestern section of the State, which includes parts of Sussex County. Land subsidence and sinkholes have been known to occur as a result of natural geologic phenomenon or as a result of human alteration of surface and underground geology (NJOEM 2019).

Naturally occurring subsidence and sinkholes in New Jersey occur within bands of carbonate bedrock. In northern New Jersey, there are more than 225 square miles that are underlain by limestone, dolomite, and marble. In some areas, no sinkholes have appeared, while in others, sinkholes are common. Sussex County has bands of carbonate rock running throughout the County; the only areas not containing notable bands of carbonate rock are along the southwestern border and part of the northern section. Overall, approximately 24.9 percent (133.1 square miles) of the County has carbonate rock formation (NJGWS 2005; Godt 2001).

Substantial areas of the New Jersey Highlands are underlain by carbonate rocks, including portions of Sussex County (Figure 4.3.6-3). These rock formations, consisting primarily of limestone, dolomite, and marble, have unique characteristics that require responses to both the policy level and in specific technical guidance to municipalities. According to the NJDEP, 59 of the 88 municipalities within the Highlands region contain carbonate rocks, with eight of those municipalities located in Sussex County. As seen in Figure 4.3.6-4, the Highlands Region has several large areas of carbonate rock formations and karst features exist in some, but not all, of these areas (Highlands Regional Master Plan 2008).

As previously stated, abandoned mines are a source for sinkholes and subsidence in New Jersey. Mines create voids under the earth's surface, making areas above mines more susceptible to land subsidence. Sinkholes and subsidence occur from the collapse of the mine roof into a mine opening. Areas most vulnerable to sinkholes are those where mining occurred 20 to 30 feet below the surface. Figure 4.3.6-5 shows the location of the mapped abandoned mines in Sussex County. The data from NJGWS and the figure indicate that Sussex County has 75 abandoned mines, mainly iron mines with a few lead, zinc, and uranium mines. These mines are principally located in the eastern and southern portions of the County (NJGWS 2006).

Figure 4.3.6-1. Landslide Susceptibility in Sussex County

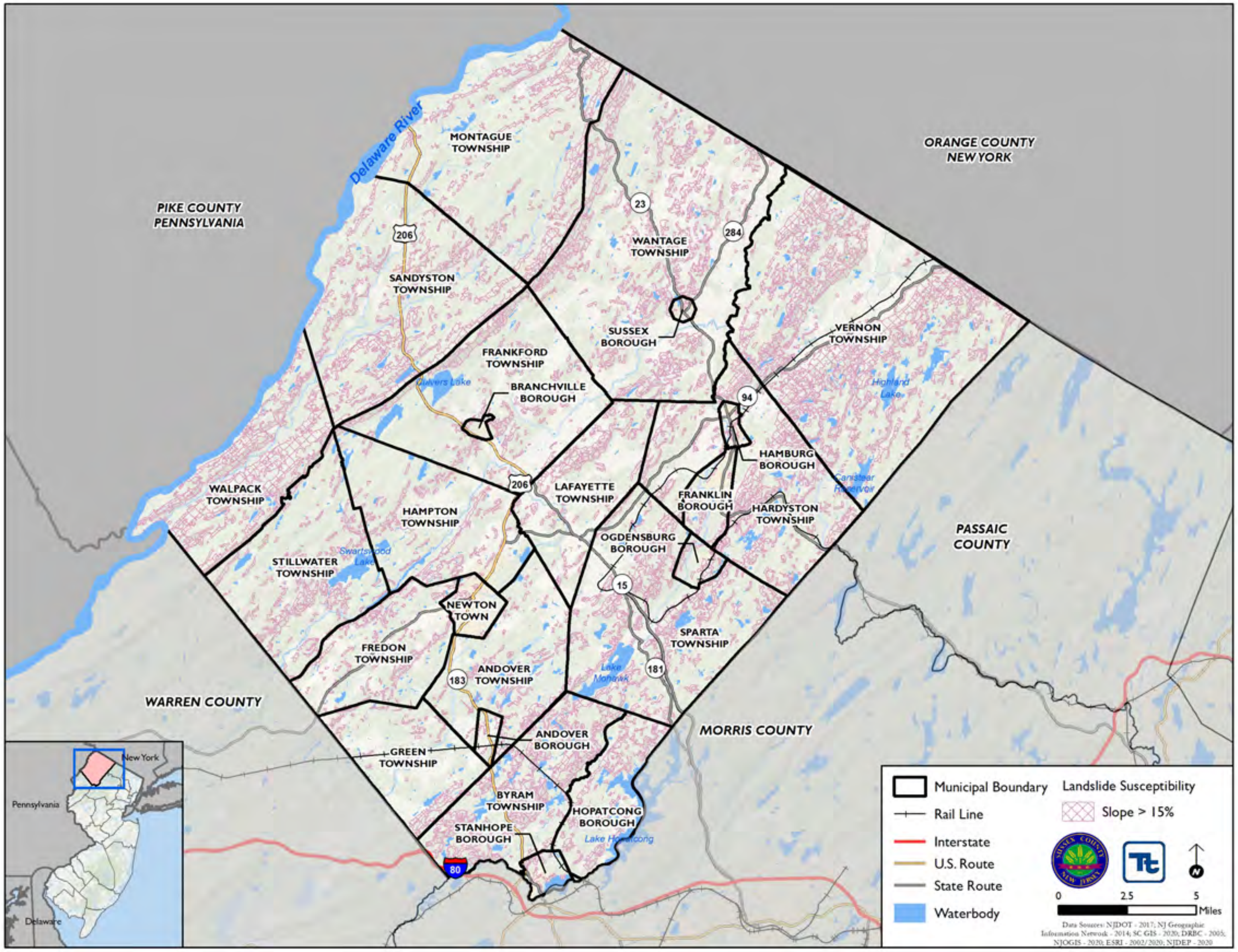


Figure 4.3.6-2. Historic Landslide Locations in Sussex County, 1869 to 2020

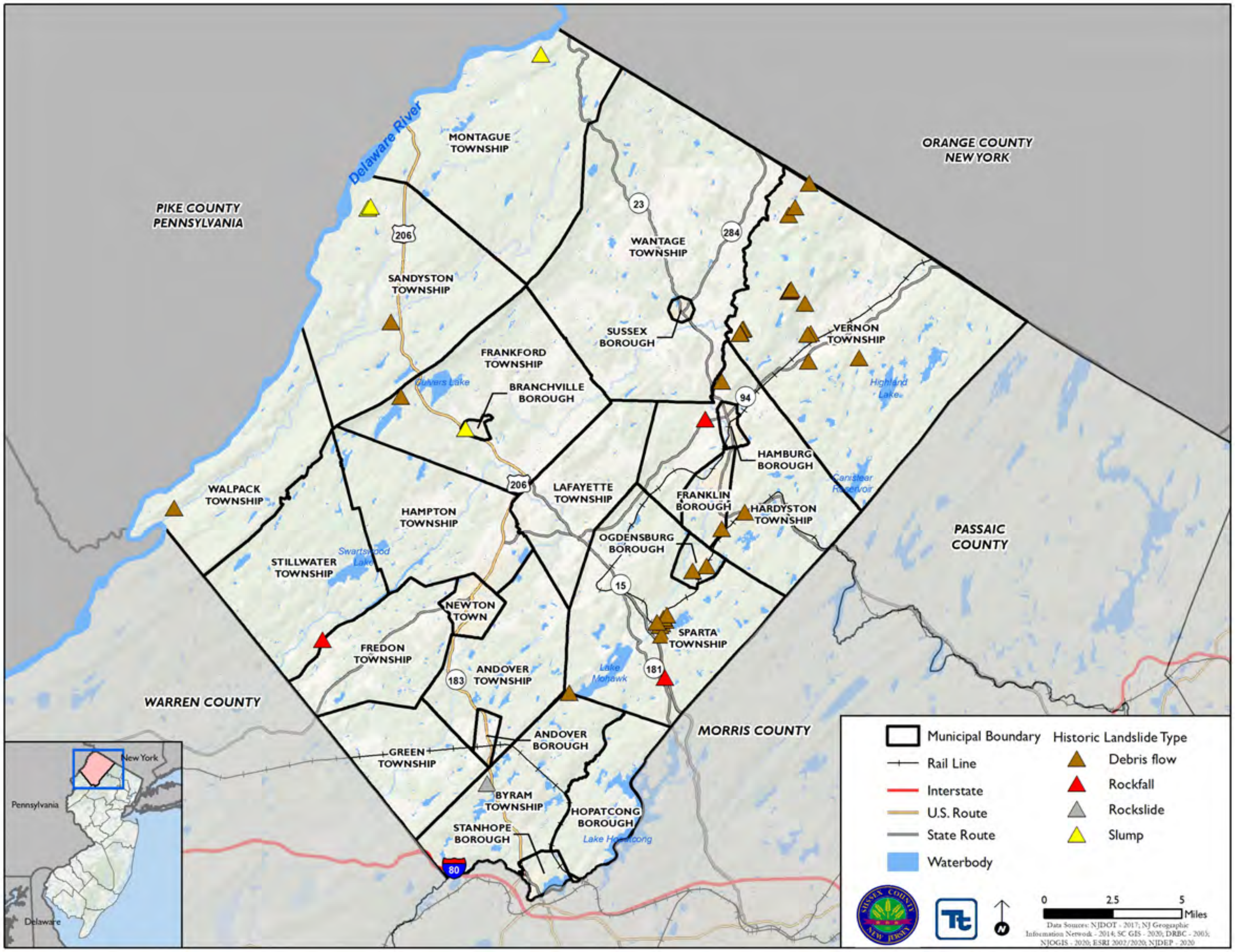
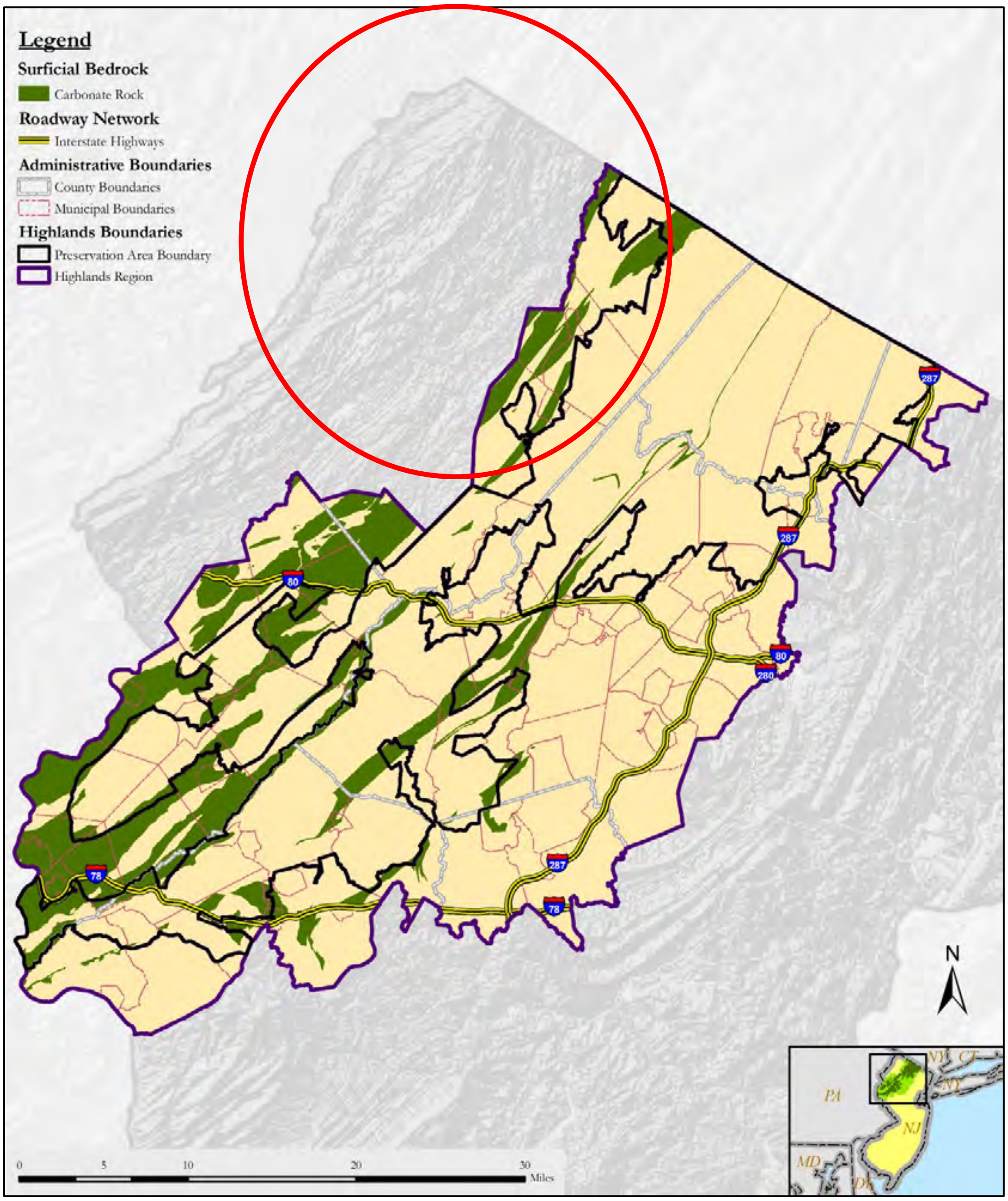


Figure 4.3.6-3. Carbonate Rock in the New Jersey Highlands



Source: New Jersey Highlands Council 2008

Note: The red circle indicates the approximate location of Sussex County.

Figure 4.3.6-5. Carbonate Rock in Sussex County

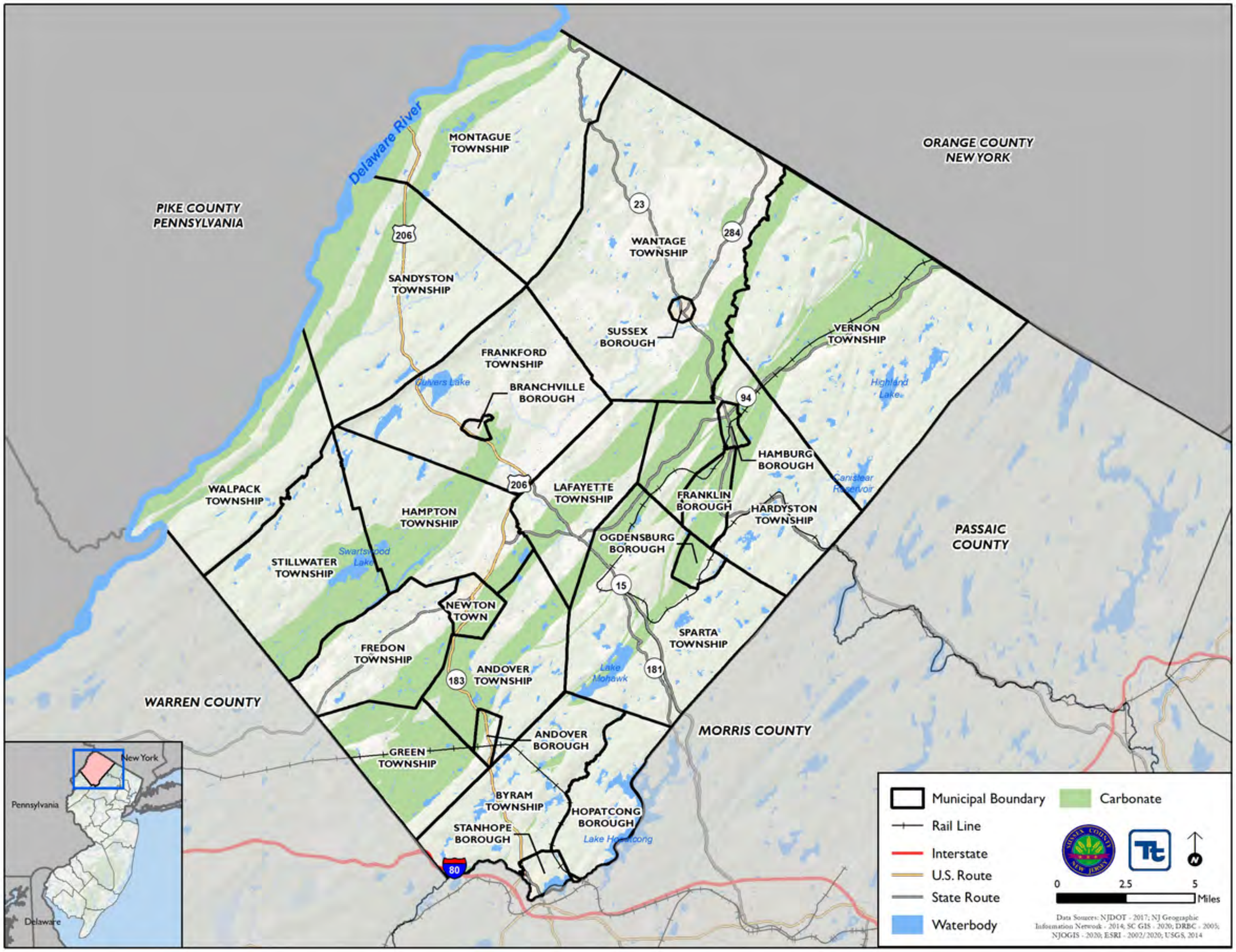
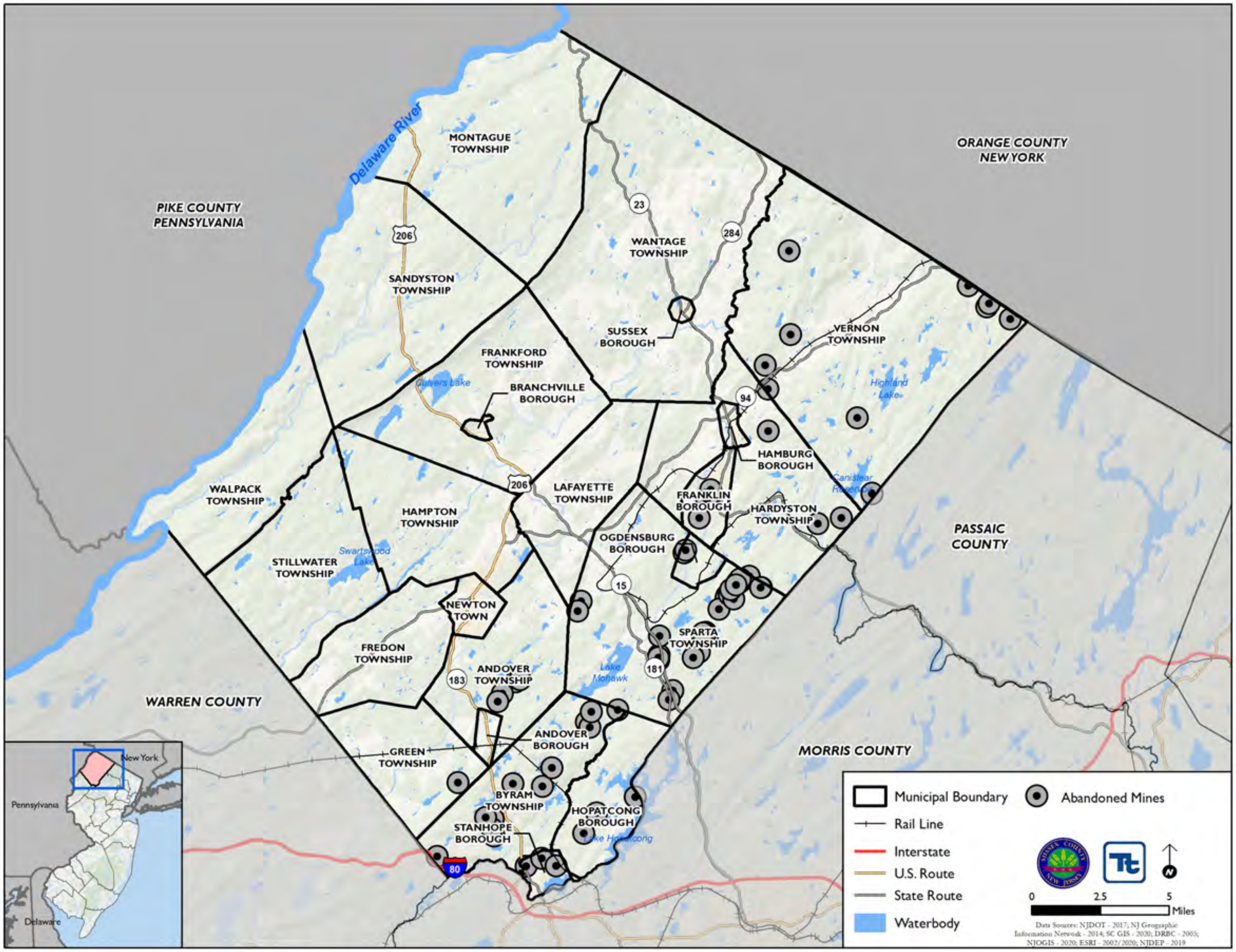


Figure 4.3.6-5. Abandoned Mines in Sussex County



Extent

Landslide

To determine the extent of a landslide hazard, the affected areas need to be identified and the probability of the landslide occurring within some time period needs to be assessed. Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions and with reliable information. As a result, the landslide hazard is often represented by landslide incidence and/or susceptibility, as defined below:

- Landslide incidence is the number of landslides that have occurred in a given geographic area. High incidence means greater than 15-percent of a given area has been involved in landsliding; medium incidence means that 1.5- to 15-percent of an area has been involved; and low incidence means that less than 1.5-percent of an area has been involved.
- Landslide susceptibility is defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. It can be assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past. Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Landslide susceptibility only identifies areas potentially affected and does not imply a time frame when a landslide might occur. High, medium, and low susceptibility are delimited by the same percentages used for classifying the incidence of landsliding (NJOEM 2019).

Subsidence/Sinkhole

Landslide subsidence occurs slowly and continuously over time or abruptly for various reasons. Subsidence and sinkholes can occur due to either natural processes (karst sinkholes in areas underlain by soluble bedrock) or as a result of human activities. Subsidence in the U.S. has directly affected more than 17,000 square miles in 45 states, and associated annual costs are estimated to be approximately $125 million. The principal causes of subsidence are aquifer-system compaction, drainage of organic soils, underground mining, hydrocompaction, natural compaction, sinkholes, and thawing permafrost (USGS 2000). There are several methods used to measure land subsidence. Global Positioning System (GPS) is a method used to monitor subsidence on a regional scale. Benchmarks (geodetic stations) are commonly space around four miles apart (State of California 2015).

Another method which is becoming increasingly popular is Interferometric Synthetic Aperture Radar (InSAR). InSAR is a remote sensing technique that uses radar signals to interpolate land surface elevation changes. It is a cost-effective solution for measuring land surface deformation for a region while offering a high degree of spatial detail and resolution (State of California 2015).

Previous Occurrences and Losses

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2015, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for one geological hazard-related event, classified as severe storms, flooding and mudslide. This declaration included Sussex County (FEMA 2020). In addition, Sussex County is included in the FEMA disaster declaration for the remnants of Tropical Storm Lee in 2011. Although this disaster is due to severe storms and flooding, it resulted in secondary geological hazard impacts such as flood-induced landslides in certain locations in the State. Sussex County experienced a debris flow along the lower end of Holland Circle a result of this incident; however, other minor events may have also occurred.

Table 4.3.6-1. FEMA DR and EM Declarations Since 2008 for Geologic Events in Sussex County

Declaration	Event Date	Declaration Date	Event Description
DR-1337	August 12, 2000 - August 21, 2000	August 17, 2000	New Jersey Severe Storms, Flooding And Mudslides
DR-4039	September 8, 2011 - October 6, 2011	October 14, 2011	New Jersey Remnants of Tropical Storm Lee

Source: FEMA 2020

U.S. Department of Agriculture Disaster 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 2015 and 2020, Sussex County was not included in geologic related agricultural disaster declarations.

Geologic events identified for Sussex County between 2015 and 2021 are listed in Table 4.3.6-2. For this 2021 HMP update, known geologic events that have impacted Sussex County prior to 2015 are identified in Appendix E (Risk Assessment Supplement).

Table 4.3.6-2. Geologic Events in Sussex County; 2015 to 2021

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Description
March 2021	Sinkhole	N/A	N/A	The Township of Vernon had a relatively small sinkhole form as a result of heavy rain, snow melt and lake run off at the National Winter Activity Center in March 2021. It was approximately 30" x 24" a 6' deep that connected to a spill way basin that ties into a stream. It was kept under watch and is being remediated with a dam replacement project.

Probability of Future Occurrences

It is likely that geological hazards will occur in Sussex County in the future. Landslide probabilities are largely a function of surface geology, but are also influenced by both weather and human activities. Because of the large number of landslides precipitated by Hurricane Irene in August 2011, landslide probability for Sussex County can be calculated in two ways. If each individual landslide during Hurricane Irene is considered a unique event, then based on NJGWS historic data, Sussex County has a roughly 50-percent chance of a landslide or other geologic event occurring in any given year. In contrast, if all of the Hurricane Irene-related landslides are treated as a single event due to having the same cause, then Sussex County has a roughly 25-percent chance of a landslide or other geologic event occurring in any given year. Specific analyses on the probability of future geologic hazard calculations can be seen in the following two tables, where the first table treats the landslides during Hurricane Irene each as unique events and the second table treats these landslides as one combined event.

There are presumably other smaller landslides and sinkholes that have occurred in the County that have not been reported to the NJGWS and are not included in these calculations. Sussex County will continue to experience the direct and indirect impacts of geological hazards and its impacts on occasion, with the secondary effects causing potential disruption or damage to communities. The table below shows the probability of future geologic events impacting the County, as based on data from the previous occurrences table in Appendix E (Risk Assessment Supplement).

Table 4.3.6-3. Probability of Future Occurrence of Geologic Events, Calculation One

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	Percent Chance of Occurring in Any Given Year
Debris Flows	32	0.46	2.2	0.45	45.1
Rockfalls	2	0.03	35.5	0.03	2.8
Rockslide	1	0.01	71.0	0.01	1.4
Slump	2	0.03	35.5	0.03	2.8
Sinkhole	1	0.01	71.0	0.01	1.4
Total	**38**	**0.54**	**1.9**	**0.54**	**53.5**

Source: NJDEP 2012; NOAA-NCEI 2020; NJ.Com 2015; NJ State HMP 2019

Note: The calculations in this table are based off each landslide during Hurricane Irene being treated as unique events. The most notable differences in calculations for this table are for the debris flows.

Table 4.3.6-4. Probability of Future Occurrence of Geologic Events, Calculation Two

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	Percent Chance of Occurring in Any Given Year
Debris Flows	13	0.19	5.5	0.18	18.3
Rockfalls	2	0.03	35.5	0.03	2.8
Rockslide	1	0.01	71.0	0.01	1.4
Slump	2	0.03	35.5	0.03	2.8
Sinkhole	1	0.01	71.0	0.01	1.4
Total	**19**	**0.27**	**3.7**	**0.27**	**26.8**

Source: NJDEP 2012; NOAA-NCEI 2020; NJ.Com 2015; NJ State HMP 2019

Note: The calculations in this table are based off all the landslides during Hurricane Irene being treated as a single event. The most notable differences in calculations for this table are for the debris flows.

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for the geologic hazard in the county is considered 'occasional' (between 10 and 100 percent annual probability of a hazard event occurring, as presented in Table 4.4-1). The ranking of the geologic hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which could increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors could increase the probability for landslide occurrences.

Landslides

Both northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12%) greater than the average from 1895-1970 (Office of New Jersey State Climatologist). Annual precipitation in New Jersey has been 8-percent above average during the last 10 years; and has experienced an upward trend of 4.1 inches in precipitation in 100-years (NJDEP 2019).

Climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Increase in global temperature could affect the snowpack and its ability to hold and store water. Warming temperatures also could increase the occurrence and duration of droughts, which would increase the probability of wildfire, reducing the vegetation that helps to support steep slopes. All of these factors would increase the probability for landslide occurrences.

Subsidence/Sinkholes

Similar to landslides, climate change will affect subsidence and sinkholes in New Jersey. As discussed throughout this profile, one of the triggers for subsidence and sinkholes is an abundance of moisture which has the potential to permeate the bedrock causing an event. Climatologists expect an increase in annual precipitation amounts. This increase will coincide with an increased risk in subsidence and sinkholes in vulnerable areas.

More recently, sinkholes have been correlated to land use practices, especially from groundwater pumping and from construction and development practices. Sinkholes may also form when the land surface is changed, such as when industrial and runoff-storage ponds are created. The substantial weight of the new material can trigger an underground collapse of supporting material, thus causing a sinkhole. Additionally, the overburden sediments that cover buried cavities in the aquifer systems are delicately balanced by groundwater fluid pressure. Groundwater is helping keep the surface soil in place. Pumping groundwater for urban water supply and for irrigation can produce new sinkholes in sinkhole-prone areas. If pumping results in a lowering of groundwater levels, then underground structural failure, sinkholes may occur as well (USGS 2020).

Vulnerability Assessment

As noted earlier, the Highland's Steep Stope Protection Area separates steep slopes into four classifications that are not only defined by percent of slope, but also by riparian areas, type of soils, and forestation (NJ Highlands Council 2020). Despite these various land attributes, any slopes above 15-percent fell into one of the four steep slope classifications. To evaluate the geological hazard, slopes above 15-percent were selected using the NJDEP contour lines. Additionally, the 2014 USGS carbonate rock layer was used to identify the geologic hazard area. The following text summarizes the potential impact of geological hazards on the County. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess geological hazard risk.

Impact on Life, Health, and Safety

Generally, a landslide or subsidence event is an isolated incidence and impacts the populations within the immediate area of the incident. Specifically, the population located downslope of the landslide hazard areas are particularly vulnerable. In addition to causing damages to residential buildings and displacing residents, landslides and subsidence events can block off or damage major roadways and inhibit travel for emergency responders or populations trying to evacuate the area.

Table 4.3.6-5 summarizes the population living on landscapes with carbonate bedrock. Table 4.3.6-6 summarizes the population living on landscapes with slopes greater than or equal to 15-percent. Overall, 40,124 persons and 18,920 persons are living on carbonate bedrock or landscapes with slopes greater than or equal to 15-percent, respectively. The Boroughs of Ogdensburg and Hamburg, and Township of Walpack have the greatest number of residents living on carbonate bedrock. The Townships of Vernon and Walpack have the greatest number of residents living on landscape slopes greater than or equal to 15-percent.

Table 4.3.6-5. Estimated Population Living on Landscape with Carbonate Rock

Jurisdiction	Total Population	Population Exposed to Carbonate Soils Hazard Area	
		Number of People	Percent of Total
Andover (B)	594	185	31.2%
Andover (Twp)	5,996	2,170	36.2%
Branchville (B)	896	341	38.1%
Byram (Twp)	8,010	469	5.9%
Frankford (Twp)	5,361	218	4.1%
Franklin (B)	4,807	3,605	75.0%
Fredon (Twp)	3,214	257	8.0%
Green (Twp)	3,495	2,564	73.3%
Hamburg (B)	3,152	2,660	84.4%
Hampton (Twp)	4,916	1,861	37.9%
Hardyston (Twp)	7,886	4,602	58.4%
Hopatcong (B)	14,362	0	0.0%
Lafayette (Twp)	2,390	1,405	58.8%
Montague (Twp)	3,716	1,894	51.0%
Newton (T)	7,895	5,279	66.9%
Ogdensburg (B)	2,314	1,721	74.4%
Sandyston (Twp)	1,925	466	24.2%
Sparta (Twp)	18,841	3,066	16.3%
Stanhope (B)	3,377	0	0.0%
Stillwater (Twp)	3,936	2,090	53.1%
Sussex (B)	1,854	0	0.0%
Vernon (Twp)	22,369	4,885	21.8%
Walpack (Twp)	6	5	81.8%
Wantage (Twp)	10,986	382	3.5%
Sussex County (Total)	**142,298**	**40,124**	**28.2%**

Source: American Community Survey 2018 5-Year Estimates; USGS – 2014
Note: B – Borough; T – Town; Twp – Township; % - Percent

Table 4.3.6-6. Estimated Population Living on Landscape with 15-Percent or Greater Slopes

Jurisdiction	Total Population	Population Exposed to Steep Slope (Greater Than 15-Percent) Hazard Area	
		Number of People	Percent of Total
Andover (B)	594	28	4.7%
Andover (Twp)	5,996	526	8.8%

Jurisdiction	Total Population	Population Exposed to Steep Slope (Greater Than 15-Percent) Hazard Area	
		Number of People	Percent of Total
Branchville (B)	896	37	4.1%
Byram (Twp)	8,010	1,398	17.5%
Frankford (Twp)	5,361	331	6.2%
Franklin (B)	4,807	420	8.7%
Fredon (Twp)	3,214	315	9.8%
Green (Twp)	3,495	322	9.2%
Hamburg (B)	3,152	334	10.6%
Hampton (Twp)	4,916	224	4.6%
Hardyston (Twp)	7,886	636	8.1%
Hopatcong (B)	14,362	1,408	9.8%
Lafayette (Twp)	2,390	202	8.5%
Montague (Twp)	3,716	167	4.5%
Newton (T)	7,895	387	4.9%
Ogdensburg (B)	2,314	199	8.6%
Sandyston (Twp)	1,925	385	20.0%
Sparta (Twp)	18,841	3,173	16.8%
Stanhope (B)	3,377	613	18.2%
Stillwater (Twp)	3,936	310	7.9%
Sussex (B)	1,854	131	7.1%
Vernon (Twp)	22,369	5,657	25.3%
Walpack (Twp)	6	2	27.3%
Wantage (Twp)	10,986	1,713	15.6%
Sussex County (Total)	**142,298**	**18,920**	**13.3%**

Source: American Community Survey 2018 5-Year Estimates; USGS 1999
Note: B – Borough; T - Town; Twp – Township; % - Percent

Research has also shown that some populations, while they may not have more hazard exposure, may experience exacerbated impacts and prolonged recovery if/when impacted. For example, persons over the age of 65 and people below the poverty level are most vulnerable to geologic hazards because of the potential limited access to mobilization or medical resources if a landslide or subsidence event occurs. According to the 2018 American Community Survey 5-Year Population Estimate, there are 22,889 persons over 65 years old and 7,191 persons living below the poverty level out of the total 142,298 persons that live in Sussex County. Higher concentrations of persons over 65 years in age reside in the Township of Walpack (i.e., 100-percent of total population) and higher concentrations of persons living below the poverty level reside in the Borough of Sussex (i.e., 16-percent of total population).

Impact on General Building Stock

In general, the built environment is vulnerable to the geologic hazard if built on soils/geology susceptible to land sliding or sink holes such as carbonate bedrock or slopes that are greater than 15-percent. Geologic hazard areas may destabilize the foundation of structures resulting in monetary losses to businesses and residents. There are 20,410 buildings with a replacement cost value of approximately $21 billion built on lands with carbonate bedrock. Furthermore, there are 9,101 buildings with a replacement cost value of approximately $4.3 billion built on lands with slopes greater than 15-percent. The Township of Vernon has the greatest number of buildings built on carbonate bedrock; 2,853 buildings (23.7-percent of its total building stock) with an estimated replacement cost of $2.1 billion. The Township of Vernon also has the greatest number of buildings built on landscapes with slopes greater than 15-percent; 2,925 buildings (24.3-percent of its total building stock) with an estimated replacement cost of $1.0 billion. Table 4.3.6-7 summarizes the number of buildings built on each geologic hazard area and the total replacement cost of these buildings by municipality.

Table 4.3.6-7. Number and Value of Buildings Built on Lands with Carbonate Bedrock and Steep Slope (>15-percent) by Municipality

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Carbonate Rock Hazard Area				Landslide - Steep Slope (Greater Than 15-Percent) Hazard Area			
			Number of Buildings	Percent of Total	Replacement Cost Value ($)	Percent of Total	Number of Buildings	Percent of Total	Replacement Cost Value ($)	Percent of Total
Andover (B)	328	628,463,030	113	34.5%	280,691,477	44.7%	14	4.3%	6,700,947	1.1%
Andover (Twp)	2,584	3,609,679,724	977	37.8%	944,612,676	26.2%	194	7.5%	89,880,361	2.5%
Branchville (B)	426	532,377,368	151	35.4%	164,220,678	30.8%	17	4.0%	70,514,303	13.2%
Byram (Twp)	3,676	2,746,550,446	241	6.6%	134,049,838	4.9%	603	16.4%	270,948,636	9.9%
Frankford (Twp)	3,537	3,129,888,305	173	4.9%	277,940,682	8.9%	221	6.2%	291,532,196	9.3%
Franklin (B)	2,061	1,921,211,856	1,574	76.4%	1,548,691,319	80.6%	166	8.1%	75,207,126	3.9%
Fredon (Twp)	1,615	1,372,050,934	128	7.9%	116,945,626	8.5%	151	9.3%	113,552,287	8.3%
Green (Twp)	1,698	1,598,635,804	1,265	74.5%	1,336,468,311	83.6%	146	8.6%	83,464,927	5.2%
Hamburg (B)	1,594	1,588,049,291	1,336	83.8%	1,301,386,122	81.9%	165	10.4%	121,533,854	7.7%
Hampton (Twp)	2,763	2,196,131,598	1,033	37.4%	682,894,556	31.1%	127	4.6%	79,371,471	3.6%
Hardyston (Twp)	4,403	3,183,033,542	2,577	58.5%	2,129,949,178	66.9%	350	7.9%	192,368,391	6.0%
Hopatcong (B)	8,040	2,888,571,676	0	0.0%	0	0.0%	794	9.9%	256,352,950	8.9%
Lafayette (Twp)	1,462	1,958,174,065	793	54.2%	829,384,510	42.4%	130	8.9%	133,486,764	6.8%
Montague (Twp)	2,175	1,459,611,020	1,113	51.2%	757,855,613	51.9%	93	4.3%	36,781,164	2.5%
Newton (T)	2,679	5,093,275,807	1,701	63.5%	1,949,256,805	38.3%	115	4.3%	81,410,916	1.6%
Ogdensburg (B)	992	819,879,629	755	76.1%	724,843,800	88.4%	89	9.0%	50,845,572	6.2%
Sandyston (Twp)	1,528	1,212,626,664	444	29.1%	419,749,258	34.6%	243	15.9%	120,669,734	10.0%
Sparta (Twp)	8,132	9,070,094,285	1,585	19.5%	3,887,789,926	42.9%	1,269	15.6%	583,093,689	6.4%
Stanhope (B)	1,557	1,051,183,581	0	0.0%	0	0.0%	267	17.1%	96,888,673	9.2%
Stillwater (Twp)	2,493	1,417,579,398	1,275	51.1%	751,289,915	53.0%	204	8.2%	110,706,157	7.8%
Sussex (B)	678	1,945,578,916	0	0.0%	0	0.0%	42	6.2%	38,283,996	2.0%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Carbonate Rock Hazard Area				Landslide - Steep Slope (Greater Than 15-Percent) Hazard Area			
			Number of Buildings	Percent of Total	Replacement Cost Value ($)	Percent of Total	Number of Buildings	Percent of Total	Replacement Cost Value ($)	Percent of Total
Vernon (Twp)	12,039	5,658,971,163	2,853	23.7%	2,059,570,999	36.4%	2,925	24.3%	1,033,072,351	18.3%
Walpack (Twp)	51	63,691,550	42	82.4%	48,293,650	75.8%	18	35.3%	8,861,768	13.9%
Wantage (Twp)	5,510	4,877,543,885	281	5.1%	685,129,146	14.0%	758	13.8%	400,957,731	8.2%
Sussex County (Total)	**72,021**	**60,022,853,539**	**20,410**	**28.3%**	**21,031,014,086**	**35.0%**	**9,101**	**12.6%**	**4,346,485,965**	**7.2%**

Source: Sussex County GIS 2020; RS Means 2020; USGS 2014; NJDEP 1999
Note: B – Borough; T - Town; Twp – Township; % - Percent

Impact on Critical Facilities and Lifelines

To estimate potential risk to critical facilities, the critical facility and lifeline inventory was overlaid upon the geologic hazard areas. There are 223 critical facilities built on lands with carbonate bedrock and 19 critical facilities built on landscapes with slopes greater than 15-percent. All of these critical facilities are considered lifelines. Refer to Table 4.3.6-8 which summarizes the number of critical facilities and lifelines exposed to the geologic hazard areas by municipality. Additionally, Table 4.3.6-9 and Table 4.5.6-10 summarize the distribution of critical facilities and lifelines exposed to the geologic hazard area by type. Overall, dams are the most common facility type exposed to both geologic hazards areas. Refer to Table 4.3.6-11 and Table 4.3.6-12 for the assets exposed to the geologic hazard areas categorized by the FEMA lifeline categories. Based on the exposure analysis, safety and security community lifelines are most at risk to impacts from the geologic hazards.

Table 4.3.6-8. Number of Critical Facilities and Lifelines Built on Land with Carbonate Bedrock and Steep Slopes (> 15-percent)

Jurisdiction	Total Critical Facilities and Lifelines Located in Jurisdiction	Carbonate Rock Hazard Area		Landslide Hazard Area - Steep Slope (Greater Than 15-Percent)	
		Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines	Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines
Andover (B)	12	3	25.0%	0	0.0%
Andover (Twp)	37	22	59.5%	1	2.7%
Branchville (B)	4	0	0.0%	0	0.0%
Byram (Twp)	37	4	10.8%	0	0.0%
Frankford (Twp)	23	6	26.1%	1	4.3%
Franklin (B)	10	9	90.0%	0	0.0%
Fredon (Twp)	17	0	0.0%	0	0.0%
Green (Twp)	21	20	95.2%	0	0.0%
Hamburg (B)	19	18	94.7%	3	15.8%
Hampton (Twp)	20	10	50.0%	1	5.0%
Hardyston (Twp)	27	8	29.6%	1	3.7%
Hopatcong (B)	22	0	0.0%	4	18.2%
Lafayette (Twp)	14	7	50.0%	0	0.0%
Montague (Twp)	32	18	56.3%	0	0.0%
Newton (T)	39	14	35.9%	1	2.6%
Ogdensburg (B)	7	5	71.4%	0	0.0%
Sandyston (Twp)	28	11	39.3%	0	0.0%
Sparta (Twp)	74	30	40.5%	0	0.0%
Stanhope (B)	7	0	0.0%	0	0.0%
Stillwater (Twp)	24	12	50.0%	0	0.0%
Sussex (B)	8	0	0.0%	0	0.0%
Vernon (Twp)	74	20	27.0%	3	4.1%

Jurisdiction	Total Critical Facilities and Lifelines Located in Jurisdiction	Carbonate Rock Hazard Area		Landslide Hazard Area - Steep Slope (Greater Than 15-Percent)	
		Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines	Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines
Walpack (Twp)	11	4	36.4%	1	9.1%
Wantage (Twp)	29	2	6.9%	3	10.3%
Sussex County (Total)	**596**	**223**	**37.4%**	**19**	**3.2%**

Source: Sussex County GIS 2020; FEMA 2020; USGS 2014; NJDEP 1999
Note: B – Borough; T - Town; Twp – Township; % - Percent

Table 4.3.6-9. Distribution of Critical Facilities by Type Built on Land with Carbonate Bedrock

Jurisdiction	Facility Types																						
	Airport	Communication Facility	Dam	DPW	Electrical Substation	EMS	EOC	Fire Station	Food Pantry	Fuel	Government Building	Hazardous Material	Police Station	Post Office	Potable Pump Station	Potable Water Treatment	Primary Education	Religious Center	Secondary Education	Senior Center	Shelter	Wastewater Pump	Well
Andover (B)	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
Andover (Twp)	1	3	7	1	0	1	1	3	0	0	0	0	1	0	0	0	1	0	0	2	1	0	0
Branchville (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Byram (Twp)	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
Frankford (Twp)	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	1	0	0	0	1	0	0
Franklin (B)	0	0	1	0	0	1	0	1	0	0	1	1	1	0	0	0	2	0	0	0	1	0	0
Fredon (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green (Twp)	0	0	3	1	0	1	1	1	0	0	1	2	0	2	0	0	4	2	1	0	1	0	0
Hamburg (B)	0	0	2	1	1	1	0	1	0	0	2	4	1	0	0	0	1	0	0	0	1	2	1
Hampton (Twp)	0	0	5	0	0	0	0	1	0	0	1	0	0	0	0	0	2	0	0	1	0	0	0
Hardyston (Twp)	0	0	0	1	0	1	0	1	0	0	1	1	1	0	0	0	2	0	0	0	0	0	0
Hopatcong (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lafayette (Twp)	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	2	0	0
Montague (Twp)	0	0	4	1	0	1	0	2	1	0	1	0	0	0	1	0	0	0	0	0	2	0	5
Newton (T)	0	0	0	1	1	1	0	1	0	0	0	1	0	0	1	0	4	0	0	0	0	4	0
Ogdensburg (B)	0	0	0	0	0	1	0	1	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0
Sandyston (Twp)	0	0	6	1	0	0	0	2	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0
Sparta (Twp)	0	0	7	2	1	1	1	0	1	0	1	4	1	0	2	0	4	0	0	0	1	3	1
Stanhope (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stillwater (Twp)	0	0	4	1	0	1	0	2	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0
Sussex (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vernon (Twp)	0	0	7	1	0	0	0	1	0	0	1	2	1	0	0	0	5	0	0	0	2	0	0
Walpack (Twp)	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Wantage (Twp)	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0

Jurisdiction	Facility Types																						
	Airport	Communication Facility	Dam	DPW	Electrical Substation	EMS	EOC	Fire Station	Food Pantry	Fuel	Government Building	Hazardous Material	Police Station	Post Office	Potable Pump Station	Potable Water Treatment	Primary Education	Religious Center	Secondary Education	Senior Center	Shelter	Wastewater Pump	Well
Sussex County (Total)	**1**	**3**	**51**	**13**	**3**	**11**	**5**	**20**	**3**	**1**	**13**	**17**	**7**	**3**	**4**	**1**	**29**	**2**	**1**	**3**	**15**	**10**	**7**

Source: Sussex County GIS 2020; USGS 2014
Notes: B = Borough, C = City, Twp = Township, T = Town, % - Percent

Table 4.3.6-10. Distribution of Critical Facilities by Type Built on Land with Steep Slopes (Greater Than 15-Percent)

Jurisdiction	Facility Types									
	Communication Facility	Correctional Facility	Dam	DPW	Potable Pump Station	Primary Education	Senior Center	Shelter	Wastewater Pump	Well
Andover (B)	0	0	0	0	0	0	0	0	0	0
Andover (Twp)	0	0	1	0	0	0	0	0	0	0
Branchville (B)	0	0	0	0	0	0	0	0	0	0
Byram (Twp)	0	0	0	0	0	0	0	0	0	0
Frankford (Twp)	0	0	0	1	0	0	0	0	0	0
Franklin (B)	0	0	0	0	0	0	0	0	0	0
Fredon (Twp)	0	0	0	0	0	0	0	0	0	0
Green (Twp)	0	0	0	0	0	0	0	0	0	0
Hamburg (B)	0	0	0	0	1	0	0	0	1	1
Hampton (Twp)	0	0	1	0	0	0	0	0	0	0
Hardyston (Twp)	0	0	1	0	0	0	0	0	0	0
Hopatcong (B)	0	0	1	0	0	1	1	1	0	0
Lafayette (Twp)	0	0	0	0	0	0	0	0	0	0
Montague (Twp)	0	0	0	0	0	0	0	0	0	0
Newton (T)	0	1	0	0	0	0	0	0	0	0

Jurisdiction	Facility Types									
	Communication Facility	Correctional Facility	Dam	DPW	Potable Pump Station	Primary Education	Senior Center	Shelter	Wastewater Pump	Well
Ogdensburg (B)	0	0	0	0	0	0	0	0	0	0
Sandyston (Twp)	0	0	0	0	0	0	0	0	0	0
Sparta (Twp)	0	0	0	0	0	0	0	0	0	0
Stanhope (B)	0	0	0	0	0	0	0	0	0	0
Stillwater (Twp)	0	0	0	0	0	0	0	0	0	0
Sussex (B)	0	0	0	0	0	0	0	0	0	0
Vernon (Twp)	0	0	3	0	0	0	0	0	0	0
Walpack (Twp)	0	0	1	0	0	0	0	0	0	0
Wantage (Twp)	1	0	2	0	0	0	0	0	0	0
Sussex County (Total)	**1**	**1**	**10**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Source: Sussex County GIS 2020; NJDEP 1999
Notes: B = Borough, C = City, Twp = Township, T = Town, % = Percent
Note: Asset types that are not listed in the tables were not exposed to the flood hazard.

Table 4.3.6-11. Number of Lifelines Located on Carbonate Rock

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Exposed to the Carbonate Rock Hazard Area
Communications	9	3
Energy	12	4
Food, Water, Shelter	75	39
Hazardous Materials	20	17
Health and Medical	15	4
Safety and Security	463	155
Transportation	2	1
Sussex County (Total)	**596**	**223**

Source: Sussex County GIS 2020; FEMA 2020; USGS 2014

Table 4.3.6-12. Number of Lifelines Built on Steep Slopes (>15-percent)

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Exposed to the Landslide - Steep Slope (Greater Than 15-Percent) Hazard Area
Communications	9	1
Energy	12	0
Food, Water, Shelter	75	4
Hazardous Materials	20	0
Health and Medical	15	1
Safety and Security	463	13
Transportation	2	0
Sussex County (Total)	**596**	**19**

Source: Sussex County GIS 2020; FEMA 2020; USGS 2014

In addition to critical facilities, a significant amount of infrastructure can be exposed to mass movements of geological material:

- *Roads*—Access to major roads is crucial to life-safety after a disaster event and to response and recovery operations. Landslides can block egress and ingress on roads, causing isolation for neighborhoods, traffic problems, and delays for public and private transportation. This can result in economic losses for businesses.
- *Bridges*—Landslides can significantly impact road bridges. Mass movements can knock out bridge abutments or significantly weaken the soil supporting them, making them hazardous for use.
- *Power Lines*—Power lines are generally elevated above steep slopes; but the towers supporting them can be subject to landslides. A landslide could trigger failure of the soil underneath a tower, causing it to collapse and ripping down the lines. Power and communication failures due to landslides can create problems for vulnerable populations and businesses.
- *Rail Lines*—Similar to roads, rail lines are important for response and recovery operations after a disaster. Landslides can block travel along the rail lines, which would become especially troublesome, because it would not be as easy to detour a rail line as it is on a local road or highway. Many residents rely on public transport to get to work around the County and into New York City, and a landslide event could prevent travel to and from work.

Several other types of infrastructure may also be exposed to the geologic hazards, including water and sewer infrastructure. The miles of roads exposed to landslide and carbonate hazard areas are summarized in Table 4.3.6-13. Out of the 1,771 miles of roads in the County, 389 miles are built on steep slopes (>15%) and 862 miles are located on carbonate rock.

Table 4.3.6-13. Major Transportation Routes Exposed to Steep Slope and Carbonate Hazard Areas

Road Type	Total Miles for County	Landslide - Steep Slope (Greater Than 15-Percent) Hazard Area		Carbonate Rock Hazard Area	
		Miles	Percent of Total	Miles	Percent of Total
Local and Private Roads	1,337	228	17.1%	471	35.2%
County Roads	313	154	49.2%	353	112.8%
State Routes	86	6	6.5%	28	32.9%
US Highways	34	1	3.5%	9	26.8%
Interstate	1	<1	<.1%	<1	<0.1%
County Total	**1,771**	**389**	**22.0%**	**862**	**48.7%**

Source: Sussex County GIS 2020; USGS 2014; NJDEP 1999; NJDOT 2017
Note: % - Percent

Impact on the Economy

Geologic hazards can impose direct and indirect impacts on society. Direct costs include the actual damage sustained by buildings, property, and infrastructure due to ground failure, which also threatens transportation corridors, fuel and energy conduits, and communication lines (USGS 2020). Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity may also occur, but are difficult to measure. Buildings susceptible to landslide events were summarized earlier in this section. Losses to these structures will impact the local tax base and economy.

Impact on the Environment

Steep slopes within the Highlands Region play an important ecological, recreational, scenic, and functional role. They provide specialized habitats for rare plant and animal species. Areas of steep slope provide recreational opportunities and contribute to the rural character of the Highlands Region and Sussex County. Disturbance of areas containing steep slopes can trigger erosion and sedimentation, resulting in the loss of topsoil. Silting of wetlands, lakes, ponds, and streams damages and degrades wetland and aquatic habitats that are found throughout the region and receive the State's highest water quality protections. Steep slope disturbance can also result in the loss of habitat quality, degradation of surface water quality, silting of wetlands, and alteration of drainage patterns (NJ Highlands Council 2012).

Future Changes That May Impact Vulnerability

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

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

Projected Development

Any areas of growth could be potentially impacted by the geologic hazard if located within the identified hazard areas or downslope. In general, development of slopes is not recommended due to the increased risk of erosion, stormwater runoff and flooding potential. The additional runoff results in sedimentation of down slope surface waters, which damages habitat and has the potential to damage property. The Highlands Council has template ordinances available to define Steep Slope Protection Areas and protect from their disturbance. In addition, there are recommendations for site design for permitted disturbances to minimize impacts.

A spatial analysis was conducted to determine the intersection of potential new development with steep slopes and carbonate soil. The exposure analysis shows that six new developments will be built in steep slope hazard area and 27 new developments will be built in the carbonate soil hazard area: refer to Figure 4.3.6-7 and Figure 4.3.6-7

Projected Changes in Population

Sussex County has experienced population decline since 2010. According to the U.S. Census Bureau, the County's population has decreased 4.7-percent between 2010 and 2018 (U.S. Census Bureau 2020). The population is expected to continue to decrease as residents move away from the suburbs and towards urban centers (Stirling 2018). Even though the population has decreased over the past decade, any changes in the density of population can impact the number of persons exposed to geologic hazard areas. Changes in density can not only create issues for local residents during evacuation of a landslide or ground failure event, but can also have an effect on commuters that travel into and out of the County for work, particularly during a geologic event that breaches major transportation corridors, which are also major commuter roads.

Climate Change

A direct impact of climate change on landslides is difficult to determine. Multiple secondary effects of climate change have the potential to increase the likelihood of landslides. Warming temperatures resulting in wildfires would reduce vegetative cover along steep slopes and destabilize the soils due to destruction of the root system; increased intensity of rainfall events would increase saturation of soils on steep slopes. Under these future conditions, the County's assets located on or at the base of these steep slopes will have an increased risk to landslides. Roadways and other transportation infrastructure located in these areas will also be at an increased risk of closure, which would impact the County's risk as described above.

Higher temperatures and the possibility of more intense, less frequent summer rainfall may lead to changes in water resource availability. Increase in average temperatures may lead to an increase in the frequency of droughts. Sinkhole activity intensifies in some karst areas during periods of drought. With an increase in drought periods, the number of sinkholes could increase. Additionally, changes to the water balance of an area including over-withdrawal of groundwater, diverting surface water from a large area and concentrating it in a single point, artificially creating ponds of surface water, and drilling new water wells will cause sinkholes. These actions can also serve to accelerate the natural processes of bedrock degradation, which can have a direct impact on sinkhole creation.

Vulnerability Changes Since the 2016 HMP

This updated HMP has utilized updated building stock and critical asset inventories to assess the County's risk to the geologic hazard areas. The building inventory was updated using RS Means 2020 values, which is more current and reflects replacement cost versus the building stock improvement values reported in the 2016 HMP. Further, the 2018 5-year population estimates from the American Community Survey were used to evaluate the population exposed to the dam inundation areas. Additionally, the 2014 carbonate rock layer from USGS and the 1999 digitized contours from NJDEP were referenced to assess the County's assets to the geologic hazard. Overall, signification increase in vulnerability would be attributed to changes in population density, impacts from storm events, and new development.

Figure 4.3.6-6 Carbonate Rock and New Development in Sussex County

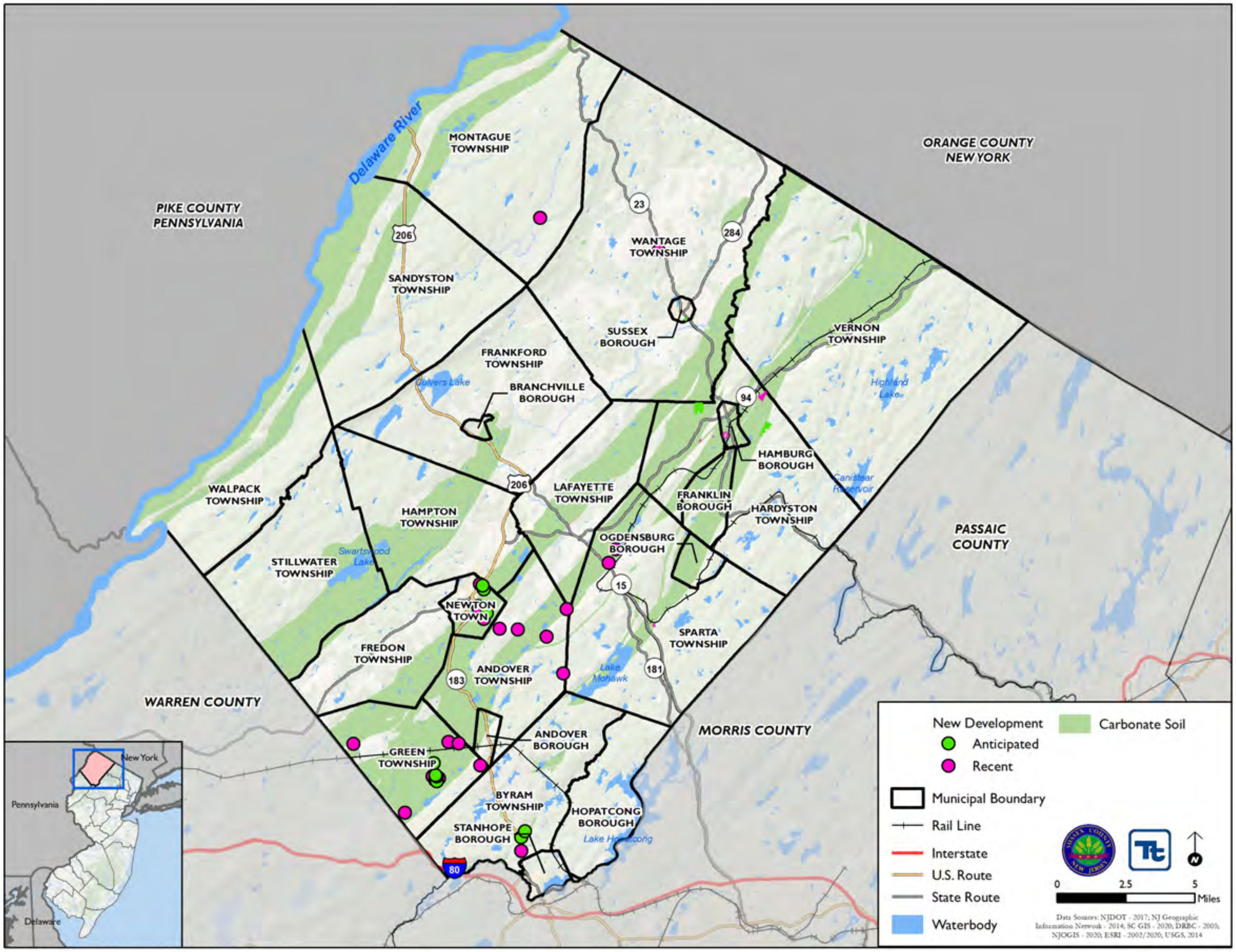
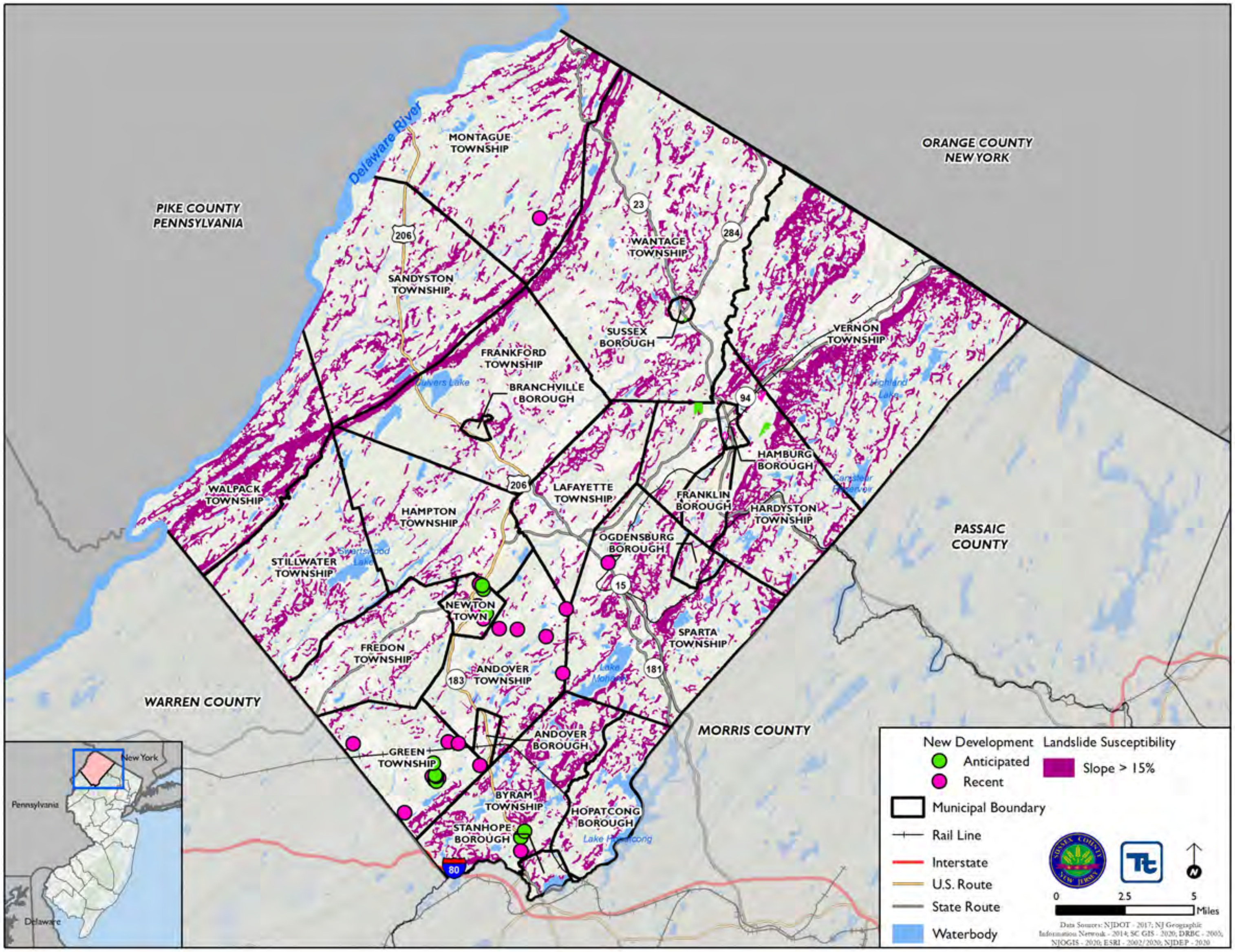


Figure 4.3.6-7 Steep Slope and New Development in Sussex County



4.3.7 HAZARDOUS MATERIALS RELEASE

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 hazardous materials hazard in Sussex County.

2021 HMP Changes

- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2015 and 2020.
- A vulnerability assessment was conducted for the hazardous materials hazard and it now directly follows the hazard profile.

Profile

Hazard Description

Hazardous substances are materials that are considered severely harmful to human health and the environment, as defined by the United States Environmental Protection Agency (USEPA) Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) (Superfund Law). Many are commonly used substances which are harmless in their normal uses but are quite dangerous if released. The Superfund law designates more than 800 substances as hazardous and identifies many more as potentially hazardous due to their characteristics and the circumstances of their release (USEPA 2013). Superfund's definition of a hazardous substance includes the following:

- Any element, compound, mixture, solution, or substance designated as hazardous under section 102 of CERCLA.
- Any hazardous substance designated under section 311(b)(2)(a) of the Clean Water Act (CWA), or any toxic pollutant listed under section 307(a) of the CWA. There are over 400 substances designated as either hazardous or toxic under the CWA.
- Any hazardous waste having the characteristics identified or listed under section 3001 of the Resource Conservation and Recovery Act.
- Any hazardous air pollutant listed under section 112 of the Clean Air Act, as amended. There are over 200 substances listed as hazardous air pollutants under the Clean Air Act (CAA).
- Any imminently hazardous chemical substance or mixture which the EPA Administrator has "taken action under" section 7 of the Toxic Substances Control Act (USEPA 2013).

If released or misused, hazardous substances can cause death, serious injury, long-lasting health effects, and damage to structures and other properties, as well as the environment. Many products containing hazardous substances are used and stored in homes and these products are shipped daily on highways, railroads, waterways, and pipelines.

Transportation of hazardous substances on highways involves tanker trucks or trailers, which are responsible for the greatest number of hazard substance release incidents. New Jersey is composed of approximately 39,000 miles of highway, many of which are used to transport hazardous substances (New Jersey Department of Transportation [NJDOT] 2019). These roads cross rivers and streams at many points; hazardous substance spills on roads have the potential to pollute watersheds that serve as domestic water supplies for parts of the State. Potential also exists for hazardous substance releases to occur along rail lines as collisions and derailments of train cars can result in large spills.

Additionally, oil is shipped by rail throughout New Jersey. The adoption of hydraulic fracturing ("fracking") to extract oil and gas has led to an increase in the production and shipment of energy products. Lack of pipelines connecting the energy-producing regions with refineries or ports, coupled with the flexibility that railroad transportation provides, have resulted in significant shipments of oil by rail. Major commodities shipped by rail include petrochemicals (including plastic pellets and crude oil), construction materials, food products, raw materials and finished goods for manufacturers (NJ DOT 2018).

Pipelines can also transport hazardous liquids and flammable substances such as natural gas and petroleum. Incidents can occur when pipes corrode, when they are damaged during excavation, incorrectly operated, or damaged by other forces. In New Jersey, most of the large pipeline leaks have been caused by marine traffic hitting or the anchors of ships effecting pipelines in the waterways. In addition, hazardous substances can be transported by aircraft or by watercraft. Crashes, spills of materials, and fires on these vessels can pose a hazard.

Nuclear incidents can also be considered a form of environmental hazard. Nuclear incidents generally refer to incidents involving (1) release of significant levels of radioactive materials or (2) exposure of workers or the general public to radiation. Primary concerns following a nuclear incident or accident are: impact on public health from direct exposure to a radioactive plume; inhalation of radioactive materials; ingestion of contaminated food, water, and milk; and long-term exposure to deposited radioactive materials in the environment that may lead to either acute (radiation sickness or death) or chronic (cancer) health effects.

The Sussex County Hazardous Materials (HAZMAT) Team was developed to support the County in the response of any HAZMAT or Chemical, Biological, Radiological, Nuclear, and Explosives (CBRNE) incident. The team is comprised of approximately 20 full-time County employees who have completed the Hazardous Materials Technician course and is a collaborative effort between the County's Sheriff's Office, Office of the Prosecutor, Division of Public Works, and Department of Environmental and Public Health Services. It has also been recognized by the New Jersey Department of Environmental Protection as a Model Program for HAZMAT response (Sussex County 2015).

Location

The following provides information regarding the location of hazardous substance incidents.

Hazardous Substances Fixed Site

Hazardous materials come in the form of explosives, flammable and combustible substances, poisons, and radioactive materials. These types of substances are most often released as a result of transportation accidents or a chemical spill at a facility. Many products containing hazardous materials are also used and stored in homes.

In response to concerns regarding health and environmental risks, Congress established the Superfund program in 1980 to clean up these sites. The Superfund program is administered by the USEPA in cooperation with individual states. In New Jersey, the Department of Environmental Protection (NJDEP) Site Remediation Program oversees the Superfund program (NJDEP 2013).

Federal regulations include the CERCLA and the Superfund Amendments and Reauthorization Act (SARA) required that a National Priorities List (NPL) of sites throughout the United States be maintained and revised at least annually (NJDEP 2013).

Fixed-site facilities that use, manufacture, or store hazardous substances in New Jersey pose risk and must comply with Title III of the federal SARA. SARA was signed into law on October 17, 1986. It is a federal law that applies nationwide. It must be realized that this law is linked to N.J.S.A. 34:5A, the New Jersey Worker and Community Right to Know Act. SARA requires the governor of each state to establish a State Emergency

Response Commission (SERC). New Jersey's SERC was established by Executive Order on February 13, 1987. SARA also requires that the emergency planning districts be established by the SERC. The Act specified that these districts can be existing political subdivisions. The function of the emergency planning district is to facilitate preparation and implementation of emergency plans. In New Jersey, all municipalities and counties have been designated emergency planning districts (total of 588). The Local Emergency Planning Committees (LEPC) is the policy body for the emergency planning district (New Jersey Division of Fire Safety 2011).

The State enacted the Toxic Catastrophe Prevention Act (TCPA), N.J.S.A. 13:1K-19 et seq. Currently, implementation of the requirements established under this Act is facilitated by the TCPA Program. Certain industrial facilities using materials considered extraordinarily hazardous must take steps to prevent releases and protect public safety. New Jersey has also mandated that facilities storing large quantities of hazardous substances take preventative measures to reduce the likelihood of a leak or discharge. Established under the New Jersey Spill Compensation and Control Act (N.J.S.A. 58:10-23.11), these requirements include testing and inspection of storage tanks, training of employees, and emergency response planning. The Discharge Prevention Containment and Countermeasure (DPCC) program facilitates implementation of these requirements. Regulations related to reporting of chemical and petroleum discharges are also administered under this program. The Program is sometimes referred to by the acronym DPCC, which refers to an important preparedness document that major facilities develop under the program (NJDEP 2018).

The Community Right to Know (CRTK) program collects, processes, and disseminates the chemical inventory, environmental release and materials accounting data required to be reported under the New Jersey Worker and Community Right to Know Act, N.J.S.A.34:5A and the federal Emergency Planning and Community Right to Know Act of 1986 (EPCRA). EPCRA is also known as Title III of the SARA. This information is used by the public, emergency planners, and first responders to determine the chemical hazards in the community (NJDEP 2012).

The U.S. EPA Hazardous Waste Report, which is a biennial report, collects data on the generation, management, and minimization of hazardous waste. This report provides detailed data on the generation of hazardous waste from large quantity generators and data on waste management practices from treatment, storage, and disposal facilities. This report lists 27 facilities in Sussex County (U.S. EPA 2019).

Superfund is a program administered by the U.S. EPA to locate, investigate, and cleanup the worst hazardous waste sites throughout the U.S. Data from the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS) database indicated that Sussex County has three Superfund sites located in Sparta Township, Byram, and Franklin Borough (U.S. EPA 2020).

New Jersey employers, whose businesses are assigned North American Industry Classification System (NAICS) codes listed in the New Jersey Worker and Community Right to Know (CRTK) regulations, are required to submit CRTK surveys listing the environmental hazardous substances (EHSs) present at their facilities in quantities that exceed 500 pounds, unless the EHS is on the federal Emergency Planning and Community Right to Know Act (EPCRA) Section 302 list of extremely hazardous substances with a lower reporting threshold. In addition, Section 312 of EPCRA requires owners and operators of federal facilities and private sector facilities that are subject to the United States Occupational Safety and Health Administration's (OSHA) Hazard Communication Standard to report their inventories of any chemical that requires a Materials Safety Data Sheet (MSDS) and is present on site in quantities that exceed 10,000 pounds, unless the chemical is an Extremely Hazardous Substance with a lower reporting threshold (NJDEP 2014).

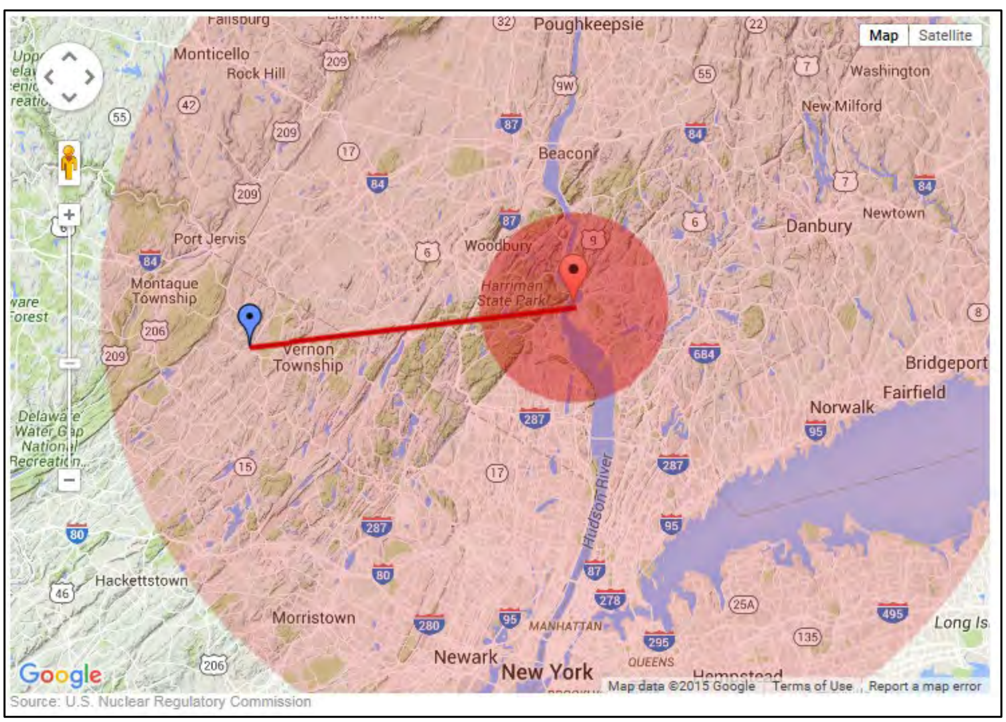
Owners and operators of manufacturing, and select non-manufacturing companies, having the equivalent of 10 or more full-time employees, and manufacturing, importing, processing or otherwise using toxic chemicals listed on the EPCRA Section 313 (TRI) list in quantities that exceed specified thresholds, are required to annually report their releases of these chemicals for the previous year. Approximately 500 New Jersey companies are required to file federal Toxic Chemical Release Inventory (TRI) forms. TRI Form R requires the listing of environmental releases, on-site waste management and off-site transfers while the simplified Form A Certification Statement requires the listing of the chemical only. These companies are also required to submit to NJDEP the Release and Pollution Prevention Report (RPPR) listing the quantities of environmental release, on-site waste management, waste transfer, and chemical throughput information. Most of these facilities are also subject to Pollution Prevention Planning Requirements and, therefore, required to report pollution prevention progress information on the RPPR (NJDEP 2014).

Nuclear Facilities

Although there are no nuclear facilities within Sussex County limits, the County is within 50 miles of Indian Point Energy Center. Indian Point Energy Center is located in Buchanan, New York, and provides about 25 percent of New York City and Westchester County New York's power (Safe.Secure.Vital 2015).

In nuclear preparedness planning, the 10 mile and 50 mile radiuses around nuclear facilities are important location boundaries. The Nuclear Regulatory Commission encourages the use of Probabilistic Risk Assessments (PRA) to estimate quantitatively the potential risk to public health and safety considering the design, operations, and maintenance practices at nuclear power plants. Preparedness plans typically consider the Plume Exposure Pathway Emergency Planning Zone (EPZ), which has a radius of 10 miles from the facility, and the Ingestion Exposure Pathway (IEP), which has a radius of 50 miles from each facility. Sussex County is located within the 50-mile IEP. Should an accident occur at the Indian Point Energy Center, the area within the IEP could receive some radioactive contamination. Figure 4.3.7-1 displays where Sussex County falls in Indian Point Energy Center's EPZ and IEP.

Figure 4.3.7-1. Indian Point Energy Center's EPZ and IEP



Source: CNN 2015
Note: The red marker indicates the nuclear facility and the blue marker indicates a location in Sussex, NJ.

Hazardous Substances In-Transit

Incidents involving hazardous substances in transit can occur anywhere in Sussex County. Major highways in the Cunty over which hazardous materials are transported daily include U.S. Route 206 and State Highway 15. A very small portion of Interstate 80 runs through and near the southern portion of the County, and U.S. Route 209 runs parallel and close to the northwestern border of Sussex County although it does not enter County limits. While Sussex County does not offer passenger service, it does maintain freight rail. This freight rail is operated by regional and short line railroads. The rail lines move between 100,001 and 300,000 tons of inbound rail freight and less than 10,000 tons of outbound rail freight (New Jersey Rail System 2012).

Hazardous substances can also be transported via pipeline across the State. New Jersey has an extensive network of natural gas and petroleum pipelines. Several of the petroleum pipelines originate in the Gulf Coast region (Colonial Pipeline and Buckeye Pipeline). Figure 4.3.7-2 shows the extent and locations of pipelines throughout the northeastern United States.

Extent

The extent of a hazardous substance release will depend on whether it is from a fixed or mobile source, the size of impact, the toxicity and properties of the substance, duration of the release, and the environmental conditions (for example, wind and precipitation, terrain, etc.).

Hazardous substance releases can contaminate air, water, and soils, possibly resulting in death and/or injuries. Dispersion can take place rapidly when the hazardous substance is transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. Hazardous substances can include toxic chemicals, radioactive substances, infectious substances, and hazardous wastes. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas.

With a hazardous substance release, whether accidental or intentional, several potentially exacerbating or mitigating circumstances will affect its severity or impact. Mitigating conditions are precautionary measures taken in advance to reduce the impact of a release on the surrounding environment. Primary and secondary containment or shielding by sheltering-in-place measures protects people and property from the harmful effects of a hazardous substance release. Exacerbating conditions, characteristics that can enhance or magnify the effects of a hazardous substance release, include:

- Weather conditions, which affect how the hazard occurs and develops
- Micro-meteorological effects of buildings and terrain, which alters dispersion of hazardous substances on-compliance with applicable codes (such as building or fire codes)
- Maintenance failures (such as fire protection and containment features), which can substantially increase the damage to the facility itself and to surrounding buildings

As discussed earlier, the severity of the incident is dependent not only on the circumstances described above, but also with the type of substance released and the distance and related response time for emergency response teams. The areas proximate to the releases are generally at greatest risk; however, depending on the agent, a release can travel great distances or remain present in the environment for a long period of time (i.e. centuries to millennia).

Figure 4.3.7-2. Major Transportation in Sussex County

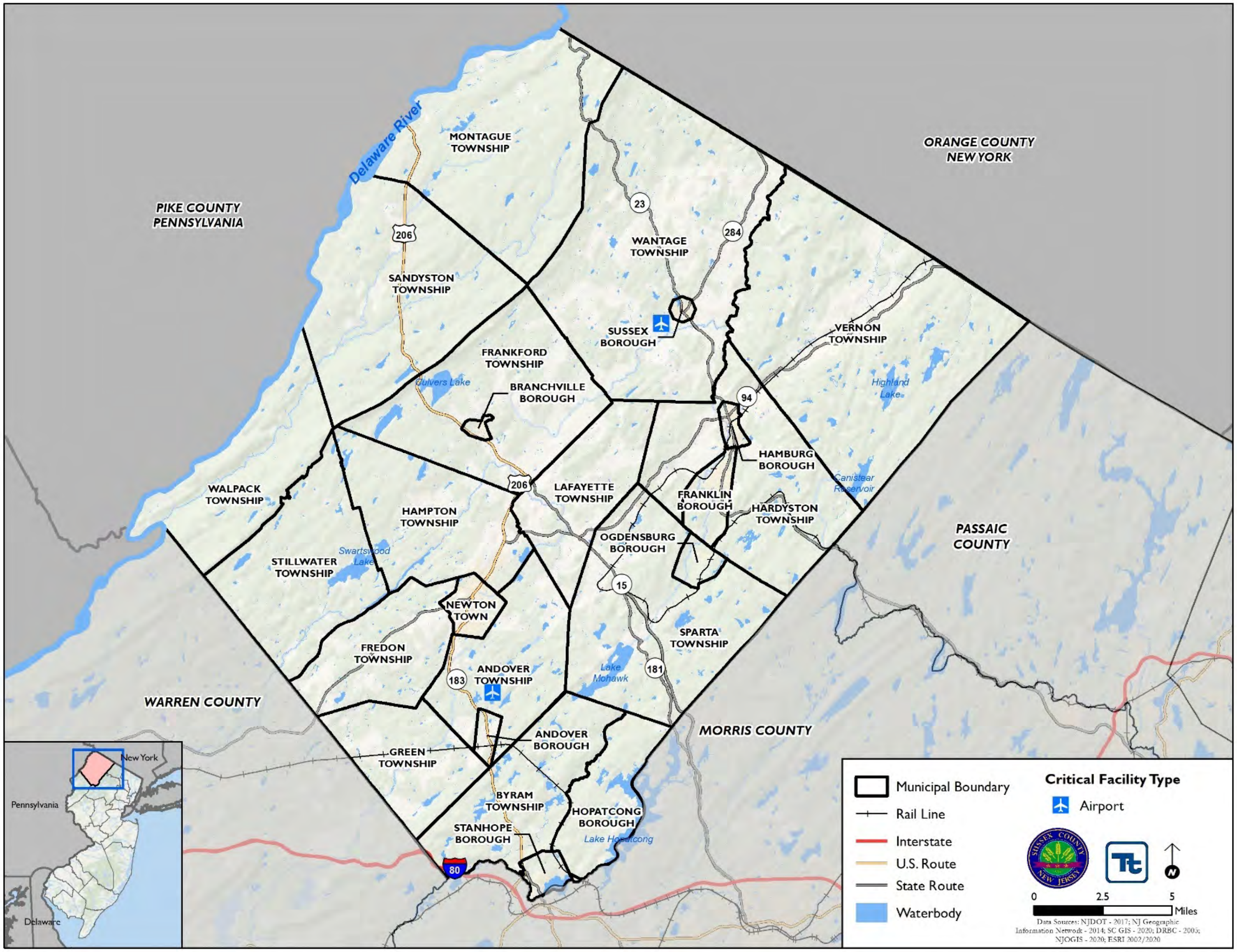
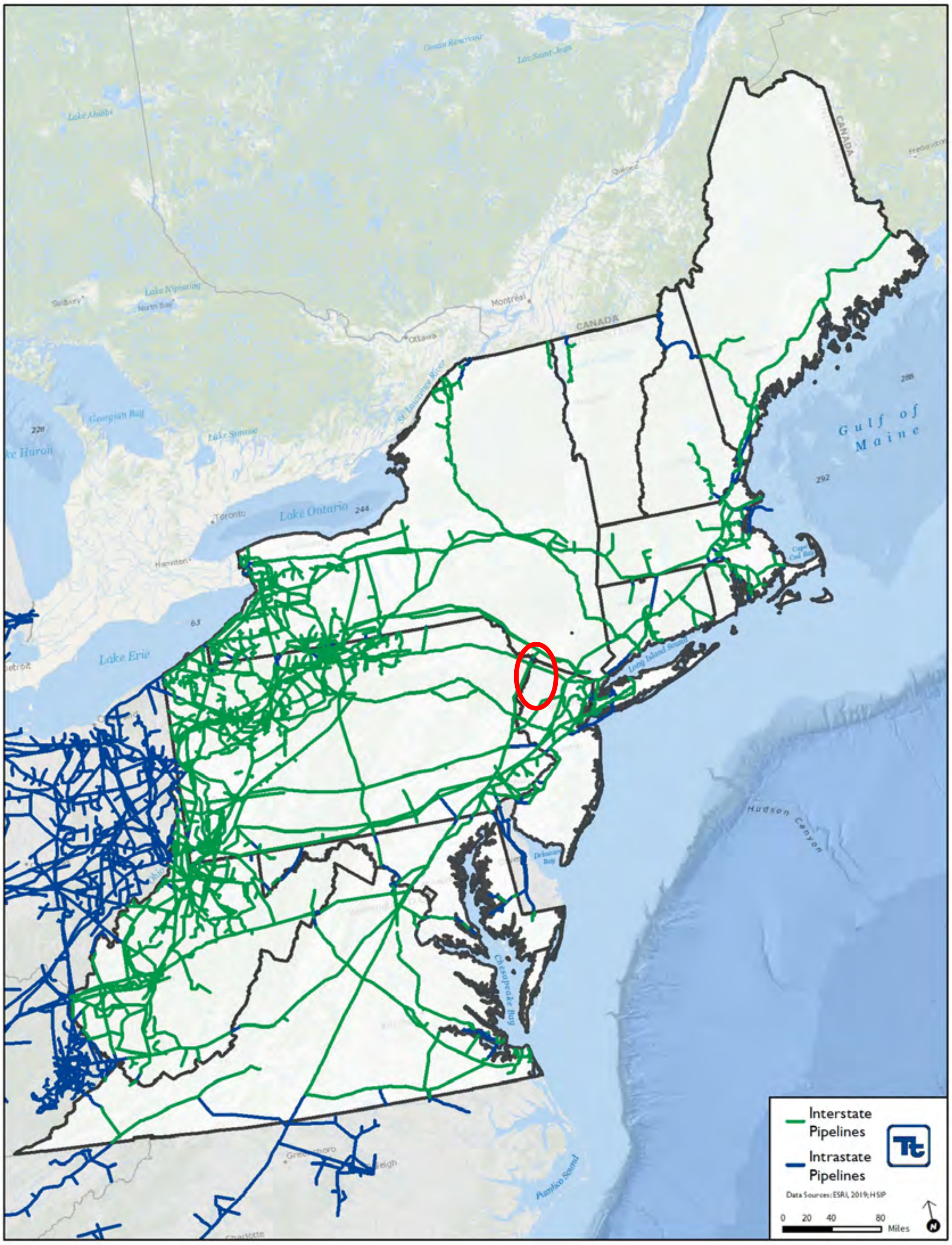


Figure 4.3.7-3. Interstate Natural Gas Pipelines in the Northeast



Source: NJDOT, n.d.

Note: The approximate location of Sussex County is indicated by the red circle.

Figure 4.3.7-4. Hazardous Material Sites with One Mile Buffer in Sussex County

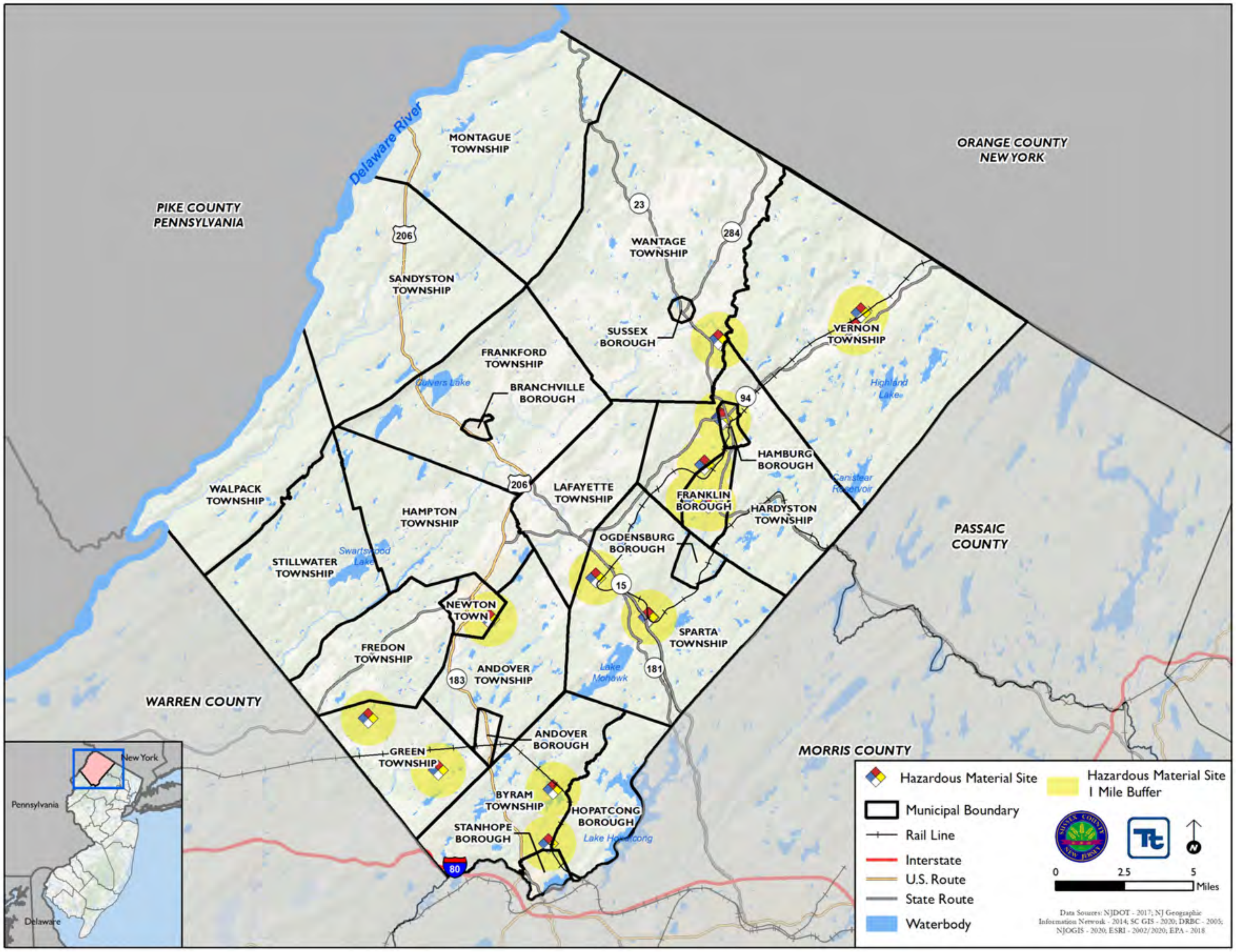


Figure 4.3.7-5 Railways with One Mile Buffer in Sussex County

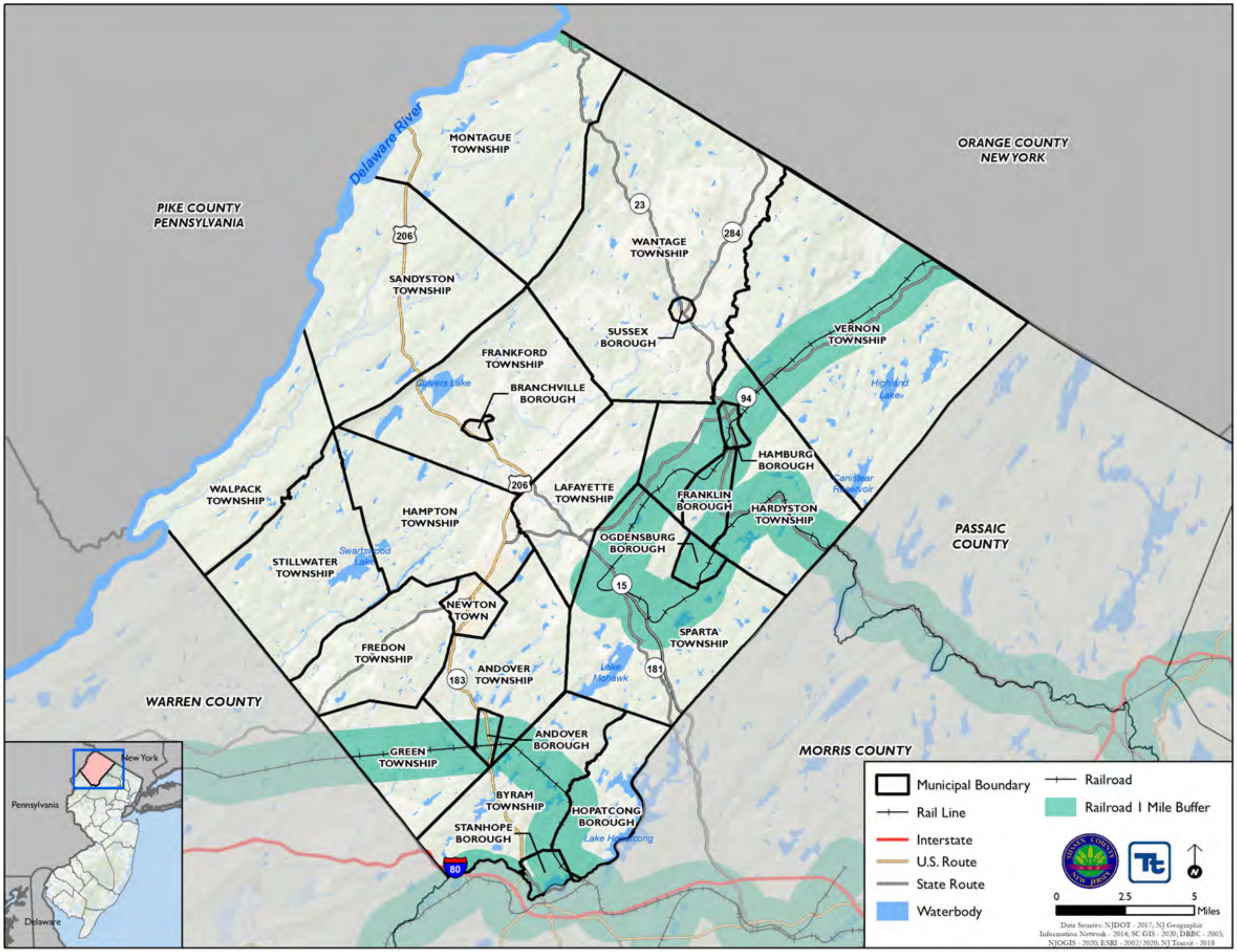
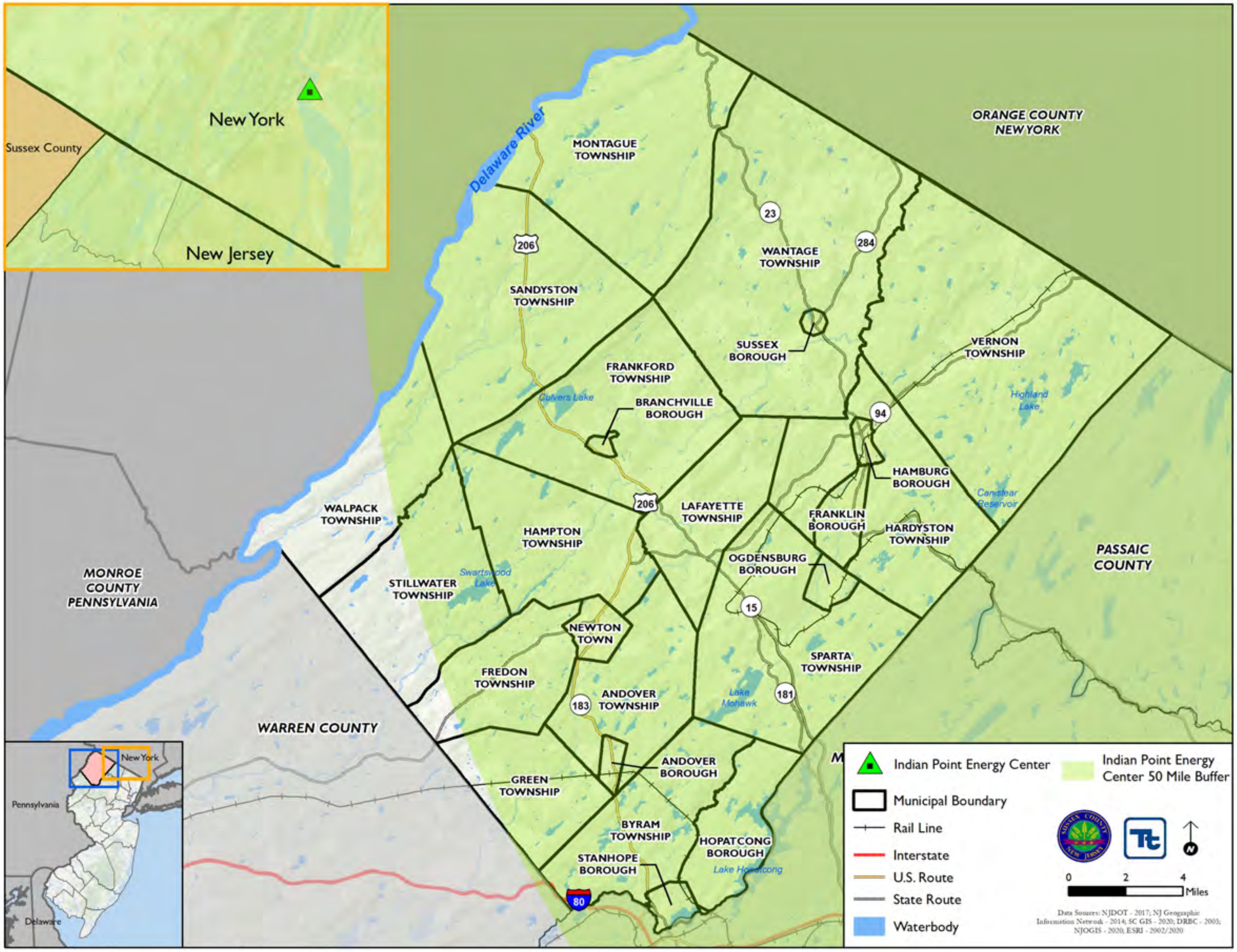


Figure 4.3.7-6 Indian Point Energy Center with Fifty Mile Buffer



Previous Occurrences and Losses

For the 2020 HMP update, known hazardous substances incidents that have impacted Sussex County between 2015 and 2020 are identified in 4.3.7-1. Refer to Section (Jurisdictional Annex) 9 for detailed information regarding impacts and losses to each municipality, where available.

FEMA Disaster Declarations

Between 1954 and 2020, the State of New Jersey was not included in any FEMA declared disasters (DR) or emergencies (EM) related to hazardous substances incidents (FEMA 20).

USDA Disaster Declarations

Agriculture-related disasters are quite common. The USDA Secretary of Agriculture 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. From 2015 to 2020, Sussex County was not included in any agriculture-related disasters (USDA 2020).

Table 4.3.7-1. Hazardous Substances Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Description
2015	Chemical Release	N/A	N/A	In 2015, 11,374 pounds of chemicals were released on-site in Sussex County.
2015	Accidents involving hazardous materials	N/A	N/A	In 2015, Sussex County experienced 1 rail accident involving hazardous materials.
2016	Chemical Release	N/A	N/A	In 2016, 10,578 pounds of chemicals were released on-site in Sussex County.
2017	Chemical Release	N/A	N/A	In 2017, 8,853 pounds of chemicals were released on-site in Sussex County.
2018	Chemical Release	N/A	N/A	In 2018, 6,155 pounds of chemicals were released on-site in Sussex County.
2019	Chemical Release	N/A	N/A	In 2019, 261 pounds of chemicals were released on-site in Sussex County.

Source: NJ HMP 2019; EPA TRI Explorer 2020
With hazardous substances incidents for New Jersey and Sussex County being so extensive, not all sources have been identified or researched. Therefore, not all events that have occurred in the County may be included.

Probability of Future Occurrences

Predicting future hazardous substance incidents in Sussex County is difficult. They can occur at anytime and anywhere in the county. Incidents can be sudden without any warning or slowly develop. Small spills, both fixed site and in-transit, occur throughout the year and the probability for these events are high. The risk of major incidents in a given year is rare. It is estimated that the county will continue to experience direct and indirect impacts of hazardous substance incidents annually that may induce secondary hazards such as infrastructure deterioration or failure, water quality and supply concerns, and transportation delays, accidents and inconveniences.

According to the 2011 HMP, the Right-to-Know Network database, and the Pipeline and Hazardous Materials Safety Administration (PHMSA), Sussex County experienced 96 hazardous material incidents (fixed site and in-transit) between 1950 and 2015. Please note that only readily available data was used for the calculations and not all events may have been included. Based on the number of occurrences, the county has a 145.45 percent chance of a hazardous material incident (fixed site or in-transit) of occurring in any given year. The table below shows these statistics, as well as the annual average number of events and the percent chance of these incidents occurring in Sussex County in future years (Sussex County HMP 2011; Right-to-Know Network 2016; PHMSA 2016).

Table 4.3.7-2. Probability of Future Hazardous Materials Incidents

Hazard Type	Number of Occurrences Between 1950 and 2015	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Hazardous Materials (fixed site)	54	0.83	1.2	0.82	81.8%
Hazardous Materials (in-transit)	42	0.65	1.6	0.64	63.6%

Source: Sussex County HMP 2011; Right-to-Know Network 2016; PHMSA 2016

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for the hazardous substances hazard in the county is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the hazardous substances hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Hazardous substance incidents are non-natural incidents; however, their release may be the result from natural hazard events. As noted in the risk assessment, climate change may potentially increase the frequency and magnitude of flood and severe weather events which may lead to an increased release of hazardous substances at both fixed sites and in-transit. Secondary impacts, such as excessive heat on containers may occur, but also can occur during normal fluctuations in temperature.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. Sussex County's vulnerability to the hazardous materials hazard was evaluated by conducting an exposure analysis of the County's assets (i.e., population, buildings, critical facilities, and new development) built within a 1-mile buffer of identified hazardous material facilities, within 1 mile of all railways, and within 50 miles of the Indian Point Energy Center.

Impact on Life, Health and Safety

Depending on the type and quantity of chemicals released and the weather conditions, an incident can affect larger areas that cross jurisdictional boundaries. When hazardous substances are released in the air, water or on land they may contaminate the environment and pose greater danger to human health. Exposure may be either acute or chronic, depending upon the nature of the substance and extent of release and contamination.

Due to the varied location of different hazardous substances and waste sites in Sussex County, the entire County is considered vulnerable to this hazard. Those particularly vulnerable include populations located along railways routes because of the quantities of chemicals transported on these major thoroughfares. Potential losses from hazardous substances incidences include human health and life and property resources. These types of incidents can lead to injury, illnesses, and/or death from both the involved persons and those living in the impacted areas.

An exposure analysis estimates there are 39,025 persons, 19,301 persons, and 140,839 persons living within 1 mile of railways, within 1 mile of hazardous material sites, and within 50 miles of the Indian Point Energy Center, respectively. The Township of Vernon has the greatest number of people living within 1 mile of railways and 50 miles of the Indian Point Energy Center, with 7,740 and 22,369 persons, respectively. The Town of Newton has the greatest number of people living within 1 mile of a hazardous material site (4,825 persons). Refer to Table 4.3.7-3 for population exposure to hazardous material incidents by jurisdiction

Table 4.3.7-3. Estimated Number of Persons Living Near Hazardous Materials Hazard Areas

Jurisdiction	Total Population	Population Exposed to Hazardous Material Release Incidents					
		Within a Mile of a Railroad		Within a Mile of a Hazardous Site		Within 50 Miles of Indian Point Energy Center	
		Number of People	Percent of Total	Number of People	Percent of Total	Number of People	Percent of Total
Andover (B)	594	510	85.9%	0	0.0%	594	100.0%
Andover (Twp)	5,996	148	2.5%	596	9.9%	5,996	100.0%
Branchville (B)	896	0	0.0%	0	0.0%	896	100.0%
Byram (Twp)	8,010	3,688	46.0%	1,657	20.7%	8,010	100.0%
Frankford (Twp)	5,361	0	0.0%	0	0.0%	5,361	100.0%
Franklin (B)	4,807	4,648	96.7%	3,898	81.1%	4,807	100.0%
Fredon (Twp)	3,214	0	0.0%	42	1.3%	3,034	94.4%
Green (Twp)	3,495	1,612	46.1%	1,008	28.8%	3,264	93.4%
Hamburg (B)	3,152	3,152	100.0%	2,807	89.1%	3,152	100.0%
Hampton (Twp)	4,916	0	0.0%	0	0.0%	4,916	100.0%
Hardyston (Twp)	7,886	5,064	64.2%	1,088	13.8%	7,886	100.0%
Hopatcong (B)	14,362	3,825	26.6%	259	1.8%	14,362	100.0%
Lafayette (Twp)	2,390	95	4.0%	107	<0.1%	2,390	100.0%
Montague (Twp)	3,716	12	0.3%	0	0.0%	3,716	100.0%
Newton (T)	7,895	0	0.0%	4,825	61.1%	7,895	100.0%
Ogdensburg (B)	2,314	2,222	96.0%	0	0.0%	2,314	100.0%
Sandyston (Twp)	1,925	0	0.0%	0	0.0%	1,925	100.0%
Sparta (Twp)	18,841	3,166	16.8%	1,212	6.4%	18,841	100.0%
Stanhope (B)	3,377	3,144	93.1%	984	29.1%	3,377	100.0%
Stillwater (Twp)	3,936	0	0.0%	0	0.0%	2,893	73.5%
Sussex (B)	1,854	0	0.0%	0	0.0%	1,854	100.0%
Vernon (Twp)	22,369	7,740	34.6%	686	3.1%	22,369	100.0%
Walpack (Twp)	6	0	0.0%	0	0.0%	1	18.2%
Wantage (Twp)	10,986	0	0.0%	132	1.2%	10,986	100.0%
Sussex County (Total)	**142,298**	**39,025**	**27.4%**	**19,301**	**13.6%**	**140,839**	**99.0%**

Source: Sussex County GIS 2020; American Community Survey 2018; EPA 2018; NJ Transit - 2018
Note: B – Borough; T – Town; Twp – Township; % - Percent

Impact on General Building Stock

Potential losses to the general building stock caused by a hazardous substance releases, whether in transit or at fixed sites, is difficult to quantify. The degree of damages depends on the scale of the incident. Potential losses may include inaccessibility, loss of service, contamination and/or potential structural and content losses if an explosion occurs. The closure of waterways, railroads, airports and highways as a result of a hazardous substance incident has the potential to impact the ability to deliver goods and services efficiently. Potential impacts may be local, regional, or statewide depending on the magnitude of the event and level of service disruptions.

An exposure analysis estimates there are 20,025 buildings or approximately $17.1 billion, 9,087 buildings or approximately $13.2 billion, and 70,919 buildings or approximately $59.1 billion living within 1 mile of all railways, within 1 mile of hazardous material sites, and within 50 miles of the Indian Point Energy Center, respectively. The Township of Vernon has the greatest number of buildings within 1 mile of a railway and 50 miles of the Indian Point Energy Center, with 4,337 and 12,039 structures, respectively. The Borough of Franklin has the greatest number of buildings located within 1 mile of a hazardous material site (1,700 structures). Refer to Table 4.3.7-4 for building exposure to hazardous material incidents by jurisdiction.

Impact on Critical Facilities and Lifelines

Potential losses to critical assets caused by a hazardous substances incident is difficult to quantify. Potential losses may include inaccessibility, loss of service, contamination and/or potential structural and content losses if an explosion occurs.

An exposure analysis estimates there are 164 critical facilities, 108 critical facilities, and 571 critical facilities built within 1 mile of all railways, within 1 mile of hazardous material sites, and within 50 miles of the Indian Point Energy Center, respectively. The Township of Sparta have the greatest number of critical facilities within 1 mile of railways, within 1 mile of hazardous material sites, and within 50 miles of the Indian Point Energy Center (i.e. 36, 20, and 74 critical facilities, respectively). Refer to Tables 4.3.7-5 through 4.3.7-9 to review the number of critical facilities and lifelines located within 1-mile of railways, 1-mile of hazardous material sites and 50-miles of the Indian Point Energy Center.

Table 4.3.7-4 Estimated Number of Buildings and Replacement Cost Value Within Hazardous Material Hazard Areas

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to Hazardous Material Release Incidents											
			Within 1 Mile of a Railroad				Within 1 Mile of a Hazardous Site				Within 50 Miles of Indian Point Energy Center			
			Number of Buildings	Percent of Total	Replacement Cost Value	Percent of Total	Number of Buildings	Percent of Total	Replacement Cost Value	Percent of Total	Number of Buildings	Percent of Total	Replacement Cost Value	Percent of Total
Andover (B)	328	$628,463,030	282	86.0%	$599,020,631	95.3%	0	0.0%	$0	0.0%	328	100.0%	$628,463,030	100.0%
Andover (Twp)	2,584	$3,609,679,724	91	3.5%	$179,023,505	5.0%	263	10.2%	$740,570,967	20.5%	2,584	100.0%	$3,609,679,724	100.0%
Branchville (B)	426	$532,377,368	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	426	100.0%	$532,377,368	100.0%
Byram (Twp)	3,676	$2,746,550,446	1,643	44.7%	$728,047,473	26.5%	742	20.2%	$383,785,519	14.0%	3,676	100.0%	$2,746,550,446	100.0%
Frankford (Twp)	3,537	$3,129,888,305	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	3,537	100.0%	$3,129,888,305	100.0%
Franklin (B)	2,061	$1,921,211,856	1,997	96.9%	$1,884,969,797	98.1%	1,700	82.5%	$1,790,111,458	93.2%	2,061	100.0%	$1,921,211,856	100.0%
Fredon (Twp)	1,615	$1,372,050,934	0	0.0%	$0	0.0%	27	1.7%	$30,659,161	2.2%	1,478	91.5%	$1,230,166,866	89.7%
Green (Twp)	1,698	$1,598,635,804	799	47.1%	$861,097,973	53.9%	503	29.6%	$468,407,040	29.3%	1,559	91.8%	$1,466,080,766	91.7%
Hamburg (B)	1,594	$1,588,049,291	1,594	100.0%	$1,588,049,291	100.0%	1,425	89.4%	$1,522,084,690	95.8%	1,594	100.0%	$1,588,049,291	100.0%
Hampton (Twp)	2,763	$2,196,131,598	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	2,763	100.0%	$2,196,131,598	100.0%
Hardyston (Twp)	4,403	$3,183,033,542	2,891	65.7%	$2,104,880,498	66.1%	685	15.6%	$760,054,379	23.9%	4,403	100.0%	$3,183,033,542	100.0%
Hopatcong (B)	8,040	$2,888,571,676	2,148	26.7%	$739,629,680	25.6%	162	2.0%	$79,936,104	2.8%	8,040	100.0%	$2,888,571,676	100.0%
Lafayette (Twp)	1,462	$1,958,174,065	70	4.8%	$77,989,545	4.0%	46	3.1%	$64,839,631	3.3%	1,462	100.0%	$1,958,174,065	100.0%
Montague (Twp)	2,175	$1,459,611,020	35	1.6%	$186,920,148	12.8%	0	0.0%	$0	0.0%	2,175	100.0%	$1,459,611,020	100.0%
Newton (T)	2,679	$5,093,275,807	0	0.0%	$0	0.0%	1,627	60.7%	$2,907,448,945	57.1%	2,679	100.0%	$5,093,275,807	100.0%
Ogdensburg (B)	992	$819,879,629	953	96.1%	$803,135,745	98.0%	0	0.0%	$0	0.0%	992	100.0%	$819,879,629	100.0%
Sandyston (Twp)	1,528	$1,212,626,664	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	1,528	100.0%	$1,212,626,664	100.0%
Sparta (Twp)	8,132	$9,070,094,285	1,731	21.3%	$4,096,771,630	45.2%	786	9.7%	$3,143,814,758	34.7%	8,132	100.0%	$9,070,094,285	100.0%
Stanhope (B)	1,557	$1,051,183,581	1,454	93.4%	$1,023,418,544	97.4%	444	28.5%	$203,269,350	19.3%	1,557	100.0%	$1,051,183,581	100.0%
Stillwater (Twp)	2,493	$1,417,579,398	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	1,688	67.7%	$812,676,244	57.3%
Sussex (B)	678	$1,945,578,916	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	678	100.0%	$1,945,578,916	100.0%
Vernon (Twp)	12,039	$5,658,971,163	4,337	36.0%	$2,217,043,699	39.2%	547	4.5%	$612,142,727	10.8%	12,039	100.0%	$5,658,971,163	100.0%
Walpack (Twp)	51	$63,691,550	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%	30	58.8%	$27,664,744	43.4%
Wantage (Twp)	5,510	$4,877,543,885	0	0.0%	$0	0.0%	130	2.4%	$533,499,414	10.9%	5,510	100.0%	$4,877,543,885	100.0%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to Hazardous Material Release Incidents											
			Within 1 Mile of a Railroad				Within 1 Mile of a Hazardous Site				Within 50 Miles of Indian Point Energy Center			
			Number of Buildings	Percent of Total	Replacement Cost Value	Percent of Total	Number of Buildings	Percent of Total	Replacement Cost Value	Percent of Total	Number of Buildings	Percent of Total	Replacement Cost Value	Percent of Total
Sussex County (Total)	**72,021**	**$60,022,853,539**	**20,025**	**27.8%**	**$17,089,998,162**	**28.5%**	**9,087**	**12.6%**	**$13,240,624,142**	**22.1%**	**70,919**	**98.5%**	**$59,107,484,471**	**98.5%**

Source: Sussex County GIS 2020; RS Means 2020; EPA 2018; NJ Transit - 2018

Note: B – Borough; T – Town; Twp – Township; % - Percent

Table 4.3.7-5. Estimated Number of Critical Facilities Located within 1-mile of Rail Lines, Hazardous Material Facilities and 50-Miles of Indian Point Energy Center

Jurisdiction	Total Critical Facilities and Lifelines Located in Jurisdiction	Hazardous Material Release Incident - Within 1 Mile of Railroads		Hazardous Material Release Incident - Within 1 Mile of Hazardous Material Facilities		Hazardous Material Release Incident - Within 50 Miles of Indian Point Energy Center	
		Number of Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines	Number of Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines	Number Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines
Andover (B)	12	10	83.3%	0	0.0%	12	100.0%
Andover (Twp)	37	2	5.4%	0	0.0%	37	100.0%
Branchville (B)	4	0	0.0%	0	0.0%	4	100.0%
Byram (Twp)	37	19	51.4%	16	43.2%	37	100.0%
Frankford (Twp)	23	0	0.0%	0	0.0%	23	100.0%
Franklin (B)	10	10	100.0%	10	100.0%	10	100.0%
Fredon (Twp)	17	0	0.0%	1	5.9%	12	70.6%
Green (Twp)	21	10	47.6%	2	9.5%	20	95.2%
Hamburg (B)	19	19	100.0%	18	94.7%	19	100.0%
Hampton (Twp)	20	0	0.0%	0	0.0%	20	100.0%
Hardyston (Twp)	27	22	81.5%	9	33.3%	27	100.0%
Hopatcong (B)	22	6	27.3%	2	9.1%	22	100.0%
Lafayette (Twp)	14	0	0.0%	0	0.0%	14	100.0%
Montague (Twp)	32	0	0.0%	0	0.0%	32	100.0%
Newton (T)	39	0	0.0%	17	43.6%	39	100.0%
Ogdensburg (B)	7	7	100.0%	0	0.0%	7	100.0%
Sandyston (Twp)	28	0	0.0%	0	0.0%	28	100.0%
Sparta (Twp)	74	36	48.6%	20	27.0%	74	100.0%
Stanhope (B)	7	7	100.0%	2	28.6%	7	100.0%
Stillwater (Twp)	24	0	0.0%	0	0.0%	13	54.2%
Sussex (B)	8	0	0.0%	0	0.0%	8	100.0%
Vernon (Twp)	74	16	21.6%	9	12.2%	74	100.0%
Walpack (Twp)	11	0	0.0%	0	0.0%	3	27.3%
Wantage (Twp)	29	0	0.0%	2	6.9%	29	100.0%
Sussex County (Total)	**596**	**164**	**27.5%**	**108**	**18.1%**	**571**	**95.8%**

Source: Sussex County GIS 2020; EPA 2018; NJ Transit - 2018
Note: B – Borough; T – Town; Twp – Township

Table 4.3.7-6. Distribution of Critical Facilities by Type Built Within 1 Mile of a Railway

Jurisdiction	Facility Types																						
	Communication Facility	Dam	DPW	Electrical Substation	EMS	EOC	Fire Station	Food Pantry	Fuel	Government Building	Hazardous Material	Health/Medical Center	Police Station	Post Office	Potable Pump Station	Potable Water Treatment	Primary Education	Secondary Education	Senior Center	Shelter	Wastewater Pump	Wastewater Treatment	Well
Andover (B)	1	1	0	1	0	0	1	0	2	1	0	0	0	0	0	1	0	0	1	1	0	0	0
Andover (Twp)	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Branchville (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Byram (Twp)	0	5	0	0	0	1	1	0	0	1	2	0	1	0	0	0	2	0	0	2	4	0	0
Frankford (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Franklin (B)	0	1	0	0	1	0	1	0	0	1	2	0	1	0	0	0	2	0	0	1	0	0	0
Fredon (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green (Twp)	0	1	1	0	0	1	1	0	0	1	1	0	0	1	0	0	2	0	0	1	0	0	0
Hamburg (B)	0	2	1	1	1	0	1	0	0	2	4	0	1	0	1	0	1	0	0	1	2	0	1
Hampton (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardyston (Twp)	0	10	1	0	2	0	1	0	0	2	1	1	1	0	0	0	2	0	0	1	0	0	0
Hopatcong (B)	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0
Lafayette (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montague (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Newton (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ogdensburg (B)	0	2	0	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0
Sandyston (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparta (Twp)	0	10	2	1	1	1	0	1	0	1	5	0	1	0	2	0	4	1	1	1	2	1	1
Stanhope (B)	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	2	0	0	1	0	0	0
Stillwater (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sussex (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vernon (Twp)	0	5	1	0	1	0	2	0	0	1	2	0	1	0	0	0	0	0	0	3	0	0	0
Walpack (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wantage (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sussex County (Total)	**1**	**41**	**7**	**3**	**8**	**3**	**10**	**1**	**2**	**12**	**17**	**1**	**8**	**1**	**3**	**1**	**17**	**1**	**3**	**13**	**8**	**1**	**2**

Source: Sussex County GIS 2020; NJ Transit - 2018
Note: B – Borough; T – Town; Twp – Township

Table 4.3.7-7. Distribution of Critical Facilities by Type Built Within 1 Mile of Hazardous Material Sites

Jurisdiction	Facility Types																		
	Dam	DPW	Electrical Substation	EMS	EOC	Fire Station	Food Pantry	Government Building	Hazardous Material Facility	Health/Medical Center	Police Station	Potable Pump Station	Primary Education	Secondary Education	Senior Center	Shelter	Wastewater Pump	Wastewater Treatment	Well
Andover (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Andover (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Branchville (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Byram (Twp)	2	0	0	0	1	1	0	1	2	0	1	0	2	0	0	2	4	0	0
Frankford (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Franklin (B)	1	0	0	1	0	1	0	1	2	0	1	0	2	0	0	1	0	0	0
Fredon (Twp)	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Green (Twp)	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Hamburg (B)	2	1	1	1	0	1	0	1	4	0	1	1	1	0	0	1	2	0	1
Hampton (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hardyston (Twp)	0	1	0	1	0	0	0	2	1	1	1	0	2	0	0	0	0	0	0
Hopatcong (B)	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lafayette (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Montague (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Newton (T)	0	0	1	1	0	1	0	2	1	1	1	1	3	0	0	1	4	0	0
Ogdensburg (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sandyston (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sparta (Twp)	1	2	1	1	1	0	1	1	5	0	1	0	1	1	1	0	2	1	0
Stanhope (B)	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0
Stillwater (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sussex (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vernon (Twp)	1	1	0	1	0	1	0	1	2	0	1	0	0	0	0	1	0	0	0
Walpack (Twp)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wantage (Twp)	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Sussex County (Total)	**9**	**6**	**3**	**6**	**2**	**5**	**1**	**9**	**21**	**2**	**7**	**2**	**13**	**1**	**1**	**6**	**12**	**1**	**1**

Source: Sussex County GIS 2020; EPA 2018 *Note: B – Borough; T – Town; Twp – Township*

Table 4.3.7-8. Distribution of Critical Facilities by Type Within 50 Miles of the Indian Point Energy Center

Jurisdiction	Facility Types																									
	Airport	Communication Facility	Correctional Facility	Dam	DPW	Electrical Substation	EMS	EOC	Fire Station	Food Pantry	Fuel	Government Building	Hazardous Material	Health/Medical Center	Police Station	Post Office	Potable Pump Station	Potable Water Treatment	Primary Education	Religious Center	Secondary Education	Senior Center	Shelter	Wastewater Pump	Wastewater Treatment	Well
Andover (B)	0	1	0	1	0	1	0	0	2	0	3	1	0	0	0	0	0	1	0	0	0	1	1	0	0	0
Andover (Twp)	1	4	0	17	2	1	1	1	3	0	0	1	0	0	1	0	0	0	2	0	0	2	1	0	0	0
Branchville (B)	0	0	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Byram (Twp)	0	2	0	14	0	0	2	2	2	0	0	1	2	0	1	0	0	0	2	0	0	0	3	6	0	0
Frankford (Twp)	0	0	0	10	2	0	1	1	3	1	0	2	0	0	1	0	0	0	1	0	0	0	1	0	0	0
Franklin (B)	0	0	0	1	0	0	1	0	1	0	0	1	2	0	1	0	0	0	2	0	0	0	1	0	0	0
Fredon (Twp)	0	0	0	9	0	0	0	0	1	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Green (Twp)	0	0	0	3	1	0	1	1	1	0	0	1	2	0	0	2	0	0	4	2	1	0	1	0	0	0
Hamburg (B)	0	0	0	2	1	1	1	0	1	0	0	2	4	0	1	0	1	0	1	0	0	0	1	2	0	1
Hampton (Twp)	0	0	0	13	0	0	0	0	3	0	0	1	0	0	0	0	0	0	2	0	0	1	0	0	0	0
Hardyston (Twp)	0	0	0	14	1	0	2	0	2	0	0	2	1	1	1	0	0	0	2	0	0	0	1	0	0	0
Hopatcong (B)	0	0	0	6	1	1	1	1	3	0	0	1	0	0	1	0	0	0	4	0	0	1	2	0	0	0
Lafayette (Twp)	0	0	0	3	1	0	1	0	1	0	0	3	0	0	0	0	0	0	1	0	0	0	4	0	0	0
Montague (Twp)	0	0	0	12	1	1	1	0	2	1	0	1	0	0	0	0	1	0	1	0	0	0	2	0	0	9
Newton (T)	0	1	1	2	1	1	1	0	2	2	0	9	1	4	1	0	2	0	4	0	1	1	1	4	0	0
Ogdensburg (B)	0	0	0	2	0	0	1	0	1	0	0	1	0	0	1	0	0	0	1	0	0	0	0	0	0	0
Sandyston (Twp)	0	0	0	20	2	0	0	0	2	1	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0
Sparta (Twp)	0	0	0	31	3	2	1	1	3	1	0	1	5	0	1	0	6	0	9	0	1	1	1	3	1	3
Stanhope (B)	0	0	0	0	0	0	1	0	1	0	0	1	0	0	1	0	0	0	2	0	0	0	1	0	0	0
Stillwater (Twp)	0	0	0	8	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0
Sussex (B)	0	0	0	1	1	1	0	1	1	0	0	1	0	1	0	0	0	0	1	0	0	0	0	0	0	0
Vernon (Twp)	0	0	0	52	1	0	3	0	4	0	0	1	2	0	1	0	0	0	6	0	0	0	4	0	0	0
Walpack (Twp)	0	0	0	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wantage (Twp)	1	1	0	14	1	0	1	1	2	0	0	1	2	0	0	0	0	1	3	0	0	0	1	0	0	0
Sussex County (Total)	**2**	**10**	**1**	**237**	**21**	**9**	**20**	**9**	**43**	**7**	**2**	**37**	**21**	**6**	**12**	**3**	**10**	**2**	**50**	**2**	**3**	**7**	28	15	1	13

Source: Sussex County GIS 2020

Note: B – Borough; T – Town; Twp – Township

Table 4.3.7-9. Number of Identified Lifelines by Category Within Hazardous Material Hazard Areas

FEMA Lifeline Category	Total Number of Lifelines in Sussex County	Number of Lifelines Within One Mile of a Railway	Number of Lifelines Within One Mile of a Hazardous Site	Number of Lifelines Within 50 Miles of Indian Point Energy Center
Communications	9	1	0	9
Energy	12	5	3	12
Food, Water, Shelter	75	28	23	74
Hazardous Materials	20	16	20	20
Health and Medical	15	5	3	15
Safety and Security	463	109	59	439
Transportation	2	0	0	2
Sussex County (Total)	**596**	**164**	**108**	**571**

Source: Sussex County GIS 2020; EPA 2018; NJ Transit – 2018; FEMA 2020

In addition to critical facilities and lifelines, the miles of roads exposed to hazardous material hazard areas are summarized in Table 4.3.6-10. Out of the 1,771 miles of transportation routes in the County, 369 miles, 203 miles, and 1,709 miles are built within 1 mile of a railway, 1 mile of hazardous material site, and 50 miles of the Indian Point Energy Center, respectively.

Table 4.3.7-10. Major Transportation Routes Located Within 1-mile of Rail Lines, Hazardous Material Facilities and 50-Miles of Indian Point Energy Center

Road Type	Total Miles for County	Roadway Miles Within One Mile of a Railway		Roadway Miles Within One Mile of a Hazardous Site		Roadway Miles Within 50 Miles of Indian Point Energy Center	
		Miles	Percent of Total	Miles	Percent of Total	Miles	Percent of Total
Local and Private Roads	1,337	275	20.6%	139	10.4%	1286	96.2%
County Roads	313	51	16.4%	38	12.2%	303	97.0%
State Routes	86	38	44.5%	25	28.5%	85	98.4%
US Highways	34	3	9.2%	2	4.6%	34	98.7%
Interstate	1	1	100.0%	0	0.0%	1	100.0%
Sussex County Total	**1,771**	**369**	**20.8%**	**203**	**11.5%**	**1,709**	**96.5%**

Source: Sussex County GIS 2020; NJDOT 2019

Impact on Economy

If a significant hazardous substances incident occurred, not only would life, safety, and building stock be at risk, but the economy of Sussex County may be impacted as well. A significant incident in an urban area may force businesses to close for an extended period of time because of contamination or direct damage caused by an explosion, if one occurred. The exact impact on the economy is difficult to determine, given the uncertain nature of the size and scope of incidents.

Hazardous substance incidents have the potential to lead to major transportation route closures in Sussex County. The closure of waterways, railroads, airports, and highways as a result of these incidents has the potential to impact the ability to deliver goods and services efficiently. Potential impacts may be local, regional, or statewide, depending on the magnitude of the event and the level of services disruptions.

Impact on Environment

Hazardous wastes that are released into the environment can be harmful to species and their habitat (EPA 2020). Wastes that get into waterways will be disruptive and sometimes deadly to aquatic species. Consequentially, wastes that get into waterways can also contaminate drinking water supplies. Hazardous wastes can also leach into soils and travel with wind, which not only impacts the localized habitat, but can create issues for surrounding communities. Strict disposal regulations have been defined by organizations like the EPA to ensure that the environment and community is protected from these types of events.

Future Changes That May Impact Vulnerability

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

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

Projected Development

Any areas of growth could be potentially impacted by the hazardous materials hazard areas. Development near the transit routes for hazardous materials and facilities will increase the County's overall risk. Therefore, the County should take precautions with the location of new development and the development's proximity to hazardous material facilities and transit routes. The County may also want to consider implementing designs into the new development that enables improved evacuation or protection from residual impacts from the hazardous materials. Refer to Section 3 (County Profile) for more information about the County's anticipated and recent new development plans.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population can impact the number of persons living near hazardous materials facilities and transit routes.

Climate Change

As temperatures change, excessive heat on containers that contain hazardous materials may alter the material properties. In addition, hazardous substances stored at fixed locations in the floodplain may experience an increase in flood events due to the project changes in increased precipitation events; magnitude and frequency

Vulnerability Changes Since the 2016 HMP

The 2021 HMP has been updated to reflect 2014-2018 American Community Survey 5-year estimates for population changes. The building stock inventory was updated using data from Sussex County. Further, the building stock inventory replacement cost values were updated using RS Means 2020 values providing an overall update to the assets assessed in this risk assessment. This HMP implemented distance buffers over three hazardous material areas, 1 mile from railways, 1 mile from hazardous material sites, and 50 miles of the Indian Point Energy Center. Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to hazardous substance incidents.

4.3.8 HURRICANE AND TROPICAL STORM

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 hurricane and tropical storm hazard in Sussex County.

2020 HMP CHANGES

- Previous occurrences were updated with events that occurred between 2016 and 2020.
- A vulnerability assessment was conducted for the hurricane and tropical storm hazard using a more accurate and updated building inventory.

Profile

Hazard Description

A tropical cyclone is characterized by a low-pressure center and numerous thunderstorms that produce strong winds and heavy rain. Tropical depressions, tropical storms, and hurricanes are all considered tropical cyclones. Tropical cyclones strengthen when water evaporated from the ocean is released as the saturated air rises, resulting in condensation of water vapor contained in the moist air. These storms rotate counterclockwise in the northern hemisphere around the center and are accompanied by heavy rain and strong winds (NOAA 2020a). Almost all tropical storms and hurricanes in the Atlantic basin (which includes the Gulf of Mexico and Caribbean Sea) form between June 1 and November 30 (hurricane season). August and September are peak months for hurricane development (NOAA 2020a).

Tropical cyclones are fueled by a different heat mechanism than other cyclonic windstorms such as Nor'Easters and polar lows. The characteristic that separates tropical cyclones from other cyclonic systems is that at any height in the atmosphere, the center of a tropical cyclone will be warmer than its surroundings; a phenomenon called "warm core" storm systems (NOAA n.d.).

A hurricane is a tropical storm that attains hurricane status when its wind speed reaches 74 or more miles per hour (mph). Tropical systems may develop in the Atlantic between the Lesser Antilles and the African coast, or may develop in the warm tropical waters of the Caribbean and Gulf of Mexico. These storms may move up the Atlantic Coast of the United States and impact the Eastern Seaboard, or move into the United States through the states along the Gulf Coast, bringing wind and rain as far north as New England, before moving offshore and heading east.

Location

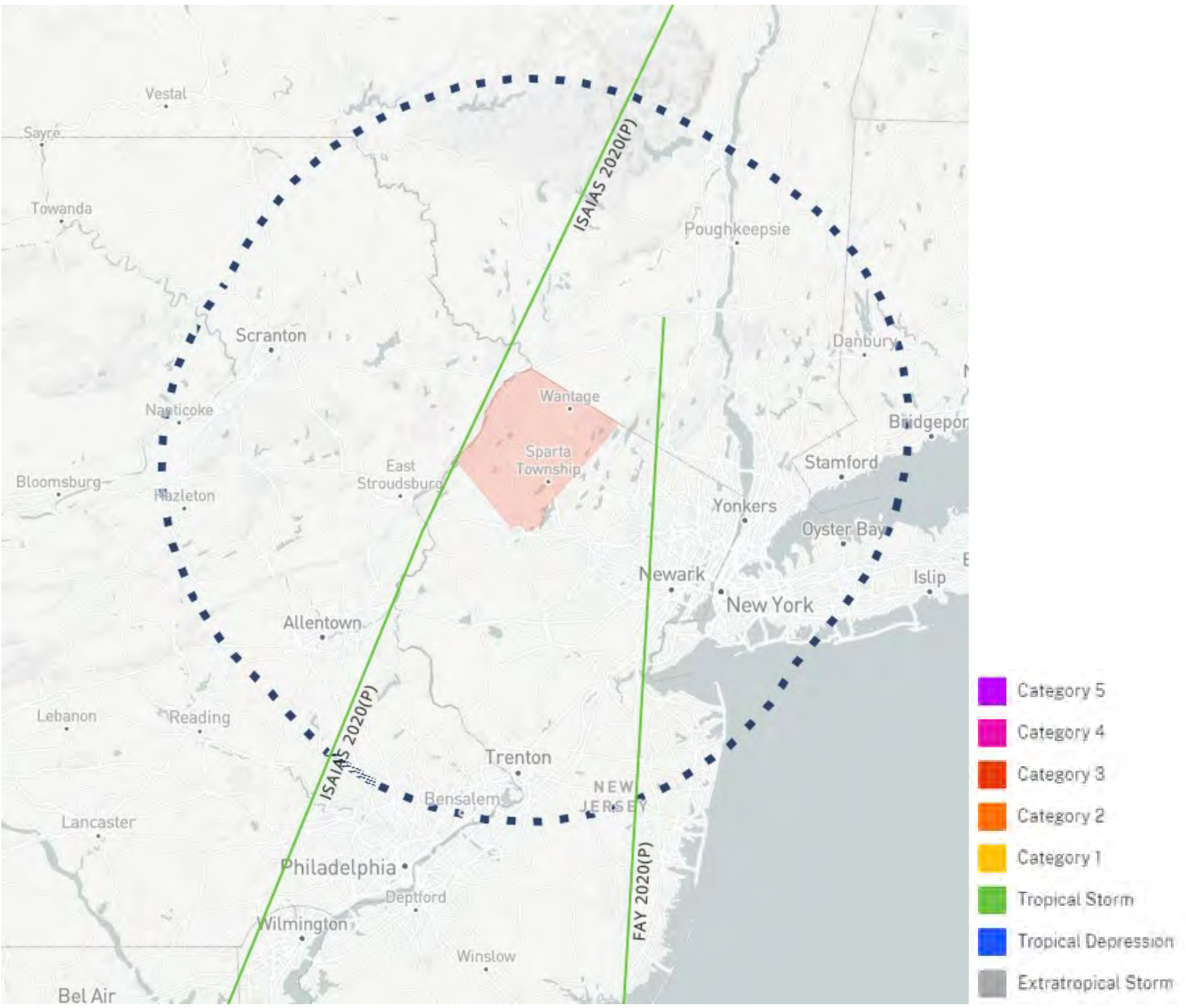
All of Sussex County is vulnerable and at risk to flooding due to heavy rains and winds produced by hurricanes and tropical storms.

NOAA's Historical Hurricane Tracks tool is a public interactive mapping application that displays Atlantic Basin and East-Central Pacific Basin tropical cyclone data. This interactive tool catalogs tropical cyclones that have occurred from 1842 to 2020 (latest date available from data source). Between 1861 and 2020, 32 events classified as either a hurricane, tropical storm, or tropical depression tracked within 65 nautical miles of Sussex County. Figure 4.3.8-1 displays tropical cyclone tracks that tracked with 65 nautical miles of Sussex County between 2015 and 2020 (only two events – Tropical Storm Fay and Tropical Storm Isaias in 2020). Refer to the "Previous Occurrences and Losses" section for further information regarding hurricane and tropical storm events that impacted Sussex County.

Extent

The extent of a hurricane is categorized in accordance with the Saffir-Simpson Hurricane Scale. The Saffir-Simpson Hurricane Wind Scale is a 1-to-5 rating based on a hurricane's sustained wind speed. This scale estimates potential property damage. Hurricanes reaching Category 3 and higher are considered major hurricanes because of their potential for significant loss of life and damage. Category 1 and 2 storms are still dangerous and require preventative measures (NOAA 2013b). Table 4.3.8-1 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Figure 4.3.8-1. Historical Tropical Storm and Hurricane Tracks 2015 to 2020



Source: NOAA 2021

Figure 4.3.8-2. Saffir-Simpson Scale

Source: NWS 2020

The NWS issues hurricane and tropical storm watches and warnings. These watches and warnings are issued or will remain in effect after a tropical cyclone becomes post-tropical, when such a storm poses a significant threat to life and property. The NWS allows the National Hurricane Center (NHC) to issue advisories during the post-tropical stage. The following are the definitions of the watches and warnings:

- *Hurricane/Typhoon Warning* is issued when sustained winds of 74 mph or higher are expected somewhere within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the warning is issued 36 hours in advance of the anticipated onset of tropical storm-force winds. The warning can remain in effect when dangerously high water or combination of dangerously high water and waves continue, even though winds may be less than hurricane force.
- *Hurricane Watch* is issued when sustained winds of 74 mph or higher are possible within the specified area in association with a tropical, subtropical, or post-tropical cyclone. Because hurricane preparedness activities become difficult once winds reach tropical storm force, the hurricane watch is issued 48 hours prior to the anticipated onset of tropical storm-force winds.
- *Tropical Storm Warning* is issued when sustained winds of 39 to 73 mph are expected somewhere within the specified area within 36 hours in association with a tropical, subtropical, or post-tropical storm.
- *Tropical Storm Watch* is issued when sustained winds of 39 to 73 mph are possible within the specified area within 48 hours in association with a tropical, sub-tropical, or post-tropical storm.
  (NWS 2013).

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a MRP is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

Figure 4.3.8-3 and Figure 4.3.8-4 show the estimated maximum 3-second gust wind speeds that can be anticipated in the study area associated with the 100- and 500-year MRP events. These peak wind speed projections were generated using FEMA's Hazus-MH v4.2 wind model. The estimated hurricane track used for the 100- and 500-year event is also shown. The maximum 3-second gust wind speeds for Sussex County are 59-64 mph (Tropical Storm), for the 100-year MRP event (tropical storm). The maximum 3-second gust wind speeds for Sussex County are 75-80 mph (Category 1 hurricane) for the 500-year MRP event. The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are discussed in the Vulnerability Assessment subsection.

Figure 4.3.8-3. Wind Speeds for the 100-Year Mean Return Period Event

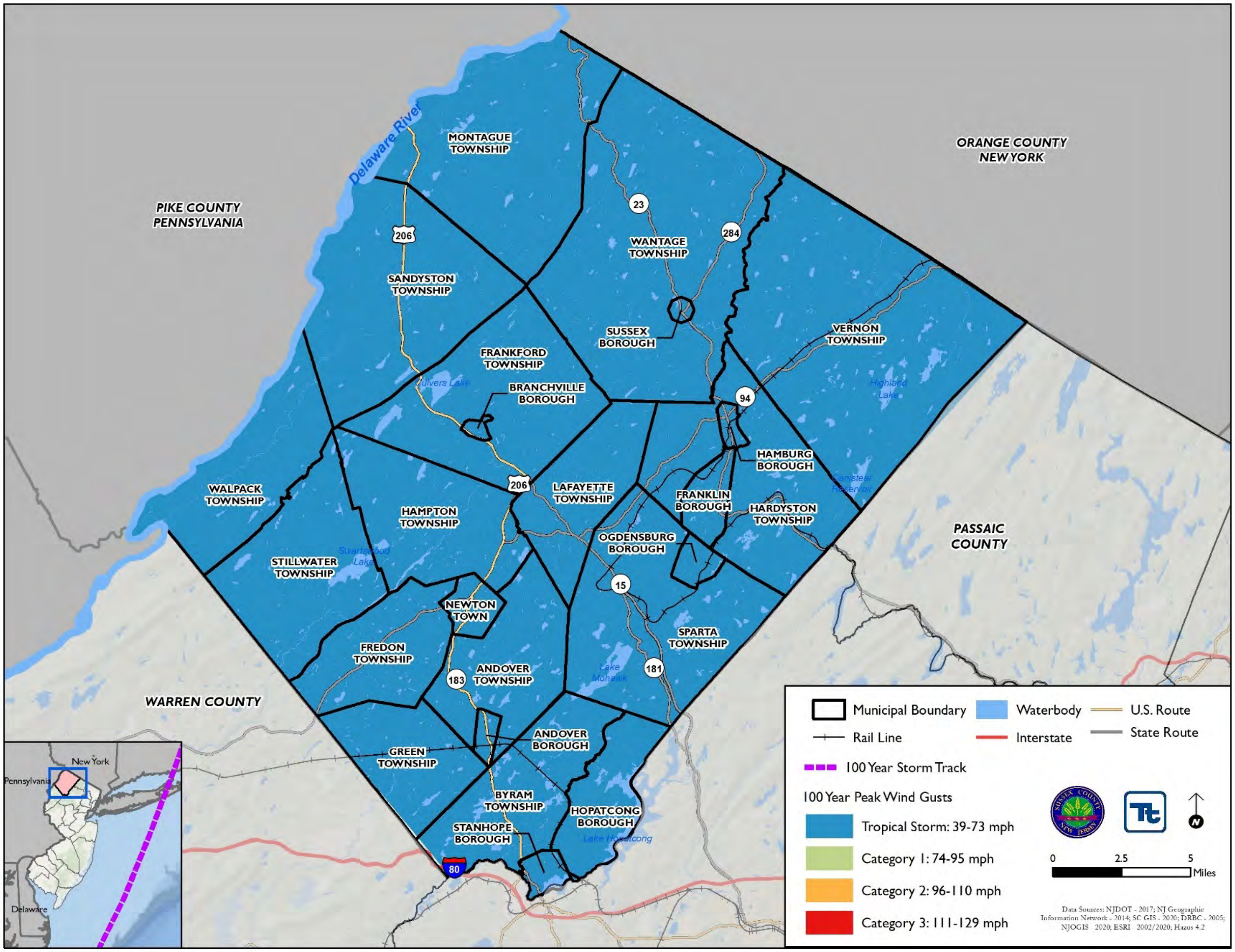
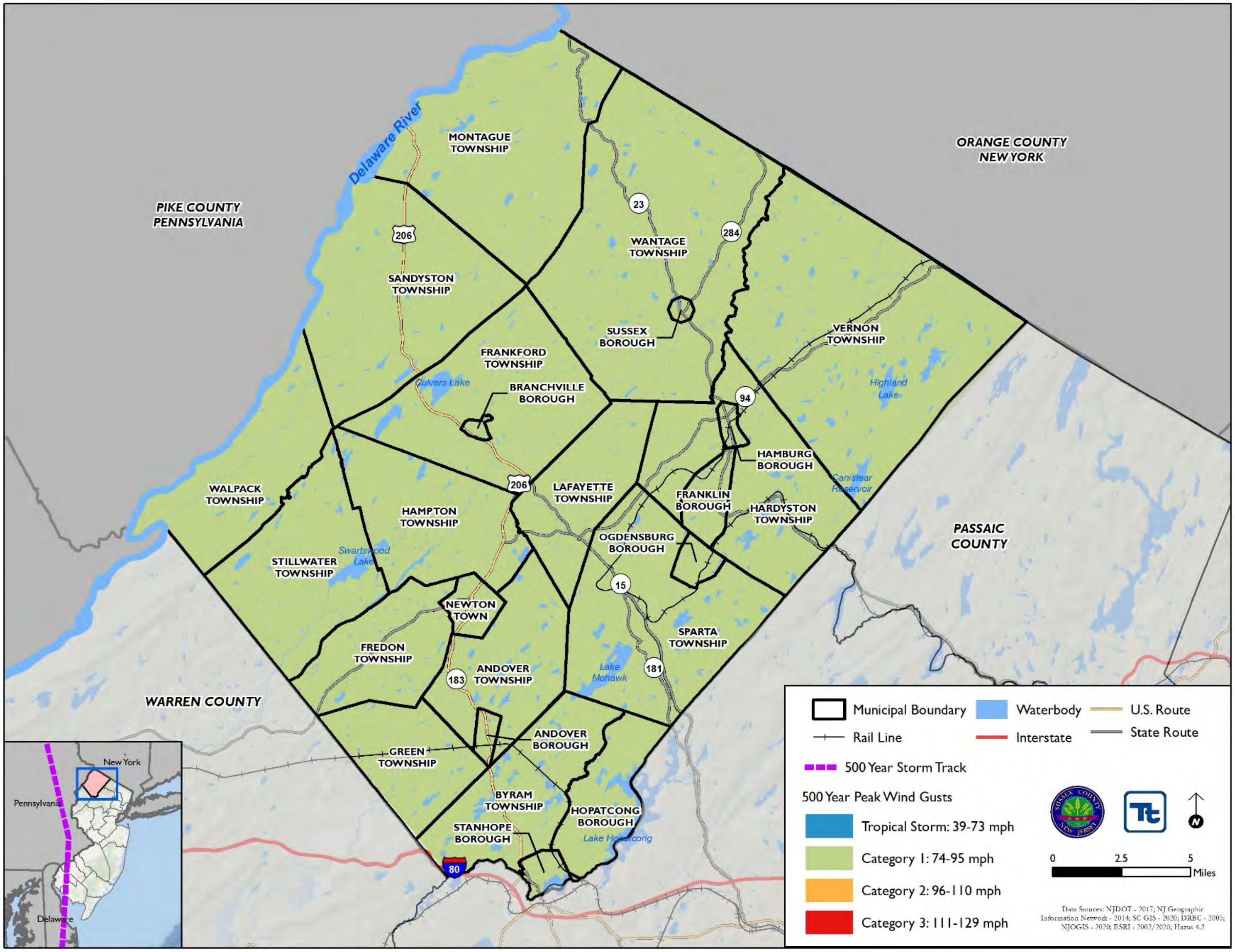


Figure 4.3.8-4. Wind Speeds for the 500-Year Mean Return Period Event



Previous Occurrences and Losses

Between 1954 and 2020, Sussex County was included in six declarations for hurricane and tropical storm-related events; refer to Table 4.3.8-1. Hurricane and tropical storm events that have impacted Sussex County between 2015 and 2020 are identified in Table 4.3.8-2 with associated impacts. 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 2015 and 2020, the period for which data was available, Sussex County was not included in any USDA agricultural disasters relating to hurricanes or tropical storms.

Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality. For events prior to 2015, refer to the Appendix E (Risk Assessment Supplement).

Table 4.3.8-1. Hurricane-Related Disaster (DR) and Emergency (EM) Declarations 1954-2020

Declaration	Event Date	Declaration Date	Event Description
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane Floyd Emergency Declarations
DR-1295	September 16-18, 1999	September 17, 1999	Hurricane Floyd Major Disaster Declarations
EM-3332	August 26 – September 5, 2011	August 27, 2011	Hurricane Irene
DR-4021	August 26 – September 5, 2011	August 31, 2011	Hurricane Irene
EM-3354	October 26 – November 8, 2012	October 28, 2012	Hurricane Sandy
DR-4086	October 26 – November 8, 2012	October 30, 2012	Hurricane Sandy

Source: FEMA 2020

Table 4.3.8-2. Hurricane and Tropical Storm Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
July 10, 2020	Tropical Storm	N/A	TBD, pending	Sussex County	Tropical Storm Fay moved northward along the coasts of Delaware and New Jersey on the afternoon and evening of July 10. The storm produced rainfall totals up to 3 to 6 inches in New Jersey, with the highest totals occurring in the southern part of the state. Some areas also experienced a period of tropical storm force winds, especially near the coast. Overall impacts from wind were limited.
August 4, 2020	Tropical Storm	N/A	TBD, pending	Sussex County	Tropical Storm Isaias brought high winds, heavy rain, several tornadoes, and coastal flooding to the mid-Atlantic region, becoming the most impactful tropical cyclone to impact most of the region since Sandy in 2012.

Source: FEMA 2020; NOAA-NCEI 2020; NWS 2020; SPC 2020; NJOEM 2019
Note: Not all events that have occurred in Sussex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
DR Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
N/A Not Applicable

Probability of Future Occurrences

Hurricane return periods are the frequency at which a certain intensity of hurricane can be expected within a given distance of a given location. For example, a return period of 20 years for a major hurricane means that on average during the previous 100 years, a Category 3 or greater hurricane passed within 58 miles of a specific location approximately 5 times. The return period of hurricanes for Sussex County was not calculated – however, the return period for surrounding counties is 18 to 19 years for a hurricane (greater than 64 mph winds) and 74 to 76 years for a major hurricane (greater than 110 mph winds) (NOAA 2013).

In order to determine the recurrence interval and the average annual number of events, data from 1950 to 2020 was looked at using NOAA's Historical Hurricane Tracks tool. A 65 nautical mile radius was used to identify any hurricane and tropical storm events Sussex County. Based on this data, 18 hurricanes, tropical storms, tropical depressions or extra-tropical storms passed within 100 nautical miles of Sussex County. The table below shows these statistics, as well as the annual average number of events and the estimated percent change of an event occurring in a given year (NHC 2021).

Table 4.3.8-3. Probability of Future Hurricane and Tropical Storm Events

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Tropical Depression	2	0.03	35.5	0.03	2.8
Tropical Storm	14	0.20	5.1	0.20	19.7
Hurricanes (all categories)	2	0.03	35.5	0.03	2.8
Total	**18**	**0.26**	**3.9**	**0.25**	**25.4**

Source: NHC 2021

It is estimated that Sussex County will continue to experience direct and indirect impacts of hurricane and tropical storms that may induce secondary hazards such as flooding, extreme wind, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for hurricane and tropical storms in the county is considered ‘frequent’ (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the hurricane and tropical storm hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State’s average temperature (Office of the New Jersey State

Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017).

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017).

Climate change may result in changes to the frequency of coastal storms. A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017). As temperatures increase so will the energy in a storm system, increasing the potential for more intense tropical storms (Huang et al. 2017), especially those of Category 4 and 5 (Melillo et al. 2014).

As oceans warm, the length of hurricane season may expand. The past five hurricane seasons have featured a tropical system occurring before the official start of the season. In 2016, a very rare winter hurricane named Alex developed in the middle of January (BBC 2019). According to NOAA's database, 39 storms formed in the Atlantic Basin before June 1 from 1851 through 2020, a long-term average of one such early storm every four to five years. The 2010s had the most such storms, and there has been a steady increase since the 1990s. However, the 1950s had six such storms, the 1930s had four and there was another four preseason storm streak from 1887 through 1890. It is possible there were other such storms in the era before satellites – before the mid-1960s – that were missed by ship observations or reports from areas impacted. It remains to be seen if expansion of the traditional hurricane season is a long-term trend or a common occurrence (Weather.com 2020).

Temperatures are predicted to increase in Sussex County and ocean temperatures are forecast to continue to increase, which may lead to an increase in intensity and frequency of hurricanes. It remains to be seen if other factors such as steering currents, atmospheric sheer, and the presence of Saharan dust will be impacted in ways which increase or decrease the risk of hurricanes in Sussex County.

Vulnerability Assessment

A probabilistic assessment was conducted for the 100- and 500-year MRPs through a Level 2 analysis in HAZUS-MH v4.2 to estimate potential losses associated with high-wind events. The impacts on population, existing structures, critical facilities and the economy are presented below.

Impact on Life, Health and Safety

The impact of a hurricane or tropical storm on life, health, and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. For the purposes of this HMP, the entire population of Sussex County (142,298 people) is exposed to hurricanes and tropical storm events (U.S. Census, American Community Survey 5-year Population Estimates 2018). Residents might be displaced or require temporary to long-term sheltering as a result of these events. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on several factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Hazus estimates no households will be displaced and temporary shelter will not be required as a result of the 100 or 500-year MRP events.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and might lack funds to evacuate. The population over the age of 65 is also more vulnerable and might physically have more difficulty evacuating. The elderly is considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that might not be available due to isolation during a storm event. The 2018 American Community Survey population estimates indicate there were 22,889 persons over 65 years old and 7,191 living below the poverty level in Sussex County. Section 3 (County Profile) provides statistics of these populations.

Secondary flooding associated with the torrential downpours during hurricanes/tropical storms is also a primary concern in the County (refer to the flooding discussion in Section 4.3.5 - Flood).

Impact on General Building Stock

It is assumed that the entire County's general building stock is exposed to the hurricane and tropical storm hazard ($60.0 billion). Building construction plays a major role in the extent of damage resulting from a storm event. Due to differences in construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings, in general, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. High-rise buildings are also very vulnerable structures. Mobile homes are the most vulnerable to damage, even if tied down, and offer little protection to people inside.

The Hazus wind model was run to estimate potential losses to buildings. Expected building damage was evaluated across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction; Table 4.3.8-4 summarizes the definition of the damage categories.

Table 4.3.8-4 Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof cover, with no or very limited water penetration.	≤2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	>2% and ≤15%	One window, door, or garage door failure	No	<5 impacts	No	No
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	>15% and ≤50%	> one and ≤ the larger of 20% & 3	1 to 3 panels	Typically 5 to 10 impacts	No	No
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	>50%	> the larger of 20% & 3 and ≤50%	>3 and ≤25%	Typically 10 to 20 impacts	No	No
Destruction Complete roof failure and/or, failure of wall frame. Loss of more than 50% of roof sheathing.	Typically >50%	>50%	>25%	Typically >20 impacts	Yes	Yes

Source: Hazus-MH Hurricane Technical Manual

According to the Hazus wind model, most Sussex structures would experience no damage with a small number experiencing minor damage. Table 4.3.8-5 indicates the number and type of buildings for each damage category.

Table 4.3.8-5 Expected Damages from 100 and 500-Year MRP Hurricane Wind Events

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	100-year		500-year	
			Building Count	Percent Buildings in Occupancy Class	Building Count	Percent Buildings in Occupancy Class
Residential Exposure (Single and Multi-Family Dwellings)	62,429	None	62,419	>99.9%	61,852	>99.9%
		Minor	10	<0.1%	570	<0.1%
		Moderate	0	0.0%	7	<0.1%
		Severe	0	0.0%	0	0.0%
		Complete Destruction	0	0.0%	0	0.0%
Commercial Buildings	3,304	None	3,297	>99.9%	3,279	>99.9%
		Minor	7	<0.1%	25	<0.1%
		Moderate	0	0.0%	0	0.0%

Occupancy Class	Total Number of Buildings in Occupancy	Severity of Expected Damage	100-year		500-year	
			Building Count	Percent Buildings in Occupancy Class	Building Count	Percent Buildings in Occupancy Class
		Severe	0	0.0%	0	0.0%
		Complete Destruction	0	0.0%	0	0.0%
Industrial Buildings	258	None	257	>99.9%	255	>99.9%
		Minor	1	<0.1%	3	<0.1%
		Moderate	0	0.0%	0	0.0%
		Severe	0	0.0%	0	0.0%
		Complete Destruction	0	0.0%	0	0.0%
Government, Religion, Agricultural, and Education Buildings	6,030	None	6,027	>99.9%	6,004	>99.9%
		Minor	3	<0.1%	25	<0.1%
		Moderate	0	0.0%	1	<0.1%
		Severe	0	0.0%	0	0.0%
		Complete Destruction	0	0.0%	0	0.0%

Source: Hazus-MH v4.2

Table 4.3.8-6 and Table 4.3.8-7 summarize the replacement cost value damage estimated for the 100- and 500-year MRP wind-only events.

The total estimated damage to buildings for all occupancy types across Sussex County is estimated to be approximately $10.0 and $67.4 million for the 100- and 500-year MRP wind-only events, respectively. Most of these losses are to residential buildings. Due to differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. The damage counts include buildings damaged at all severity levels from minor damage to destruction. Total dollar damage reflects the overall impact to buildings at an aggregate level. The Township of Vernon is estimated to experience the greatest damage in a 100-year MRP event, approximately $2.1 million. The Township of Sparta is estimated to experience the greatest damage in a 500-year event, losing $9.9 million. Damages to buildings is a direct result of wind speeds, direction and duration; which is dependent upon the storm's intensity and track.

Table 4.3.8-6. Estimated Building Value Damaged by the 100 and 500-Year MRP Hurricane-Related Winds (Building Structure and Content)

Jurisdiction	Total Replacement Cost Value (All Occupancies)	Estimated Total Damages		Percent of Total Building and Contents Replacement Cost Value	
		100-Year	500-Year	100-Year	500-Year
Andover (B)	$628,463,030	$65,969	$482,051	<0.1%	0.1%
Andover (Twp)	$3,609,679,724	$402,887	$3,444,722	<0.1%	0.1%
Branchville (B)	$532,377,368	$49,511	$465,331	<0.1%	0.1%
Byram (Twp)	$2,746,550,446	$158,478	$1,713,526	<0.1%	0.1%

Jurisdiction	Total Replacement Cost Value (All Occupancies)	Estimated Total Damages		Percent of Total Building and Contents Replacement Cost Value	
		100-Year	500-Year	100-Year	500-Year
Frankford (Twp)	$3,129,888,305	$371,869	$3,658,865	<0.1%	0.1%
Franklin (B)	$1,921,211,856	$331,708	$1,932,696	<0.1%	0.1%
Fredon (Twp)	$1,372,050,934	$231,557	$2,088,224	<0.1%	0.2%
Green (Twp)	$1,598,635,804	$314,315	$2,917,436	<0.1%	0.2%
Hamburg (B)	$1,588,049,291	$274,204	$1,408,409	<0.1%	0.1%
Hampton (Twp)	$2,196,131,598	$304,221	$2,943,964	<0.1%	0.1%
Hardyston (Twp)	$3,183,033,542	$872,641	$4,516,987	<0.1%	0.1%
Hopatcong (B)	$2,888,571,676	$385,082	$3,109,993	<0.1%	0.1%
Lafayette (Twp)	$1,958,174,065	$223,659	$1,759,760	<0.1%	0.1%
Montague (Twp)	$1,459,611,020	$244,371	$1,842,918	<0.1%	0.1%
Newton (T)	$5,093,275,807	$277,957	$3,312,499	<0.1%	0.1%
Ogdensburg (B)	$819,879,629	$175,178	$1,046,811	<0.1%	0.1%
Sandyston (Twp)	$1,212,626,664	$158,825	$1,136,422	<0.1%	0.1%
Sparta (Twp)	$9,070,094,285	$1,619,592	$9,875,755	<0.1%	0.1%
Stanhope (B)	$1,051,183,581	$283,585	$1,946,102	<0.1%	0.2%
Stillwater (Twp)	$1,417,579,398	$226,775	$2,263,005	<0.1%	0.2%
Sussex (B)	$1,945,578,916	$87,646	$692,029	<0.1%	0.0%
Vernon (Twp)	$5,658,971,163	$2,106,600	$9,190,004	<0.1%	0.2%
Walpack (Twp)	$63,691,550	$5,301	$37,930	<0.1%	0.1%
Wantage (Twp)	$4,877,543,885	$781,076	$5,623,717	<0.1%	0.1%
Sussex County (Total)	**$60,022,853,539**	**$9,953,005**	**$67,409,158**	**<0.1%**	**0.1%**

Source: Hazus-MH 4.2; Sussex County GIS 2020; RS Means 2020

Notes: B – Borough; Twp. – Township; T = Town; % - Percent

**The Estimated Total Damages column represents the sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious, and government) based on replacement cost value.*

Table 4.3.8-7. Estimated Building Value of Residential, Commercial, and Other Occupancy Types Damaged by the 100-Year and 500-Year MRP Event Winds

Jurisdiction	Total Replacement Cost Value (All Occupancies)	Estimated Residential Damages		Estimated Commercial Damages		Estimated Damages for All Other Occupancies	
		100-Year MRP Event	500-Year MRP Event	100-Year MRP Event	500-Year MRP Event	100-Year MRP Event	500-Year MRP Event
Andover (B)	$628,463,030	$65,969	$455,728	$0	$22,504	$0	$3,819
Andover (Twp)	$3,609,679,724	$402,618	$3,187,863	$202	$210,672	$67	$46,187
Branchville (B)	$532,377,368	$49,511	$442,963	$0	$18,977	$0	$3,392
Byram (Twp)	$2,746,550,446	$158,207	$1,531,548	$206	$159,144	$65	$22,834
Frankford (Twp)	$3,129,888,305	$371,869	$3,544,452	$0	$96,755	$0	$17,658
Franklin (B)	$1,921,211,856	$302,956	$1,823,447	$19,117	$83,222	$9,635	$26,027
Fredon (Twp)	$1,372,050,934	$231,557	$2,039,186	$0	$10,674	$0	$38,364
Green (Twp)	$1,598,635,804	$314,315	$2,857,242	$0	$15,510	$0	$44,684
Hamburg (B)	$1,588,049,291	$246,517	$1,326,939	$15,786	$68,616	$11,901	$12,854
Hampton (Twp)	$2,196,131,598	$304,221	$2,860,242	$0	$61,615	$0	$22,107
Hardyston (Twp)	$3,183,033,542	$861,208	$4,414,884	$9,780	$81,912	$1,653	$20,191
Hopatcong (B)	$2,888,571,676	$357,459	$2,995,325	$16,750	$84,711	$10,873	$29,957
Lafayette (Twp)	$1,958,174,065	$223,505	$1,651,470	$116	$53,334	$38	$54,956
Montague (Twp)	$1,459,611,020	$244,371	$1,815,035	$0	$19,505	$0	$8,378
Newton (T)	$5,093,275,807	$277,957	$2,926,377	$0	$294,308	$0	$91,814
Ogdensburg (B)	$819,879,629	$165,127	$1,000,351	$3,533	$32,841	$6,518	$13,619
Sandyston (Twp)	$1,212,626,664	$158,825	$1,112,355	$0	$11,590	$0	$12,477
Sparta (Twp)	$9,070,094,285	$1,459,587	$9,303,493	$131,331	$486,978	$28,674	$85,284
Stanhope (B)	$1,051,183,581	$266,003	$1,893,816	$6,868	$29,462	$10,715	$22,824
Stillwater (Twp)	$1,417,579,398	$226,775	$2,244,493	$0	$13,995	$0	$4,517
Sussex (B)	$1,945,578,916	$87,646	$530,262	$0	$145,944	$0	$15,823
Vernon (Twp)	$5,658,971,163	$2,051,946	$9,109,822	$26,780	$49,910	$27,874	$30,272
Walpack (Twp)	$63,691,550	$5,301	$37,127	$0	$387	$0	$416
Wantage (Twp)	$4,877,543,885	$780,919	$5,502,893	$157	$87,011	$0	$33,813
Sussex County (Total)	**$60,022,853,539**	**$9,614,367**	**$64,607,314**	**$230,624**	**$2,139,577**	**$108,014**	**$662,267**

Source: Hazus-MH 4.2; Sussex County GIS 2020; RS Means 2020
Notes: B – Borough; Twp. – Township; T = Town; % - Percent

Impact on Critical Facilities and Lifelines

Utility infrastructure could suffer damage from high winds associated with falling tree limbs or other debris, resulting in the loss of power. Loss of service can impact residents and business operations alike. Interruptions in heating or cooling utilities can affect populations such as the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water, wastewater treatment, and communications. In addition to public water services, property owners with private wells might not have access to potable water due to pump failure until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its citizens.

Overall, all critical facilities and lifelines are exposed to the wind hazard. Hazus estimates the probability that critical assets (i.e., medical facilities, fire/EMS, police, EOC, schools, and user-defined facilities such as shelters and municipal buildings) could sustain damage as a result of 100-year and 500-year MRP wind events. Additionally, Hazus estimates the loss of use for each facility in number of days. Due to the sensitive nature of this dataset, individual facility estimated loss is not provided.

No critical facilities would experience damage as the result of the 100-year MRP event. Table 4.3.8-8 summarizes the percent probability that each facility type may experience damage as a result of the 500-year MRP event.

Table 4.3.8-8. Estimated Impacts to Critical Facilities for the 500-Year Mean Return Period Winds

Facility Type	Loss of Days	Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
EOC	0	1.0%	0.0%	0.0%	0.0%
Medical	0	0%-1.0%	0.0%	0.0%	0.0%
Police	0	1.0%	0.0%	0.0%	0.0%
Fire	0	0%-1.0%	0.0%	0.0%	0.0%
Schools	0	1.0%	0.0%	0.0%	0.0%

Source: Hazus-MH v4.2; Sussex County GIS 2020

Impact on Economy

Damage to structures from flooding and wind can be the most immediate result of hurricane and tropical storm events; however, this damage can have long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings. As evidenced by Hurricane Sandy, the State of New Jersey, including Sussex County, lost millions of dollars in wages and economic activity.

HAZUS-MH estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Direct building losses are the estimated costs to repair or replace the damage caused to the building. This is reported in the "Impact on General Building Stock" section discussed earlier. Business interruption losses are the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event. Refer to Table 4.3.8-9 which summarizes the economic losses estimated by Hazus.

Table 4.3.8-9. Estimated Economic Losses for the 100-Year and 500-Year Mean Return Period Hurricane Wind Events

Mean Return Period (MRP)	Inventory Loss	Relocation Loss	Building and Content Losses	Wages Losses	Rental Losses	Income Losses
100-year MRP	$0	$10	$9,953,000,000	$0	$0	$0
500-year MRP	$210,000	$506,040,000	$67,409,160,000	$0	$161,230,000	$0

Source: Hazus-MH v4.2; Sussex County GIS 2020; RS Means 2020

Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and heating or cooling provisions to the population.

Debris management can be costly and impact the local economy. Hazus estimates the amount of debris that might be produced as result of the 100- and 500-year MRP wind events. Table 4.3.8-10 summarizes the estimated debris by municipality, which should be considered a lower-bound analysis. Because the estimated debris production does not include debris generated by flooding, this is likely a conservative estimate and could be higher if multiple impacts occur.

Table 4.3.8-10. Debris Production for 100- and 500-Year Mean Return Period Event Winds

Jurisdiction	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year
Andover (B)	0	18	0	0	64	257	115	458
Andover (Twp)	0	171	0	0	639	2,554	853	3,415
Branchville (B)	0	23	0	0	156	624	153	610
Byram (Twp)	0	147	0	0	1	715	6	1,293
Frankford (Twp)	0	159	0	0	993	3,970	1,162	4,650
Franklin (B)	1	106	0	0	148	589	549	2,196
Fredon (Twp)	0	103	0	0	572	2,286	500	2,000
Green (Twp)	0	133	0	0	520	2,080	513	2,054
Hamburg (B)	1	68	0	0	76	193	609	1,525
Hampton (Twp)	0	100	0	0	810	3,240	958	3,831
Hardyston (Twp)	0	161	0	0	1,036	4,145	1,202	4,808
Hopatcong (B)	8	265	0	0	1	298	2	770
Lafayette (Twp)	0	112	0	0	570	2,280	401	1,604
Montague (Twp)	0	53	0	0	1,472	4,416	938	2,815
Newton (T)	0	237	0	0	117	569	567	2,819
Ogdensburg (B)	0	44	0	0	73	299	276	1,110
Sandyston (Twp)	0	35	0	0	2,081	6,244	1,015	3,044
Sparta (Twp)	14	480	0	0	828	3,717	1,909	8,122
Stanhope (B)	0	64	0	0	70	349	358	1,789
Stillwater (Twp)	0	55	0	0	916	3,662	997	3,989
Sussex (B)	0	65	0	0	22	108	148	737
Vernon (Twp)	0	277	0	0	1,514	5,320	2,740	9,736

Jurisdiction	Brick and Wood (tons)		Concrete and Steel (tons)		Tree (tons)		Eligible Tree Volume (cubic yards)	
	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year	100-Year	500-Year
Walpack (Twp)	0	1	0	0	69	208	34	102
Wantage (Twp)	0	240	0	0	2,158	7,552	1,774	6,379
Sussex County (Total)	**24**	**3,120**	**0**	**0**	**14,906**	**55,675**	**17,779**	**69,856**

Source: Hazus-MH 4.2; Sussex County GIS 2020
Notes: B – Borough; T – Town; Twp. – Township; % - Percent

Impact on the Environment

The impacts of hurricane related winds on the environment typically take place over a larger area. Where these events occur, widespread, severe damage to tree and plant species is likely. This includes uprooting or destruction of trees and an increased threat of wildfire in areas where dead trees are not removed. Section 4.3.5 (Flood) provides additional environmental impacts due to flooding from heavy rainfalls.

Future Changes that May Impact Vulnerability

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

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

Projected Development

Understanding future changes that impact vulnerability in the Sussex County can assist in planning for future development and ensuring that appropriate mitigation, planning, and preparedness measures are in place. It is anticipated that any new development and new residents will be exposed to the hurricane and tropical storm hazard. However, due to increased standards and codes, new development might be less vulnerable to wind-related hazards compared to the aging building stock.

Projected Changes in Population

Sussex County has experienced a population decline since 2010. According to the U.S. Census Bureau, the County's population has decreased 4.7-percent between 2010 and 2018 (U.S. Census Bureau 2020). The Township of Walpack and the Borough of Sussex have experienced the greatest decline with a decrease of 62.5-percent and 13.0-percent, respectively. The population is expected to continue to decrease as residents move away from the suburbs and towards urban centers (Stirling 2018).

Even though the population has decreased over the past decade, any changes in the density of population can impact the number of persons exposed to hurricanes and tropical storms. As the population changes, so will the number of people impacted by this hazard.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. An increase in temperatures may also lead to an increase in the frequency and intensity of coastal storms. More frequent and severe storms will increase the County's vulnerability to both wind-related and heavy rain impacts.

The northeast region of the United States has experienced a greater increase in extreme precipitation than any other region in the U.S. between 1958 and 2010, the Northeast experienced more than 70% increase in the amount of precipitation falling in rain events (Global Change 2014). Refer to Section 4.3.5 (Flood) for a discussion related to the impact of climate change due to increases in rainfall. An increase in storms will produce more wind events and may increase tornado activity. With an increased likelihood of strong winds and tornado events, all the County's assets will experience additional risk for losses as a result of extreme wind events.

Vulnerability Changes Since the 2016 HMP

Since the 2016 analysis, population statistics have been updated using the 2014-2018 American Community Survey. The Hazus wind analysis was performed in Hazus-MH v4.2 for Sussex County and was based on the most current and best available data, including building and critical facility inventories. The general building stock was also updated using RS Means 2020 building valuations that estimated replacement cost value for each building in the inventory. This provides an up-to-date look at the entire building stock for Sussex County and gives more accurate results for the exposure and loss estimation analysis.

4.3.9 Infestations and Invasive Species

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 infestation and invasive species hazard in Sussex County.

2021 HMP Changes

- This is a new hazard of concern for Sussex County.

Profile

Hazard Description

An infestation is defined as a state of being invaded or overrun by parasites that attack plants, animals and humans. Insect, fungi and parasitic infestations can result in destruction of various natural habitats and cropland, impact human health, and cause disease and death among native plant, wildlife and livestock. An infestation is the presence of a large number of pest organisms in an area or field, on the surface of a host, or in soil. They result from when an area is inhabited or overrun by these pest organisms, in numbers or quantities large enough to be harmful, threatening or obnoxious to native plants, animals and humans. Pests are any organism (insects, mammals, birds, parasite/pathogen, fungi, non-native species) that are a threat to other living species in its surrounding environment. Pests compete for natural resources or they can transmit diseases to humans, crops and livestock. Human populations are generally impacted by insect or animal infestations that can result in health impacts and can lead to potential epidemics or endemics. For more information on health impacts caused by infestations, refer to Section 4.3.2 (Disease Outbreak).

For the purpose of this HMP update, the infestation and invasive species hazard profile will include the following: Hemlock Woolly Adelgid, mosquitos, Emerald Ash Borer, Spotted Lanternfly, White and harmful algal bloom.

Hemlock Woolly Adelgid

Source: NJDA 2020

The Hemlock Woolly Adelgid, a tiny aphid-like insect from Asia, was first discovered in the Pacific Northwest in the 1920's. By the early 1950's it was discovered in Virginia and has since been found as far north as Rhode Island. Its preferred host tree is hemlock, but it may also attack spruce. A tree infested with Hemlock Woolly Adelgid will exhibit gray-green needles and cotton-like wool tufts under the needles. By frequently inspecting trees for signs of Hemlock Woolly Adelgid, a homeowner can intervene in a timely manner and possibly prevent the tree from dying (NJ DEP 2020).

Mosquitoes

Mosquito infestations can result in the spread of disease such as West Nile Virus, Eastern Equine Encephalitis (EEE), and Zika virus through bites from infested mosquitoes. Mosquitos typically lay eggs in or near standing water. For more information on infectious disease spread by mosquitoes, refer to 4.3.2 (Disease Outbreak).

Emerald Ash Borer

Source: NJDA 2020

Emerald Ash Borer (EAB) was first discovered in Somerset County in 2014 and has spread through the northern half of the state. This Asian beetle infests and kills North American ash tree species, including green, white, black and blue ash; making all native ash trees susceptible to this insect. The insect is typically present from late May through early September and is most common in June and July. Signs of infection include tree canopy dieback and yellowing and browning of leaves. Most trees die within two to four years of becoming infested (NJDA 2020).

Spotted Lanternfly

Source: NJAES 2020

The spotted lanternfly (*Lycorma deliculta*) is an Asian plant hopper. The adults are quite colorful with a black head, grayish black spotted forewings, and reddish black spotted hind wings. Adults are approximately 1" in length and a 1/2" in width and are present from mid-July through the fall. During this time, SLF adults are mating and laying eggs. Egg masses are laid on smooth surfaces and appear like a patch of mud.

In the USA, spotted lanternfly is an invasive species that could be very devastating to some New Jersey crops and hardwood trees. This insect was accidentally introduced into Pennsylvania and was confirmed in September 2014. In 2018, spotted lanternfly populations were found in New Jersey and a state quarantine encompassing Mercer, Hunterdon, and Warren counties has been established by the NJ Department of Agriculture (New Jersey Agricultural Experiment Station [NJAES] 2020).

The spotted lanternfly can feed on more than 70 plant species including cultivated grapes, fruit trees, and hardwood trees. One tree of particular importance is *Ailanthus altissima* or the Tree of Heaven which is abundant in New Jersey. Tree of Heaven typically grows in clumps in sunny areas along highways or disturbed habitats such as the edges of crop fields, open spaces, or parks. Other key tree hosts include black walnut; red maple; and agricultural crops such as grapes, hops, apples, and peaches.

As with all plant hoppers, the spotted lanternfly has sucking mouthparts that it inserts into plant tissues to remove the fluids it needs to survive. Adults and nymphs are phloem feeders that feed in large congregations on woody tissue. Although there are no numbers or estimates on the economic impact of the spotted lanternfly—because this insect feeds in large numbers it can quickly cause damage. Feeding occurs on the trunk and limbs of plants, not on the fruit or leaf tissues. During feeding, the insect excretes significant amounts of honey dew (or sugar water). Honey dew deposits provide a food source for a sooty mold fungus that can grow on plant surfaces and fruit leading to reduced photosynthesis and plant vigor, leading to additional plant damage (NJAES 2020).

White-Tailed Deer

White-Tailed Deer can be found from southern Canada to South America. In summer months, they typically live in fields and meadows and during the winter, the deer generally keep to forests. White-tailed deer are herbivores and graze on most types of plants. There are not many natural predators to white-tailed deer which causes the deer population to grow too large for their environment and some areas may experience an overpopulation of deer (National Geographic 2015).

White-tailed deer are a major component throughout the State, with the exception of the most urbanized areas, affecting forests, farms, gardens, backyards and roadways. They can have negative impacts on humans, including car accidents, depredation of agricultural and ornamental plantings, and the potential for harboring diseases that are transmissible to man or domestic animals. The size of the deer population in New Jersey is managed through controlled sport hunting, with the main goal being to maintain healthy deer populations at a density tolerable to residents. In Sussex County, the white-tailed deer population have a history of impacting agriculture in the County.

Canada Geese

One of the most widely distributed waterfowl species in the United States is the Canada goose (*Branta canadensis*). After near extinction, the species bounced back to numbers far exceeding historic estimates, due to regulatory actions, habitat restoration, species conservation initiatives, and increased man-made habitat such as mowed lawns, golf courses, and stormwater detention basins. Two classes of Canada geese exist in the U.S. Migratory Canada geese (considered the Atlantic population) are those that breed north of the continental U.S., in Alaska, Canada, Newfoundland, and Labrador. These birds spend the nonbreeding season in the U.S. and northern Mexico and are present typically between October and February. Resident Canada geese are those that spend the entire year within the continental U.S. Considered a nuisance by some and a culturally important species by others, resident geese significantly affect both human and ecosystem health (Rutgers 2013).

Harmful Algal Bloom

A harmful algal bloom (HAB) is an algal bloom that can be dangerous to people, animals or the ecology. HABs can occur in both the freshwater and marine water environments. There is no scientifically sound treatment to eliminate HABs from water bodies, so advanced and continuous monitoring is the key element in protecting health and assessing when the lake is safe for swimming and recreational activities (NJDEP 2020).

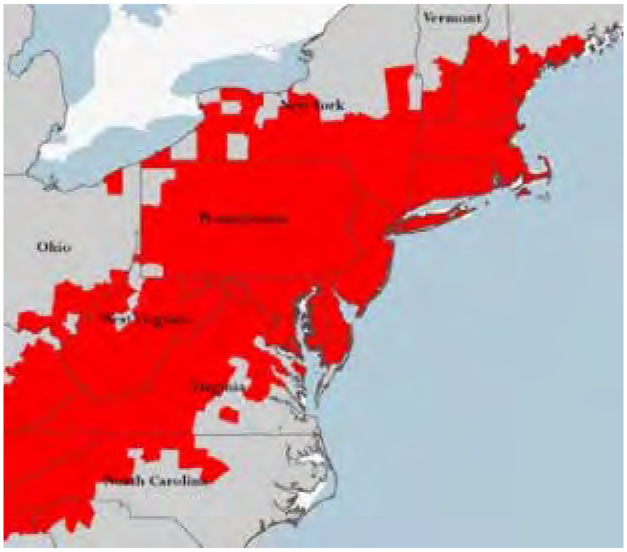
Location

Due to the diversity of landscape in Sussex County, the entire County has the potential to be impacted by each of the species identified above. Bodies of water, including Lake Hopatcong have the potential to be impacted by HABs.

Hemlock Woolly Adelgid

Hemlock Woolly Adelgid are found throughout New Jersey and many areas throughout the northeast and Appalachian Mountain.

Figure 4.3.9-1. Hemlock Woolly Adelgid Distribution in the Eastern United States

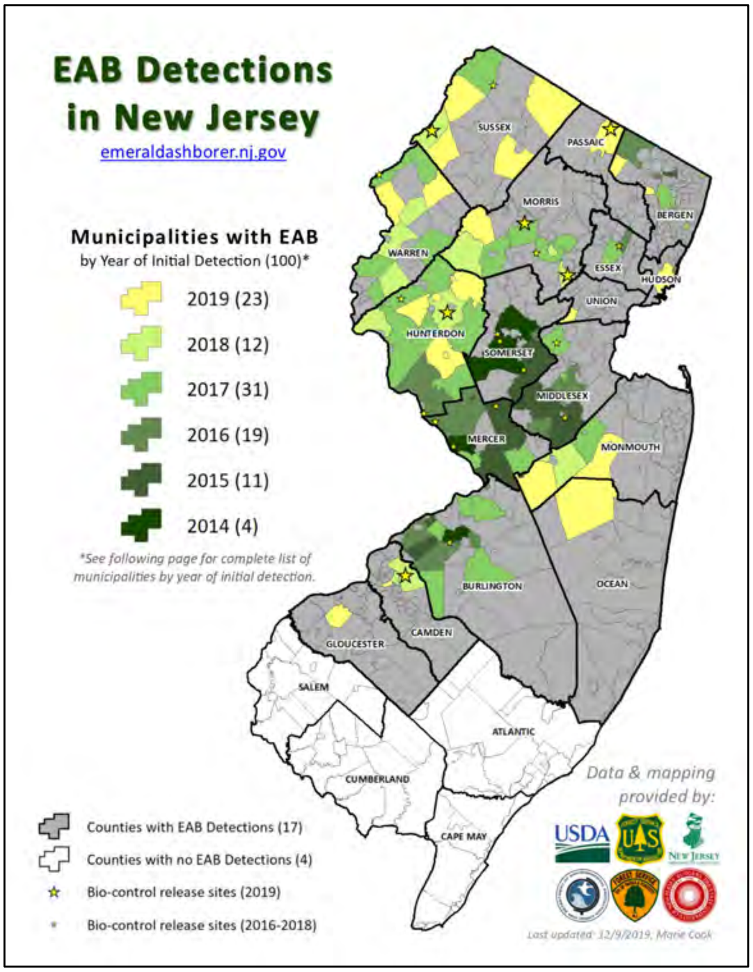


Source: USDA 2019

Emerald Ash Borer

Three species of ash are native to Sussex County an all are susceptible to EAB: white ash *(F. Americana),* green ash *(T. pennsylvanica*), and black ash (*F. nigra*). EAB was first detected in New Jersey in 2014. The New Jersey Department of Agriculture (NJDA) is coordinating New Jersey's EAB biocontrol program. Municipalities in Sussex County that have had EAB populations detected include the Township of Montague, the Township of Walpack, the Township of Sparta, the Township of Vernon, the Township of Stillwater, and the Township of Sandyston (NJDA 2020).

Figure 4.3.9-2. Emerald Ash Borer Detections in New Jersey

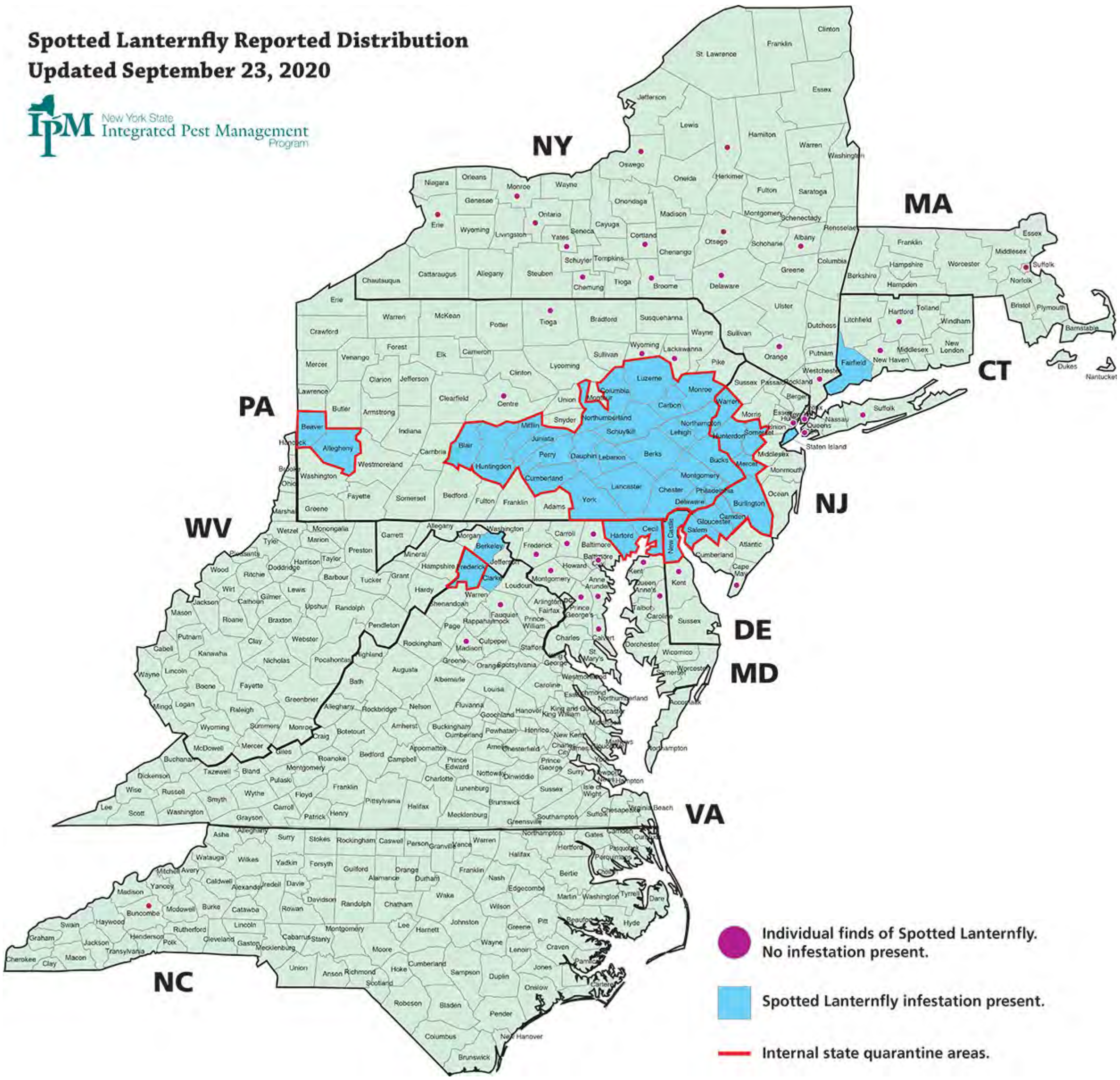


Source: State of New Jersey Department of Agriculture 2020

Spotted Lanternfly

According to NYS Integrated Pest Management (IPM), there is no spotted lanternfly infestation present in Sussex County as of September 2020; however, spotted lanternflies have been identified within the County during the fall of 2020. Refer to Figure 4.3.9-3 which displays a map of the distribution reported in the Northeast.

Figure 4.3.9-3. Spotted Lanternfly Reported Distribution as of September 2020



Source: NYS IPM 2020

White-Tailed Deer and Canada Geese

White-Tailed Deer and Canada Geese are found throughout Sussex County and New Jersey. Canada Geese are most commonly found near water bodies. White-Tailed Deer are most commonly found on the edge of wooded areas.

Harmful Algal Bloom

HABs have the potential to impact waterbodies throughout Sussex County and New Jersey.

Extent

The extent and location of infestations and invasive species depends on the preferred habitat of the species, as well as the species' ease of movement and establishment. However, each of these threats can impact many areas of Sussex County. The magnitude of infestations and invasive species ranges from nuisance to widespread. The threat is typically intensified when the ecosystem or host species is already stressed, such as periods of drought. The already weakened state of the ecosystem causes it to more easily be impacted to an infestation.

Hemlock Woolly Adelgid

The Hemlock Woolly Adelgid nymphs and adults feed on sap from the tree's twigs. The tree drops its needles and, if left uncontrolled, the adelgid can kill a tree within a year. Treatment involves manual removal of infected tree branches or spraying of horticultural oils (NJ DEP 2020).

Mosquitoes

The extent of mosquito-borne viruses is described in Section 4.3.2 (Disease Outbreak). Disease impacts can result in flu-like symptoms, brain damage, or death.

Emerald Ash Borer

The NJ Emerald Ash Borer Task Force and other experts predict a 99% mortality rate for untreated ash trees. Peak die off of trees is likely to occur 9 to 10 years after the initial infestation. This suggests that Sussex County will be dealing with large volumes of tree deaths in the next 15 years. Management options for EAB include tree removal, treating with insecticides, and biological controls (the release of wasps which act as parasitoids for egg and larvae). The United States Department of Agriculture, Animal and Plant Health Inspection Service, Plant Protection and Quarantine (USDA, APHIS, PPQ), operates the biological control production facility in Michigan which was designed to produce EAB parasitoids for release. In order to be considered for inclusion in the parasitoid release program, release sites must meet a certain criteria to be eligible: the site must be forested at least 40 acres in size; the site must contain no less than 25 percent ash of varying age classes; ash trees must be relatively healthy; and EAB must be detected in close proximity to the release site and be in low to moderate densities (NJDA 2020).

Spotted Lanternfly

Spotted Lantern Fly damages plants through the extraction of plant sap. Infestations of Spotted Lanternfly can result in decimation of crops, forest habitat, and landscaping (NJDA 2020).

White-Tailed Deer

White-Tailed Deer can have negative impacts on humans, including vehicle collisions, depredation of agricultural and ornamental plantings, and the potential for harboring parasites which can transmit diseases to man or domestic animals. Deer are selective browsers, and over time, herds can eat some plants out of existence and reduce the populations of other plants. Because tree seedlings are especially vulnerable to hungry deer, the future species composition of forests can be determined by deer browsing. While trees eventually grow out of a deer's reach, many other plants never do. Because deer browsing can significantly change habitat composition, it also exerts a strong influence on other animal populations (NJ DEP 2019).

Canada Geese

Canada geese are carriers of several bacteria and parasites that may be pathogenic to humans. The bacterium most commonly associated with Canada goose droppings is the fecal coliform, *Escherichia coli* (*E. coli*). High levels of *E. coli* can result in closure of recreational waterways. Canada geese can be a threat to aircraft and can result in air strikes. Aggressive behavior of nests and protection of goslings can result in attacks on humans and pets in areas commonly used for recreational purposes. Canada goose damage in agricultural systems can be severe (Rutgers 2013).

Harmful Algal Bloom

Some, but not all, HABs produce chemicals that can be toxic to humans and animals if ingested, inhaled, or if contacted by skin or mucous membranes. These toxins can also accumulate in fish and shellfish which can cause illness when either are consumed (NJDEP 2020). NJDEP now has an algal bloom sampling dashboard (HAB Interactive Map Reporting and Communication System) available online with samples categorized in accordance with alert levels as displayed in Figure 4.3.9-4.

Figure 4.3.9-4. HAB Alert Levels

HAB Not Present	HAB reported and investigated. No HAB present.	None
WATCH *Suspected or confirmed HAB with potential for allergenic or irritative health effects*	Suspected HAB based on field survey **OR** Confirmed cell counts ≥20K - <80K cells/mL **AND** No known toxins above public health thresholds	**Public Bathing Beaches Open** Waterbody Accessible: Use caution during **primary contact (e.g. swimming) and secondary (e.g. non-contact boating)** activities Do not ingest water (people/pets/livestock) Do not consume fish
ADVISORY *Confirmed HAB with moderate risk of adverse health effects and increased potential for toxins above public health thresholds*	Lab testing for toxins Microcystins: ≥3 µg/L Cylindrospermopsin: ≥8 µg/L Anatoxin-a: ≥27 µg/L **OR** Confirmed cell counts ≥80K cells/mL	**Public Bathing Beaches Closed** Waterbody Remains Accessible: Avoid primary contact recreation Use caution for secondary contact recreation Do not ingest water (people/pets/livestock) Do not consume fish
WARNING *Confirmed HAB with high risk of adverse health effects due to high toxin levels*	Toxin (microcystins) ≥20 - <2000 µg/L	**Public Bathing Beaches Closed** Cautions as above May recommend against secondary contact recreation.
DANGER *Confirmed HAB with very high risk of adverse health effects due to very high toxin levels*	Toxin (microcystins) ≥2000 µg/L	**Public Bathing Beaches Closed** Cautions as above. Possible closure of all or portions of waterbody and possible restrictions access to shoreline.

Source: NJDEP 2021

Previous Occurrences and Losses

Infestation and Invasive Species events that have impacted Sussex County between 2015 and 2020 are discussed below. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Hemlock Woolly Adelgid is now common throughout the state. Emerald Ash Borer was first identified in Sussex County in 2017 and has continued to impact additional municipalities in the last several years. Many species of mosquitos are native to Sussex County but additional species such as the Asian Tiger Mosquito have been introduced or expanded their range into the state and Sussex County in recent decades. Spotted Lanternflies have recently entered Sussex County as of fall 2020.

White-tailed Deer and Canada Geese overpopulation continue to impact agriculture throughout Sussex County.

In 2019, recreational use of Lake Hopatcong was severely limited due to harmful algal blooms. Freeholder boards in Sussex and Sussex counties have agreed to allocate a total of $50,000 in matching funds to support an application by the Lake Hopatcong Commission for a potential $500,000 state grant to study and reduce harmful algal blooms (HABs) (Sussex County 2020). New algal blooms took place in 2020 (Northjersey.com 2020). In 2020, Lake Neepaulin and Swartswood Lake were placed under HAB watches (NJDEP 2020).

According to the NJDEP HAB Interactive Map Reporting and Communication System, samples were collected and categorized on the 'watch' alert level in the fall 2020 for Lake Hopatcong, Lake Owassa, Lake Neepaulin and Lake Musconetcong (NJDEP 2021).

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, Sussex County was included in one emergency declaration related to infestation or invasive species for West Nile Virus. For more information regarding the impacts of West Nile Virus, refer the Section 5.4.13 (Disease Outbreak).

Table 4.3.9-1. Infestation or Invasive Species-Related Disaster (DR) and Emergency (EM) Declarations 1954-2020

Declaration	Event Date	Declaration Date	Event Description
EM-3156	May 30 -November 1, 2000	November 1, 2000	West Nile Virus Threat

Source: FEMA 2020

U.S. Department of Agriculture Disaster Declarations

The Secretary of Agriculture from the 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 2015 and 2020, Sussex County was not included in any infestation or invasive species related agricultural disaster declarations.

Probability of Future Occurrences

Based on historical documentation, increased incidences of infestation throughout the State of New Jersey and the overall impact of changing climate trends, it is estimated that Sussex County and all its jurisdictions will continue to experience infestation events that may induce secondary hazards and health threats to the County population if infestations are not prevented, controlled or eradicated effectively.

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for infestation and invasive species in the county is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the infestation and invasive species hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Providing projections of future climate change for a specific region is challenging. Shorter term projections are more closely tied to existing trends making longer term projections even more challenging. The further out a prediction reaches the more subject to changing dynamics it becomes.

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation. Changes in winter temperatures could result in a change in the frequency of ice jam events.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

The following provides information on the different infestations impacted Sussex County and how they may be affected by climate change.

Hemlock Woolly Adelgid, Emerald Ash Borer, Mosquitoes, and Spotted Lanternfly

A warmer climate would extend the active insect season and allow for species that are not as cold tolerant to move north and expand their range. This increases the extent of invasive insects and their related impacts.

Harmful Algal Bloom

The projected increase in precipitation is expected to occur via heavy downpours and less in the form of light rains. Rising air temperatures intensify the water cycle by increasing evaporation and precipitation, which can cause an increase in rain totals during storm events, with longer dry periods between those events. Alternating periods of drought and heavy rainfall increase the likelihood of nutrient runoff into waterways, which can fuel algal blooms (EPA 2017a).

Warmer temperatures could lead to an increase of the length of the algal growing season and increase the likelihood of algal blooms. In addition to warmer temperatures and heavy precipitation events, carbon dioxide levels are forecast to continue to increase. Higher levels of carbon dioxide in the atmosphere and water can lead to increased algal growth, particularly for cyanobacteria that float at the surface (EPA 2017a).

White-Tailed Deer and Canada Geese

White-Tailed Deer and Canada Geese are cosmopolitan species and are found in a wide variety of climates. As such, neither species is likely to be significantly impacted by climate change.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. All of the County is considered exposed to infestations and invasive species, with waterbodies potentially vulnerable to the harmful algal bloom hazard of concern. The following text evaluates Sussex County's vulnerability in a qualitative nature.

Impact on Life, Health and Safety

The entire population of Sussex County is vulnerable to infestations, invasive species, and harmful algal blooms. According to the 2018 American Community Survey (ACS) 5-year Estimate, Sussex County had a population of 142,298. Of that total population, the elderly population and people with suppressed immune systems are most susceptible to the effects of infestations such as West Nile Virus. The ACS has identified that there are 22,889 persons over the age of 65 in Sussex County.

As discussed earlier, infestations can have an impact on agricultural commodities. The NJDA has indicated that New Jersey farmers lose $290 million annually in direct crop loss or damage caused by agricultural pests (New Jersey Department of Agriculture n.d.). This destruction of crop may include consumable resources that are sold to persons in the County. Section 4.3.2 (Drought) discusses the number of farms that are operating in the County (i.e., 1,008 farms). Based on the Department of Agriculture's study, it is reasonable to assume that the farms in Sussex County also experience losses in crops. This not only impacts the livelihood of the farmers; it also affects the community that relies on these crops for food or other commodities.

Additionally, the impacts of harmful algal blooms on life, health, and safety depend on several factors, including the severity of the event and whether citizens and tourists have become exposed to waters suspected of containing toxins associated with cyanobacteria. Routes of exposure include consumption, inhalation, and dermal exposure. The population living near or visiting waterbodies is at risk for exposure as well as those that use those waterbodies for recreation, fishing, and water supply. Contact with water containing harmful algal blooms can cause various health effects including diarrhea, nausea or vomiting; skin, eye, or throat irritation; and allergic reactions or breathing difficulties (CDC 2020).

Further, the population living near waterbodies is at risk for exposure to HABs as well as those that use those waterbodies for recreation, fishing, and water supply. Therefore, exposure should not be limited to only those who reside in a defined hazard zone, but visitors to Sussex County waterbodies as well. Contact with water containing HABs can cause various health effects including diarrhea, nausea or vomiting; skin, eye, or throat irritation; and allergic reactions or breathing difficulties (NJDEP 2020).

Cyanobacteria blooms are one of the most common freshwater HABs and have been identified by NJDEP as being present in Sussex County blooms. Cyanobacteria are known to produce toxins from the following classes:

Endotoxins: Endotoxins associated with cyanobacteria have been tied to fever and inflammation in humans that have come in contact with water that contains cyanobacterial blooms.

Hepatotoxins: Hepatotoxins are commonly tied to animal poisonings that are associated with cyanobacterial blooms. Animals may exhibit weakness, heavy breathing, paleness, cold extremities, vomiting, diarrhea, and bleeding in the liver. In humans, hepatotoxins have been indicated to promote tumors and may lead to increases in liver cancer. Some types of hepatotoxins, such as microcystin, can persist in fresh water for up to 2 weeks before being naturally broken down (algae).

Neurotoxins: Neurotoxins act to block transfers between neurons. Extreme cases can result in paralysis (EPA 2014).

The EPA has established an incident checklist for HAB incidents impacting water utilities (EPA 2017). This tool is available to help utilities detect, identify, and monitor a bloom. The County is recommended to coordinate with the supplier to ensure that the water is clear of harmful algae, thus maintaining the safety of users of the purchased water.

Impact on General Building Stock

Structures are not anticipated to be directly affected by infestation, invasive species, or harmful algal blooms. However, the EAB may cause a catastrophic loss of ash trees throughout the County, which could result in stream bank instability, erosion, and increased sedimentation, impacting ground stabilization and possibly cause foundation issues for nearby structures. Additionally, with an increased number of dead trees, there is an increased risk of trees falling on roadways, power lines, and buildings.

Some invasive plants have been shown to destabilize soil due to high densities and shallow root systems, negatively impacting nearby buildings and septic systems. Other invasive plant species have been known to clog culverts and streams, increasing flooding risk.

Impact on Critical Facilities and Lifelines

Water treatment plants could be impacted by infestation and invasive species because of similar issues that the general building stock may experience. Water that becomes polluted due to increased sedimentation and erosion will require additional treatment. If the system becomes clogged with these pollutants, the ability of water treatment plants to operate may become impaired. Additionally, soil that becomes unstable due to decaying vegetation can impact critical facilities that are built on or around these soils.

The typical impact harmful algal blooms have on critical facilities are shutdowns of water intakes from the surface waters that are impacted by blooms and their toxins. Water treatment plants can remove variable amounts of microcystin from drinking water depending on the active removal process used by the water treatment plant (EPA 2020). However, applying the wrong treatment process at a specific state in treatment could damage the facility and release cyanotoxins rather than remove them. The EPA has summarized the effectiveness of treatment options for harmful algal blooms (refer to Table 4.3.9-2).

Table 4.3.9-2. Assessment of Treatment Options for HABs

Treatment Process	Relative Effectiveness
Intracellular Cyanotoxins Removal (Intact Cells)	
Pre-treatment oxidation	Oxidation often stresses or lyses cyanobacteria cells releasing the cyanotoxin to the water. If oxidation is required to meet other treatment objectives, consider using lower doses of an oxidant less likely to lyse cells. If oxidation at higher doses must be used, sufficiently high doses should be used to not only lyse cells but also destroy total toxins present (see extracellular cyanotoxin removal).
Coagulation/ Sedimentation/ Filtration	Effective for the removal of intracellular toxins (cyanobacteria cells). Ensure that captured cells accumulated in sludge are removed frequently to release toxins. Ensure that sludge supernatant is not returned to the supply after sludge separation.
Membranes	Effective for removal of intracellular cyanotoxins (cyanobacteria cells). Microfiltration and ultrafiltration are effective when cells are not allowed to accumulate on membranes for long periods of time. More frequent cleaning may be required during a bloom event.
Flotation	Flotation processes, such as Dissolved Air Flotation (DAF), are effective for removal of intracellular cyanotoxins since many of the toxin-forming cyanobacteria are buoyant.
Extracellular (Dissolved) Cyanotoxins Removal	

Treatment Process	Relative Effectiveness
Membranes	Depends on the type of cyanotoxin, membrane material, membrane pore size distribution, and influent water quality. Nanofiltration is generally effective in removing extracellular microcystins. Reverse osmosis filtration is generally applicable for removal of microcystins and cylindrospermopsin. Cell lysis is highly likely. Further research is needed to characterize performance.
Potassium Permanganate	Effective for oxidizing microcystins and anatoxins. Further research is needed for cylindrospermopsin. Not effective for oxidizing saxitoxin.
Ozone	Very effective for oxidizing microcystins, anatoxin-a, and cylindrospermopsin. Not effective for oxidizing saxitoxin.
Chloramines	Not effective.
Chlorine dioxide	Not effective at doses typically used in drinking water treatment.
Free Chlorine	Effective for oxidizing microcystins as long as the pH is below 8. Effective for oxidizing cylindrospermopsin and saxitoxin. Not effective for oxidizing anatoxin-a.
UV Radiation	UV radiation alone is not effective at oxidizing microcystins and cylindrospermopsin at doses typically used in drinking water treatment. When UV radiation is coupled with ozone or hydrogen peroxide (called “advanced oxidation”), the process is effective at oxidizing anatoxin-a, cylindrospermopsin, and with high UV doses, microcystins.
Activated Carbon Adsorption	Powdered activated carbon (PAC): Effectiveness of PAC adsorption varies based on type of carbon, pore size, type of cyanotoxin, and other water quality parameters such as natural organic matter (NOM) concentration. Wood-based activated carbons are generally the most effective at microcystins adsorption. More research is needed to evaluate PAC’s effectiveness at adsorbing cylindrospermopsin, anatoxin-a, and saxitoxin, however the limited research has demonstrated promising results. Doses in excess of 20mg/L may be needed for complete toxin removal, especially if NOM concentrations are high. Granular activated carbon (GAC): Effectiveness of GAC adsorption varies based on type of carbon, pore size, type of cyanotoxin, and other water quality parameters such as NOM concentration. GAC is effective for microcystins, and likely effective for cylindrospermopsin, anatoxin-a and saxitoxin. The condition of the carbon is an important factor in determining GAC’s effectiveness for cyanotoxin removal. GAC may need to be regenerated more frequently to ensure adequate adsorption capacity for HAB season.

Source: EPA 2020

Impact on Economy

Impacts of infestation, invasive species, and harmful algal blooms on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with activities and programs implemented to conduct surveillance and address invasive species and infestations have not been quantified in available documentation. However, as indicated by the NJDA, farmers across the State may collectively revenue because of crop losses from invasive species and infestations (New Jersey Department of Agriculture n.d.). In 2017, there were 25,671 acres of cropland in Sussex County, and 20,441 acres that was harvested (USDA 2017). Revenues for Sussex County from crop sales and livestock stocks sales were approximately $10.8 million and $7.4 million, respectively. Therefore, it is reasonable to believe that Sussex County farmers have experienced monetary losses from infestations.

The New Jersey Forest Service has indicated that 9-percent of New Jersey forests are susceptible to EAB attacks (NJDEP 2016). EAB can infect nursery stock and mature trees, which could reduce the timber value of hardwood exports (CFIA 2014). In 2010, the USDA Northern Research Station conducted computer simulations of EAB spread to estimate the cost of ash tree treatment, removal, and replacement (re-planting of new trees) between 2009 and 2019. The simulations predicted an EAB infestation covering 25 states, and assumed treatment, removal, and replacement of more than 17 million ash trees on developed land within established communities. The total costs were estimated at $10.7 billion. This figure doubled when the model was reset to include developed land outside, as well as inside, human communities (USDA 2013).

HAB-related economic impacts on Sussex County would largely focus on the agricultural and recreation sector. News of a closure of a body of water can result in visitors avoiding the area. Even after closures are lifted, negative public reaction can persist and continue to impact local revenue and property values. As mentioned, there is a price tied to programs that protect water bodies from harmful algal blooms. The cost to operate and monitor these programs will vary depending on the extent of the blooms. Additional costs may include money spent on nutrient reduction programs for agricultural commodities, purchasing backup water sources, and costs to implement advanced drinking water treatment. Agricultural producers may need to develop better strategies to reduce the nutrient runoff that cause harmful algal blooms, which may increase production costs for their commodities and overall costs for their buyers.

Impact on the Environment

As previously discussed, Sussex County's parks, forests and neighborhood trees are vulnerable to mosquitos, spotted lanternfly, Canadian geese, and EAB. Species that cause eventual destabilization of soil, such as invasive insects that destroy plants or invasive plants that outcompete native vegetation but have less effective root systems, can increase runoff into waterbodies. This can lead to increased harmful algal blooms and negative impact on drinking water supplies. Soil destabilization can also increase the likelihood of mudslides in areas with a steep slope.

The New Jersey Forest Service has indicated that EAB will first infest the top of the tree's crown. This leads to the crown dying, bark splitting, and exit holes are created on lower parts of the tree. Trees that are infested only live on average of 3 to 4 years (NJDEP 2016).

Furthermore, harmful algal blooms can release toxins that can kill fish and invertebrate (EPA 2019). Animals that prey on fish and invertebrates in surface waters, such as birds and mammals, may be affected if they ingest impacted prey. Both harmful and non-harmful algal blooms can have drastic impacts on oxygen levels in surface waters. When algae begin to die off following a bloom, bacteria begin to decompose the organic material. This decomposition consumes dissolved oxygen and releases carbon dioxide. If the bloom and die off is large enough, dissolved oxygen levels in aquatic systems can rapidly crash. Anoxic conditions connected to algal blooms have resulted in large fish and invertebrate kills.

Future Changes that May Impact Vulnerability

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

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

Projected Development

As discussed in Sections 3 (County Profile) and 9 (Jurisdictional Annexes), areas targeted for future growth and development have been identified across Sussex County. Changes in land use have the potential to render some habitats more susceptible to invasive species, such as clearing the land and providing opportunities for invasive species to inhabit the area. Clearing the land may also reduce the habitat for predator species that could manage the spread of invasive species naturally. As increased development is often associated with stormwater and runoff issues, harmful algal blooms may become more likely in areas of increased development. The specific areas of development are indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population nearby waterbodies can impact the number of persons exposed to harmful algal blooms. During summer months, there is an increase in visitors to the County's lakes and shorelines which can increase exposure to harmful algal blooms.

Infestation to cropland and nurseries can also have an impact on persons outside of Sussex County if the farmers within the County supply resources to neighboring communities. Being aware of trends occurring around the County may reveal that infestations within agricultural commodities provided by the County impacts a greater number of persons.

Climate Change

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Changing weather patterns could create a change in the migration patterns for when these species move into and out of Sussex County. If the species have a more prolonged existence in the County, there may also be a greater number of infestation events or a higher value of loss tied to infestation. Warmer temperatures could lead to an increase of the length of the algal growing season and increase the likelihood of algal blooms. Increased alternation of drought and heavy precipitation could result in additional nutrient runoff into local waterbodies, providing more fuel for algal blooms. Higher carbon dioxide levels in the atmosphere and surface waters could create a more favorable growing environment for HABs (EPA 2019).

Vulnerability Change Since the 2016 HMP

Harmful algal blooms, infestations, and invasive species are a new hazard of concern for Sussex County.

4.3.10 NOR'EASTER

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 Nor'Easter hazard in Sussex County.

2021 HMP UPDATE CHANGES

- Previous occurrences were updated with events that occurred between 2015 and 2021.
- An updated qualitative vulnerability assessment was conducted.

Profile

Hazard Description

A Nor'Easter is a cyclonic storm that moves along the East Coast of North America. It is called a Nor'Easter because the damaging winds over coastal areas blow from a northeasterly direction. Nor'Easters can occur any time of the year, but are most frequent and strongest between September and April. These storms usually develop between Georgia and New Jersey within 100 miles of the coastline and typically move from southwest to northeast along the Atlantic Coast of the United States (NOAA 2013). A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted.

In order to be called a Nor'Easter, a storm must have the following conditions, as per the Northeast Regional Climate Center (NRCC):

- Must persist for at least a 12-hour period
- Have a closed circulation
- Be located within the quadrilateral bounded at 45°N by 65°W and 70°W and at 30°N by 85°W and 75°W
- Show general movement from the south-southwest to the north-northeast
- Contain wind speeds greater than 23 miles per hour (mph)

A Nor'Easter event can cause storm surges, waves, heavy rain, heavy snow, wind, and coastal flooding. Nor'Easters have diameters that can span 1,200 miles, impacting large areas of coastline. The forward speed of a Nor'Easter is usually much slower than a hurricane, so with the slower speed, a Nor'Easter can linger for days and cause tremendous damage to those areas impacted. Approximately 20 to 40 Nor'Easters occur in the northeastern United States every year, with at least two considered severe (Storm Solution, 2014). New Jersey can be impacted by 10 to 20 Nor'Easters each year, with approximately five to 10 of those having significant impact on the State. The intensity of a Nor'Easter can rival that of a tropical cyclone in that, on occasion, it may flow or stall off the mid-Atlantic coast resulting in prolonged episodes of precipitation, coastal flooding, and high winds.

For the purpose of this HMP, only Nor'Easter events are being further discussed within this hazard profile, due to their significant historical impact on Sussex County. For information flooding related to Nor'Easters, refer to Section 4.3.5 (Flood) and Section 4.3.8 (Hurricane). For information on severe winter storms, refer to Section 4.3.12.

Location

The entire State of New Jersey, including Sussex County, is susceptible to the effects of Nor'Easters; however, coastal communities and other low-lying areas are particularly vulnerable. Nor'Easters usually form off the east coast near the Carolina, and then follow a track northwards along the coast until they blow out to sea. Although Sussex County is bordered to the west by the Delaware River which is considered a coastal boundary in New Jersey, it is well upriver of areas that would experience coastal flooding. The County is exposed to the direct and indirect impacts of a Nor'Easter including rain, snow, and wind.

Extent

The magnitude or severity of a severe winter storm or Nor'Easter depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and time of occurrence during the day (e.g., weekday versus weekend), and time of season.

The extent of a severe winter storm can be classified by meteorological measurements and by evaluating its societal impacts. NOAA's National Climatic Data Center (NCDC) is currently producing the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from 1 to 5. It is based on the spatial extent of the storm, the amount of snowfall, and the interaction of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCDC 2011). Table 4.3.10-1 presents the five RSI ranking categories.

Table 4.3.10-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCDC 2011
Note: RSI = Regional Snowfall Index

Previous Occurrences and Losses

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2020, FEMA included the State of New Jersey in seven Nor'Easter-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: severe storm, high tides, flooding, coastal storm, coastal flooding, or tropical depression. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Sussex County has been included in two Nor'Easter-related declarations. Table 4.3.10-2 lists FEMA DR and EM declarations for Sussex County.

Table 4.3.10-2. FEMA Declarations for Nor'Easter Events in Sussex County

FEMA Declaration Number	Date(s) of Event	Date Declared	Event Type
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storms and Inland and Coastal Flooding

FEMA Declaration Number	Date(s) of Event	Date Declared	Event Type
DR-4048	October 29, 2011	November 30, 2011	Severe Storm

Source: FEMA 2020; NJ HMP 2019

For this plan update, known Nor'Easter events that have impacted Sussex County between 2015 and 2021 are identified in Table 4.3.10-3. Events identified in the 2016 HMP are included in Appendix E (Risk Assessment Supplement). For detailed information on damages and impacts to each municipality, refer to Section 9 (Jurisdictional Annexes).

Table 4.3.10-3. Nor'Easter Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
January 22-24, 2016	Winter Storm	DR-4264	No	Sussex County	An impulse from the west coast traversed the midsection of the country, then developed into a low pressure system as it tracked across the Gulf states before intensifying along the Carolina coast into a major nor'easter, producing record snowfall in parts of New Jersey on January 23rd. It then moved out to sea after passing by the mid-Atlantic coast early on January 24th. Snow began falling during the Friday afternoon commute on January 22nd, then continued, heavy at times, Friday night into early Sunday morning. Wind gusts up to 60 MPH produced blizzard conditions as visibilities dropped to one-quarter mile or less in spots. Representative snowfall totals include 16.0 inches in Stockholm (Sussex).
January 24, 2017	Heavy Rain, Nor'Easter	N/A	N/A	Sussex County	Just over 2 inches of rain fell in association with the Nor'easter.
March 14, 2017	Blizzard	N/A	N/A	Sussex County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind and a foot of snow were reported across Sussex County.
March 2, 2018	Winter Storm	N/A	N/A	Sussex County	A heavy, wet snow accumulated to a depth of over 16 inches in the higher elevations of the county, and around 6 inches or so in the valleys. Some snowfall totals include 16.5 inches in Branchville, 14.0 inches in Highland Lakes, 13.5 inches at High Point, 8 inches near Wantage, 7.0 inches in Stockholm, and 2.3 inches near Sussex. A wind gust of 48 MPH was reported at High Point Monument at 1125EST on the 2nd. Blowing and drifting snow made travel hazardous Friday afternoon and evening. Numerous power outages, some lasting over two weeks, were widespread throughout the county due to tree and wire damage. Warming centers were established around the county for affected residents.
March 7, 2018	Winter Storm	DR-4368	No	Sussex County	Narrative A broad area of low pressure extending from the Ohio Valley to the Piedmont of South Carolina consolidated off the Virginia Capes during the early morning of March 7th. This new primary low moved northeast and gradually deepened as it passed east of the Delaware and New Jersey coasts on March 7th. The snow contained large amounts of liquid, making it heavy and wet. This resulted in downed trees, limbs, and wires, leading to numerous power outages across portions of New Jersey, especially where the heaviest snow was reported. Many customers were still without power from the previous

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					storm when this storm struck. Governor Murphy estimated about 350,000 customers state-wide lost power as a result of this second storm. Although all portions of the county experienced significant snowfall from this event, the higher amounts occurred over the central and eastern portions of the county which were closer to the low pressure system. Some reported snowfall totals include: 21.0 inches in Highland Lakes, 17.0 inches in Stockholm, 16.0 inches in Sparta, 15.5 inches in Hardyston Township, 15.0 inches in Vernon, 13.5 inches in Wantage, 12.7 inches in Montague, and 12.0 inches in Newton.
March 21-22, 2018	Winter Storm	N/A	N/A	Sussex County	A complex area of low pressure over the middle Atlantic, which involved several individual centers, slowly consolidated off the Virginia Capes Tuesday morning, March 20th into Wednesday March 21st along a frontal boundary. This primary low, the fourth nor'easter of March, gradually moved northeast Wednesday night, to a position southeast of the 40 North/70 West Benchmark coordinates on Thursday morning. Precipitation began as a wet, heavy snow during the evening hours on March 20th. After a lull during the overnight hours, a drier snow began falling, heavy at times, during the afternoon and evening hours on March 21st. The heaviest snow from this event fell in the southern one-half of the county, with a sharp drop off in the far north. Some snowfall reports include: 10.0 inches in both Stockholm and Byram Township, 9.5 inches in Fredon, 8.5 inches in both Hardyston Township and Newton, 7.0 inches in Ogdensburg, 7.0 inches in Andover, Sparta, and Franklin, 2.5 inches in Vernon Valley, 1.3 inches in Sussex, 1.1 inches in Wantage, and 0.2 inches in Montague.
March 3-4, 2019	Winter Storm	N/A	N/A	Sussex County	An offshore low pressure system brought a period of heavy precipitation to the mid-Atlantic. A mix of rain, sleet, and snow was observed, with snow confined mainly to interior areas and sleet and rain more abundant near the coast. Snowfall totals inland approached 10, with snowfall rates exceeding one inch per hour for several hours. A sharp gradient in snowfall with a steep drop in snow totals was observed just west of the Interstate 95 corridor. A trained spotter in Highland Lakes reported 8.2 inches of snow.

Source: NOAA NCEI 2020, NJ HMP 2019, SHELDUS

Probability of Future Occurrences

Sussex County will continue to experience the direct and indirect impacts of Nor'Easters. Secondary hazards may include flooding, extreme wind, erosion, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents, and inconveniences.

As with any weather phenomenon, it is nearly impossible to assign probabilities to Nor'Easters, except over the long-term. High activity seasons are when storm activity exceeds the historical 75th percentile. This means that seasons with this number of storms are expected to occur during one out of four years. Lower activity seasons are defined as when storm activity falls below the historical 75th percentile; meaning this number of storms are expected to occur during three out of four years (East Coast Winter Storms 2013).

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for nor'easter in the county is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the nor'easter hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015).

Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017).

Climate change may result in changes to the frequency of coastal storms. A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017).

Some climatologists believe that climate change may play a role in the frequency and intensity of Nor'Easters. Two ingredients are needed to produce strong Nor'Easters and intense snowfall: (1) temperatures which are just below freezing, and (2) massive moisture coming from the Gulf of Mexico. When temperatures are far below freezing, snow is less likely. As temperatures increase in the winter months, they will be closer to freezing rather than frigidly cold. Climate change is expected to produce more moisture, thus increasing the likelihood that these two ingredients (temperatures just below freezing and intense moisture) will cause more intense snow events.

Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. For the Nor'Easter hazard, all of Sussex County has been identified as potentially exposed or vulnerable. Therefore, all assets in the County (population, structures, critical facilities and lifelines), as described in Section 3, are vulnerable to a Nor'Easter.

Impact on Life, Health and Safety

The impact of a Nor'Easter on life, health and safety is dependent upon several factors including the severity of the event and whether or not adequate warning time was provided to residents. Typically, a Nor'Easter has a longer duration (potentially lasting days) than a hurricane or tropical storm event, which normally pass through an area in a matter of hours. It is assumed that the entire County's population (i.e., 142,298 total persons, American Community Survey 2018) could be exposed to this hazard (wind and rain/snow) and secondary impacts discussed earlier associated with a Nor'Easter. Further, residents may be displaced or require temporary to long-term sheltering. Refer to Section 4.3.10 (Hurricanes and Tropical Storms) which displays the peak gust wind speeds of the 100- and 500-year mean return period probabilistic wind events modeled in Hazus v4.2.

Impact on General Building Stock

The entire County's building stock is exposed to the wind and/or rain/snow from the Nor'Easter hazard. Sussex County is estimated to have 72,021 buildings, with a replacement cost value (structure and content) of approximately $60.0 billion. Refer to Section 4.3.5 (Flood), Section 4.3.8 (Hurricane and Tropical Storms), Section 4.3.11 (Severe Weather), and Section 4.3.12 (Severe Winter Weather) for more information about the wind, rain, and snow hazard impacts to the building stock in Sussex County.

Impact on Critical Facilities and Lifelines

All of Sussex County's critical facilities are exposed to the wind and/or rain/snow from the Nor'Easter hazard. Sussex County is estimated to have 596 critical facilities, all of which are considered lifelines. Refer to Section 4.3.5 (Flood), Section 4.3.8 (Hurricane and Tropical Storm), Section 4.3.11 (Severe Weather), and Section 4.3.12 (Severe Winter Weather) for more information about the wind, rain, and snow hazard impacts to the critical facilities in Sussex County.

Impact on the Economy

Nor'Easter events can greatly impact the economy, including loss of business function, damage to inventory (utility outages), relocation costs, wage loss, and rental loss due to the repair/replacement of buildings. Damages to buildings can impact a community's economy and tax base. In addition, damages to buildings and critical infrastructure, as well as road closures, can delay emergency response services during these events. Refer to Section 4.3.5 (Flood), Section 4.3.8 (Hurricane), Section 4.3.11 (Severe Weather), and Section 4.3.12 (Severe Winter Weather) for more information about the wind, rain, and snow hazard impacts to the economy in Sussex County.

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. Several factors are examined in this section to assess hazard vulnerability.

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by a Nor'Easter event if structures do not consider current mitigation measures against flooding, rain, wind, and snow. Therefore, it is the intention of the County and all participating municipalities to discourage development in vulnerable areas or to encourage higher regulatory standards at the local level.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population can impact the number of persons exposed to Nor'Easter events. Refer to Section 3 (County Profile) for more information about population trends in the County.

Climate Change

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of Nor'Easter events and their affects under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (EPA 2020).

Change of Vulnerability Since the 2016 HMP

Overall, the County's vulnerability has not changed; the entire County continues to be exposed and potentially vulnerable to the Nor'Easter hazard. Hazards that relate to Nor'Easter events (i.e., flood, hurricane, severe weather, and severe winter weather) use an updated building stock and critical facility data to assess the County's risk to flood, wind, rain, and snow. The building inventory was updated using RS Means 2020 values, which is more current and reflects replacement cost versus the building stock improvement values reported in the 2016 HMP. Further, the 2018 5-year population estimates from the ACS were used to evaluate the population exposed to the flood, hurricane, severe weather, and severe winter weather hazards of concern.

4.3.11 SEVERE WEATHER

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 severe weather hazard in Sussex County.

2021 HMP Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2015 and 2020.
- The vulnerability assessment was conducted using updated population, building and critical facility/lifeline spatial data to estimate potential losses from the wind hazard using the FEMA Hazus-MH hurricane model. These wind-related results are discussed in greater detail in Section 4.3.8 (Hurricane and Tropical storm).

Profile

Hazard Description

For the purpose of this HMP update and as deemed appropriated by the Sussex County Planning Committee, the severe weather hazard includes high winds, tornadoes, thunderstorms and lightning, extreme temperatures, and hail, which are defined below.

Thunderstorms

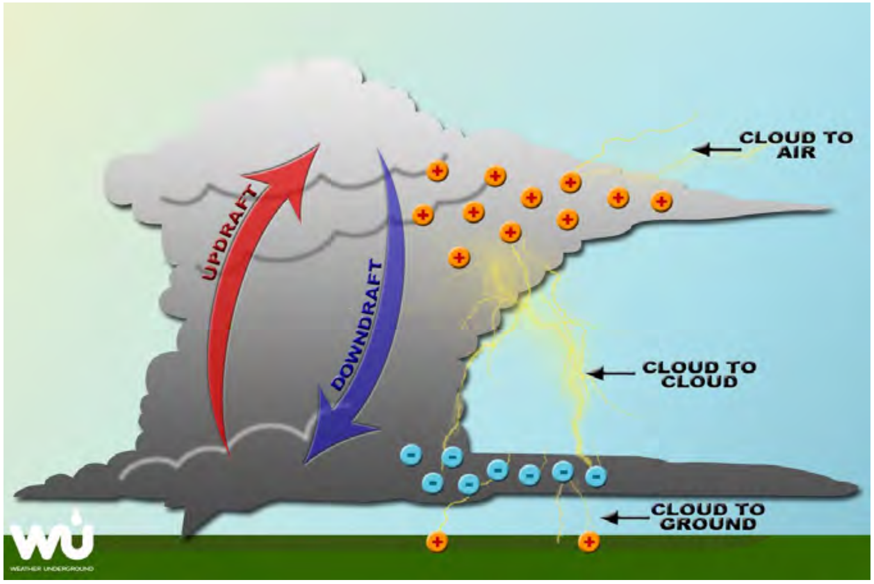
A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (National Weather Service [NWS] 2009). A thunderstorm forms from a combination of moisture; rapidly rising warm air; and a force capable of lifting air, such as a warm front, cold front, a sea breeze, or a mountain. Thunderstorms form from the equator to as far north as Alaska. Although thunderstorms generally affect a small area when they occur, they have the potential to become dangerous due to their ability to generate tornadoes, hailstorms, strong winds, flash flooding, and lightning.

Thunderstorms can lead to heavy rain induced flooding, landslides, strong winds, and lightning. Roads may become impassable from flooding, downed trees or power lines, or a landslide. Downed power lines can lead to loss of utility services, such as water, phone, and electricity. Typical thunderstorms are 15 miles in diameter and last an average of 30 minutes. During the summer, thunderstorms are responsible for most of the rainfall.

Lightning

Lighting is a bright flash of electrical energy produced by a thunderstorm. The resulting clap of thunder is the result of a shock wave created by the rapid heating and cooling of the air in the lightning channel. All thunderstorms produce lightning and are very dangerous. Lightning ranks as one of the top weather killers in the United States, killing approximately 50 people and injuring hundreds each year. Lightning can occur anywhere there is a thunderstorm. Lightning can be cloud to air, cloud to cloud, and cloud to ground. Figure 5.4.8-1 demonstrates the variety of lightning types.

Figure 4.3.11-1. Types of Lightning

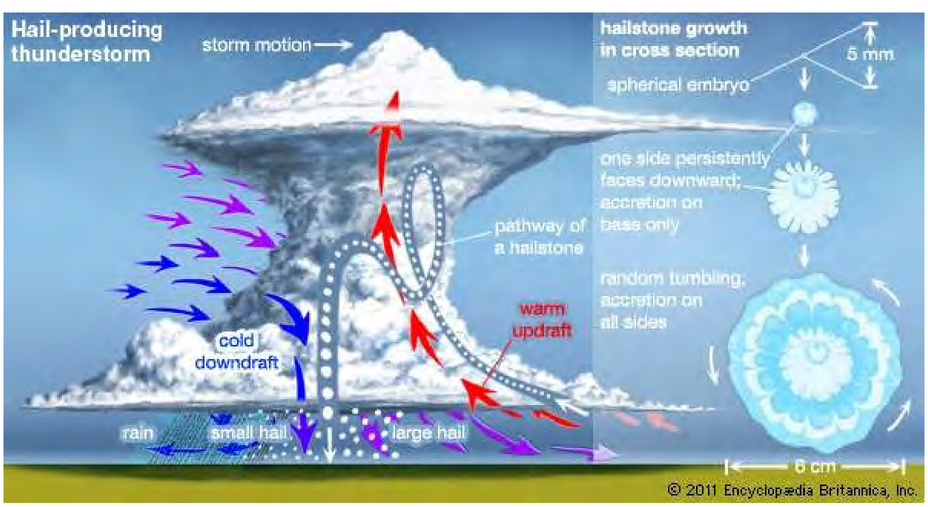


Source: Weather Underground date unknown

Hailstorms

Hail forms inside a thunderstorm or other storms with strong updrafts of warm air and downdrafts of cold water. If a water droplet is picked up by the updrafts, it can be carried well above the freezing level. Water droplets freeze when temperatures reach 32 degrees Fahrenheit (°F) or colder. As the frozen droplet begins to fall, it may thaw as it moves into warmer air toward the bottom of the thunderstorm. However, the droplet may be picked up again by another updraft and carried back into the cold air and re-freeze. With each trip above and below the freezing level, the frozen droplet adds another layer of ice. The frozen droplet, with many layers of ice, falls to the ground as hail. Most hail is small and typically less than 2 inches in diameter (NWS 2010). Figure 4.3.11-2 shows how hail is formed within thunderstorms.

Figure 4.3.11-2. Hail Formation in Thunderstorms



Source: Encyclopedia Britannica 2011

Windstorms

Wind begins with differences in air pressures and occurs through rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. High winds are often associated with other severe weather events such as thunderstorms, tornadoes, nor'easters, hurricanes, and tropical storms.

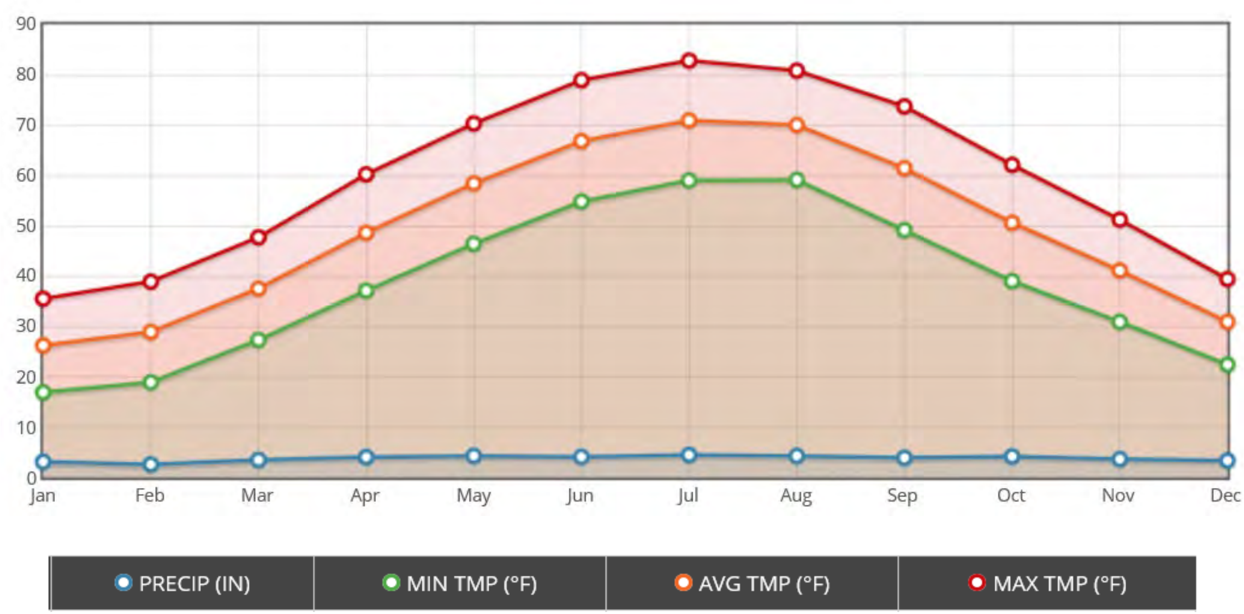
Tornadoes

A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour (mph). Damage paths can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997). Tornadoes can occur at any time of the year, with peak seasons at different times for different states (National Severe Storms Laboratory [NSSL] 2013).

Extreme Temperatures

Extreme temperature includes both heat and cold events that can have significant direct impacts to human health and commercial/agricultural businesses and primary and secondary effects on infrastructure (e.g., burst pipes and power failure). Distinguishing characteristics of "extreme cold" or "extreme heat" vary by location, based on the conditions to which the population is accustomed. Figure 4.3.11-3 shows the average low and high temperatures each month at the Sussex Airport station in Sussex County.

Figure 4.3.11-3. Average Temperatures at Sussex Airport



Source: NWS 2020

Extreme Cold

Extreme cold events are when temperatures drop well below normal in an area. In regions relatively unaccustomed to winter weather, near freezing temperatures are considered "extreme cold." Extreme cold temperatures are generally characterized in temperate zones by the ambient air temperature dropping to approximately 0ºF or below (Centers of Disease Control and Prevention [CDC] 2007). Extremely cold temperatures often accompany a winter storm, which can cause power failures and icy roads. Although staying indoors as much as possible can help reduce the risk of car crashes and falls on the ice, individuals may also face indoor hazards. Many homes will be too cold—either due to a power failure or because the heating system is not adequate for the weather. The use of space heaters and fireplaces to keep warm increases the risk of household fires and carbon monoxide poisoning (CDC 2007).

Extreme Heat

Extreme heat is defined as temperatures which hover 10 degrees or more above the average high temperature for a region and that last for several weeks (Centers for Disease Control and Prevention [CDC] 2016). A heat wave is defined as a period of abnormally and uncomfortably hot and unusually humid weather. Typically, a heat wave lasts two or more days. (National Weather Service [NWS] 2009). There is no universal definition of a heat wave because the term is relative to the usual weather in a particular area. The term heat wave is applied both to routine weather variations and to extraordinary spells of heat which may occur only once a century (Meehl and Tebaldi 2004).

Urbanized areas and urbanization creates an exacerbated type of risk during an extreme heat event, compared to rural and suburban areas. As defined by the U.S. Census, urban areas are classified as all territory, population, and housing units located within urbanized areas and urban clusters. The term urbanized area denotes an urban area of 50,000 or more people. Urban areas under 50,000 people are called urban clusters. The U.S. Census delineates urbanized area and urban cluster boundaries to encompass densely settled territory, which generally consists of:

- A cluster of one or more block groups or census blocks each of which has a population density of at least 1,000 people per square mile at the time.
- Surrounding block groups and census blocks each of which has a population density of at least 500 people per square mile at the time.
- Less densely settled blocks that form enclaves or indentations or are used to connect discontiguous areas with qualifying densities (U.S. Census 2010).

As these urban areas develop and change, so does the landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas. This forms an 'island' of higher temperatures (U.S. Environmental Protection Agency [EPA] 2009).

The term 'heat island' describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with more than one million people can be between 1.8 ºF and 5.4ºF warmer than its surrounding areas. In the evening, the difference in air temperatures can be as high as 22ºF. Heat islands occur on the surface and in the atmosphere. On a hot, sunny day, the sun can heat dry, exposed urban surfaces to temperatures 50ºF to 90ºF hotter than the air. Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and death, and water quality degradation (EPA 2010 and 2011).

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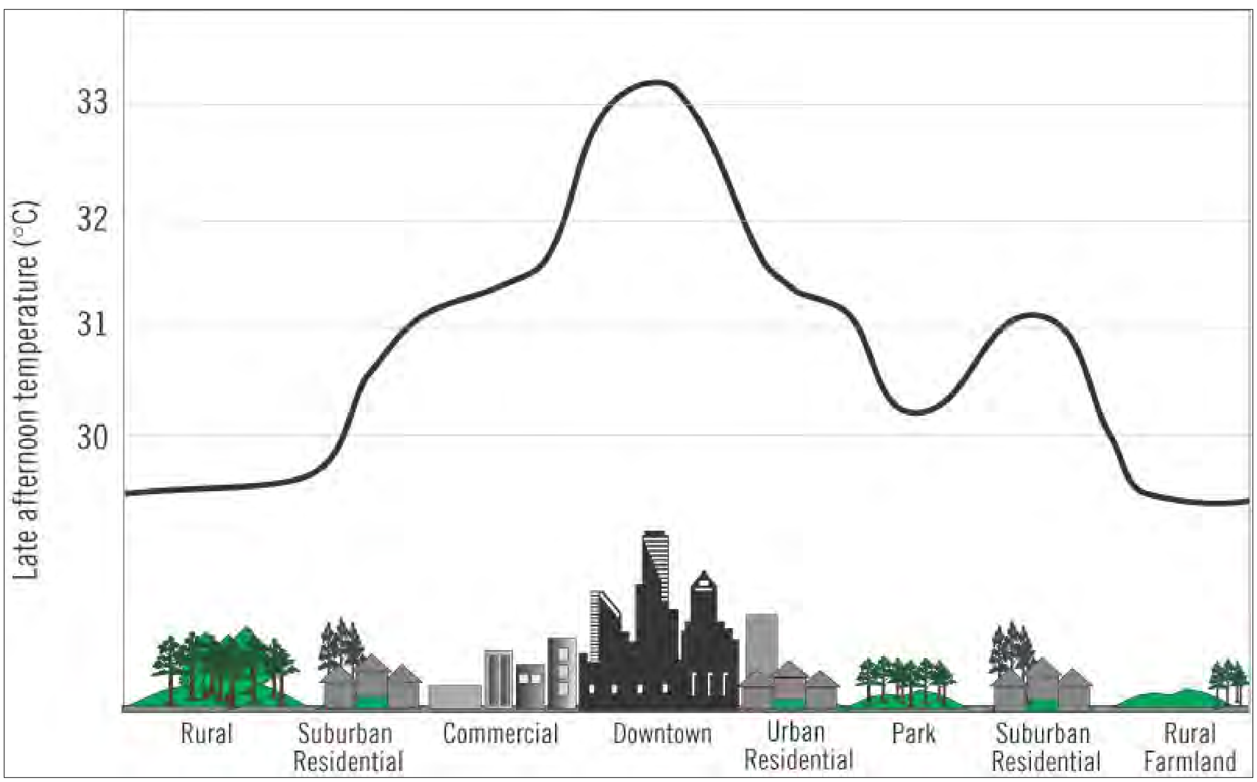
- A cluster of one or more block groups or census blocks each of which has a population density of at least 1,000 people per square mile at the time.
- Surrounding block groups and census blocks each of which has a population density of at least 500 people per square mile at the time.
- Less densely settled blocks that form enclaves or indentations, or are used to connect discontiguous areas with qualifying densities (U.S. Census 2010).

As urban areas develop and change, so does the landscape. Buildings, roads, and other infrastructure replace open land and vegetation. Surfaces that were once permeable and moist are now impermeable and dry. These changes cause urban areas to become warmer than the surrounding areas. This forms an 'island' of higher temperatures (U.S. EPA 2019).

The term 'heat island' describes built up areas that are hotter than nearby rural areas. The annual mean air temperature of a city with more than one million people can be between 1.8 ºF and 5.4ºF warmer than its surrounding areas. In the evening, the difference in air temperatures can be as high as 22ºF. Heat islands occur on the surface and in the atmosphere. On a hot, sunny day, the sun can heat dry, exposed urban surfaces to temperatures 50ºF to 90ºF hotter than the air. Heat islands can affect communities by increasing peak energy demand during the summer, air conditioning costs, air pollution and greenhouse gas emissions, heat-related illness and death, and water quality degradation (U.S. EPA 2019).

Figure 4.3.11-4 below illustrates an urban heat island profile. The graphic demonstrates that heat islands are typically most intense over dense urban areas. Further, vegetation and parks within a downtown area may help reduce heat islands (U.S. EPA 2019).

Figure 4.3.11-4. Urban Heat Island Profile

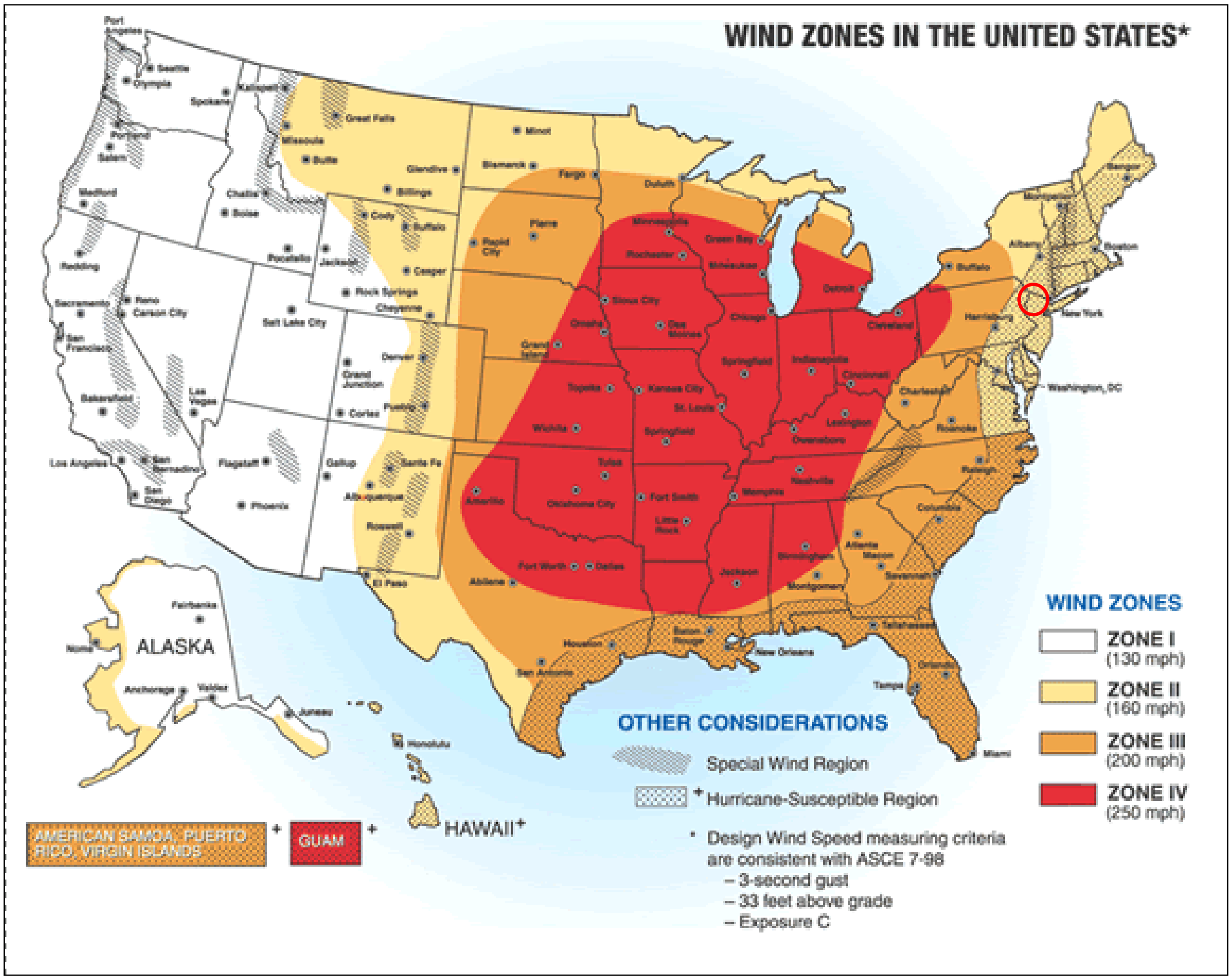


Source: EPA 2019
ºC degrees Celsius

Location

All of Sussex County is exposed to severe weather. According to the FEMA Winds Zones of the United States map, Sussex County is located in Wind Zone II, where wind speeds can reach up to 160 mph and is part of the hurricane susceptible region. Figure 4.3.11-5 illustrates wind zones across the United States, which indicate the impacts of the strength and frequency of wind activity per region. The information on the figure is based on 40 years of tornado data and 100 years of hurricane data collected by FEMA.

Figure 4.3.11-5. Wind Zones in the United States

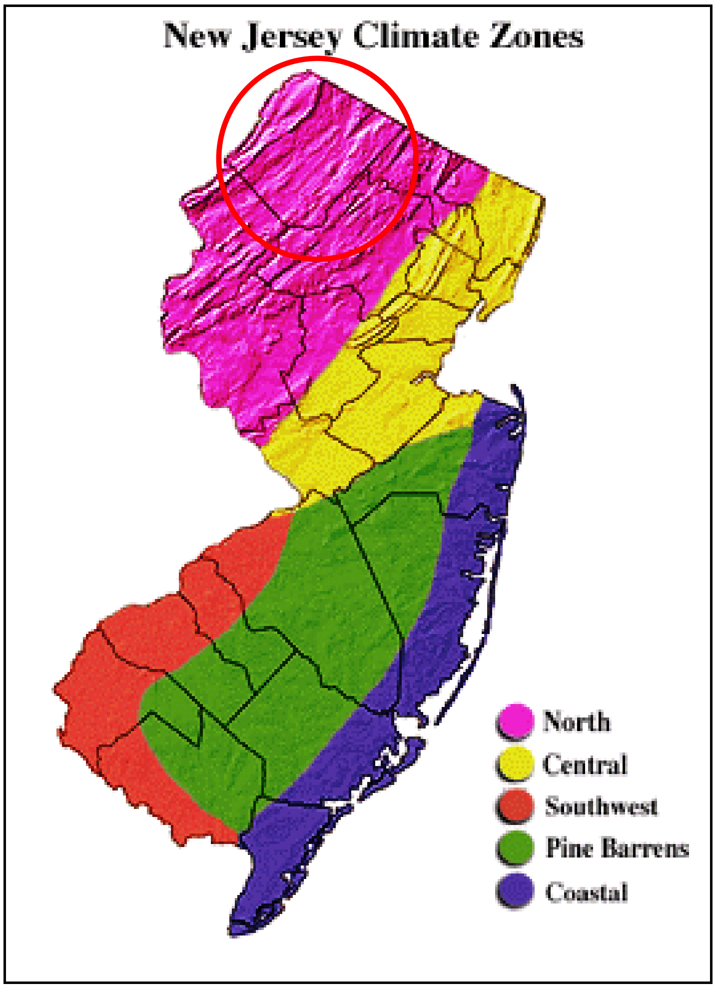


Source: FEMA 2012
Note: The red circle indicates the approximate location of Sussex County.

According to the ONJSC, New Jersey has five distinct climate regions. Elevations, latitude, distance from the Atlantic Ocean, and landscape (e.g. urban, sandy soil) produce distinct variations in the daily weather between each of the regions. The five regions include: Northern, Central, Pine Barrens, Southwest, and Coastal (ONJSC Rutgers University n.d.). Figure 4.3.11-6 depicts these regions. Sussex County is located within the Northern Climate Region.

The Northern Region covers about one-quarter of New Jersey and consists mainly of elevated highlands and valleys which are part of the Appalachian Uplands. Surrounded by land, this region can be characterized as having a continental type of climate with minimal influence from the Atlantic Ocean, except when the winds contain an easterly component. Prevailing winds are from the southwest in summer and from the northwest in winter. Being in the northernmost portion of the state, and with small mountains up to 1800 feet in elevation, the Northern Zone normally exhibits a colder temperature regime than other climate regions of the State. This difference is most dramatic in winter when average temperatures in the Northern Zone can be more than ten degrees Fahrenheit cooler than in the Coastal Zone. A storm track extending from the heart of the Mississippi Valley, over the Great Lakes, and along the St. Lawrence Valley is a major source of precipitation for this region. Coastal storms, with precipitation shields that reach well enough inland add to the precipitation totals. During the warm season, thunderstorms are responsible for most of the rainfall. Cyclones and frontal passages are less frequent during this time. Thunderstorms spawned in Pennsylvania and New York State often move into Northern New Jersey, where they often reach maximum development in the evening. This region has about twice as many thunderstorms as the coastal zone, where the nearby ocean helps stabilize the atmosphere. The Northern Climate Zone usually has the shortest growing season, about 155 days. The average date for the last killing Spring frost is May 4. The first frost in Fall is around October 7. The exact dates vary significantly within the region as well as from year to year. Some valley locations have observed killing frost in mid-September and as late as mid-June (ONJSC Rutgers University n.d.).

Figure 4.3.11-6. Climate Regions of New Jersey



Source: ONJSC Rutgers University n.d.

Note: The red circle indicates the location of Sussex County. The County is located in the North Climate Zone of New Jersey.

Extent

The extent (severity or magnitude) of a severe storm is largely dependent upon the most damaging aspects of each type of severe weather. This section describes the extent of thunderstorms, lighting, hail, windstorms, and tornadoes in Sussex County. Historical data presented in Table 4.3.11-1 shows the most powerful severe weather records in Sussex County.

Table 4.3.11-1. Severe Storm Extent in Sussex County (1950-2020)

Extent of Severe Storms in Sussex County	
Largest Hailstone on Record	1.75 inches
Strongest Tornado on Record	EF-2
Highest Wind Speed on Record	63 knots

Source: NOAA-NCEI 2019

Thunderstorms

NWS considers a thunderstorm severe if it produces damaging wind gusts of 58 mph or higher, hail 1 inch (quarter size) in diameter or larger, or tornadoes (NWS 2010). Severe thunderstorm watches and warnings are issued by the local NWS office and NOAA's Storm Prediction Center (SPC). NWS and SPC will update the watches and warnings and will notify the public when they are no longer in effect. Watches and warnings for thunderstorms in New Jersey are defined as follows:

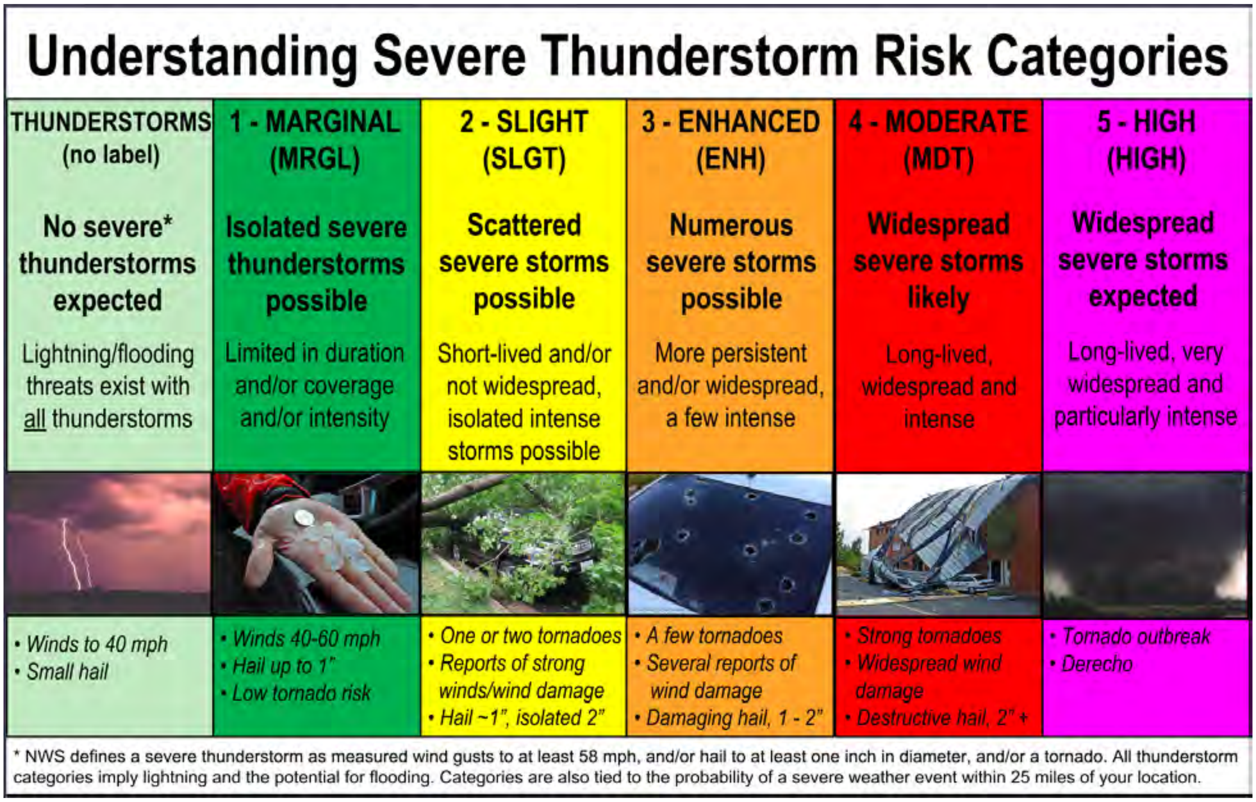
- *Severe Thunderstorm Warnings* are issued when there is evidence based on radar or a reliable spotter report that a thunderstorm is producing (or is forecast to produce) wind gusts of 58 mph or greater, structural wind damage, and hail 1 inch in diameter or greater. A warning will include the location of the storm, the municipalities that are expected to be impacted, and the primary threat associated with the severe thunderstorm warning. After it has been issued, the NWS office will follow up periodically with Severe Weather Statements, which contain updated information on the severe thunderstorm and will let the public know when the warning is no longer in effect (NWS 2010).

- *Severe Thunderstorm Watches* are issued by the SPC when conditions are favorable for the development of severe thunderstorms over a larger-scale region for a duration of at least 3 hours. Tornadoes are not expected in such situations, but isolated tornado development may also occur. Watches are normally issued well in advance of the actual occurrence of severe weather. During the watch, NWS will keep the public informed on developments happening in the watch area and will also notify the public when the watch has expired or been cancelled (NWS 2010).

- *Special Weather State for Near Severe Thunderstorms* bulletins are issued for strong thunderstorms that are below severe levels, but still may have some adverse impacts. Usually, they are issued for the threat of wind gusts of 40 to 58 mph or small hail less than one (1) inch in diameter (NWS 2010).

In addition, the SPC issues severe thunderstorm risk maps based on the likelihood of different severities of thunderstorms. Figure 4.3.11-7 shows the SPC's severe thunderstorm risk categories.

Figure 4.3.11-7. Severe Thunderstorm Risk Categories



Source: NOAA SPC 2017

Lightning

Lightning is most often associated with moderate to severe thunderstorms. The severity of lightning refers to the frequency of lightning strikes during a storm. Multiple devices are available to track and monitor the frequency of lightning.

Hail

The severity of a hailstorm is measured by duration, hail size, and geographic extent. Most hail stones from hailstorms are made up of variety of sizes. The size of hail is estimated by comparing it to a known object. Table 4.3.11-2 describes the different sizes of hail as compared to real-world objects and lists approximate measurements.

Table 4.3.11-2. Hail Size

Description	Diameter (in inches)
Pea	0.25
Marble or mothball	0.50
Penny or dime	0.75
Nickel	0.88
Quarter	1.00

Description	Diameter (in inches)
Golf ball	1.75
Hen's egg	2.00
Tennis ball	2.5
Baseball	2.75
Tea cup	3.00

Description	Diameter (in inches)	Description	Diameter (in inches)
Half dollar	1.25	Grapefruit	4.00
Walnut or ping pong ball	1.50	Softball	4.50

Source: NOAA 2012

Windstorms

Table 4.3.11-3 provides the NWS descriptions of winds during wind-producing events.

Table 4.3.11-3. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, or damaging	≥40
Very windy	30-40
Windy	20-30
Breezy, brisk, or blustery	15-25
None	5-15 or 10-20
Light or light and variable wind	0-5

Source: NWS 2015

NWS issues advisories and warnings for winds, which are normally site-specific. High wind advisories, watches, and warnings are issued by the NWS when wind speeds may pose a hazard or may be life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories for New Jersey are as follows:

- *High Wind Warnings* are issued when sustained winds of 40 mph or greater are forecast for 1 hour or longer, or wind gusts of 58 mph or greater are forecast for any duration.
- *Wind Advisories* are issued when sustained winds of 30 to 39 mph are forecast for one 1 hour or longer, or wind gusts of 46 to 57 mph are forecast for any duration (NWS 2015).

Tornado

The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). Table 4.3.11-8 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Figure 4.3.11-8. Enhanced Fujita Tornado Intensity Scale Ratings, Wind Speeds, and Expected Damage

EF Rating	Wind Speeds	Expected Damage
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.

Source: NWS 2018

Tornado watches and warning are issued by the local NWS office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2011).

Extreme Heat

NOAA's heat alert procedures are based mainly on Heat Index values. The Heat Index is given in degrees Fahrenheit. The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. To find the Heat Index temperature, the temperature and relative humidity need to be known. Once both values are known, the Heat Index will be the corresponding number with both values (Figure 5.4.8-1). The Heat Index indicated the temperature the body feels. It is important to know that the Heat Index values are devised for shady, light wind conditions. Exposure to full sunshine can increase heat index values by up to 15°F. Strong winds, particularly with very hot dry air, can also be extremely hazardous (NWS 2013).

Figure 4.3.11-9. NWS Heat Index Chart

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Source: NWS 2015c
°F degrees Fahrenheit
% percent

Figure 4.3.11-10. Adverse Effects of Prolonged Exposures to Heat on Individuals

Category	Heat Index	Health Hazards
Extreme Danger	130 °F – Higher	Heat Stroke / Sunstroke is likely with continued exposure.
Danger	105 °F – 129 °F	Sunstroke, muscle cramps, and/or heat exhaustion possible with prolonged exposure and/or physical activity.
Extreme Caution	90 °F – 105 °F	Sunstroke, muscle cramps, and/or heat exhaustions possible with prolonged exposure and/or physical activity.
Caution	80 °F – 90 °F	Fatigue possible with prolonged exposure and/or physical activity.

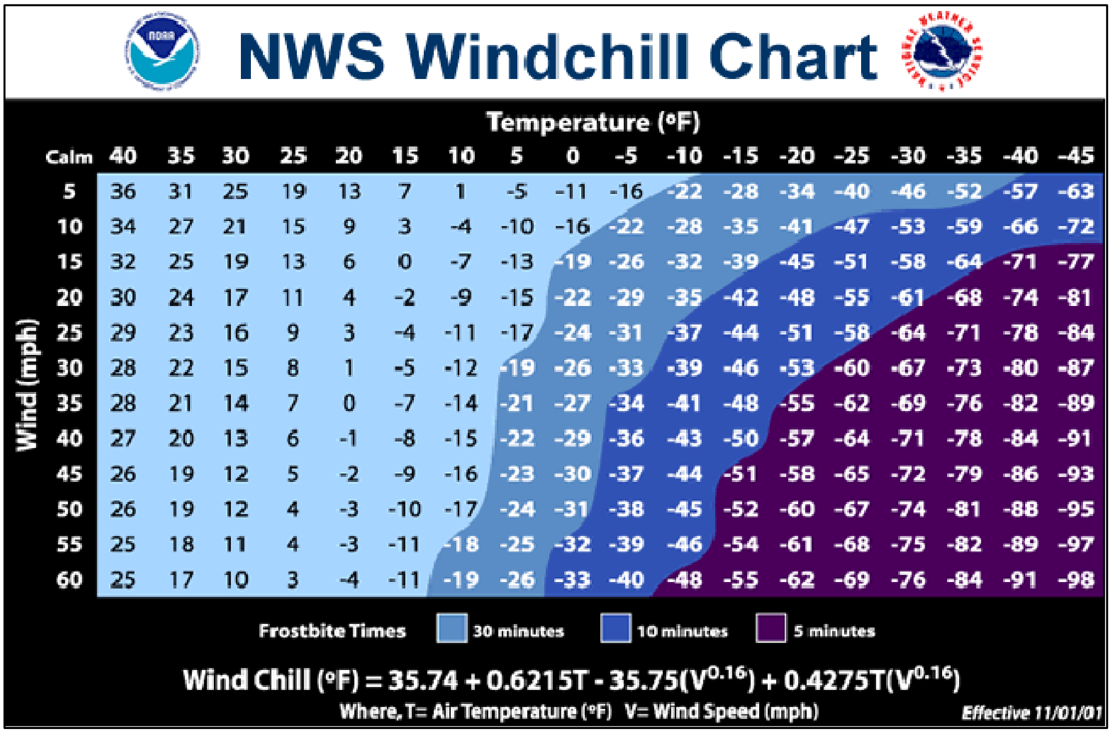
Source: NWS 2009
°F degrees Fahrenheit

Extreme Cold

The extent (severity or magnitude) of extreme cold temperatures are generally measured through the Wind Chill Temperature (WCT) Index. Wind Chill Temperature is the temperature that people and animals feel when outside and it is based on the rate of heat loss from exposed skin by the effects of wind and cold. As the wind increases, the body is cooled at a faster rate causing the skin's temperature to drop (NWS n.d.).

On November 1, 2001, the NWS implemented a new WCT Index. It was designed to more accurately calculate how cold air feels on human skin. The table below shows the new WCT Index. The WCT Index includes a frostbite indicator, showing points where temperature, wind speed, and exposure time will produce frostbite to humans. Figure 5.4.8-3 shows three shaded areas of frostbite danger. Each shaded area shows how long a person can be exposed before frostbite develops (NWS n.d.).

Figure 4.3.11-10. NWS Wind Chill Index



NWS Windchill Chart

Temperature (°F)

Wind (mph)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm																		
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T= Air Temperature (°F) V= Wind Speed (mph)

Effective 11/01/01

Source: *NWS n.d.*
°F *degrees Fahrenheit*
mph *miles per hour*

Warning Time

Meteorologists can accurately forecast extreme temperature event development and the severity of the associated conditions with several days lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations. For heat events, the NWS issues excessive heat outlooks when the potential exists for an excessive heat event in the next three to seven days. Watches are issued when conditions are favorable for an excessive heat event in the next 24 to 72 hours. Excessive heat warning/advisories are issued when an excessive heat event is expected in the next 36 hours. Winter temperatures may fall to extreme cold readings with no wind occurring. Currently, the only way to headline very cold temperatures is with the use of the NWS-designated Wind Chill Advisory or Warning products. When actual temperatures reach Wind Chill Warning criteria with little to no wind, extreme cold warnings may be issued (NWS n.d.).

Previous Occurrences and Losses

Between 1954 and 2020, Sussex County has been included in 15 declarations for severe storm-related events classified as severe storm (FEMA 2020). Severe weather events that have impacted Sussex County between 2015 and 2020 are identified in Tables 4.3.11-4 and 4.3.11-5. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

The USDA Secretary of Agriculture 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 2015 and 2020, Sussex County was included in two severe storm related agricultural disaster declarations. In 2019, Sussex County was included in declaration S4479 for excessive precipitation and S4455 for the combined effects of excessive rainfall, moisture, and storm-force winds from Hurricane Florence. In 2019, indemnities for moisture/precipitation/rain for all other crops totaled $43,692.

Table 4.3.11-4. Severe Storm-related FEMA Disaster Declarations

Declaration	Event Date	Declaration Date	Event Description
DR-1337	August 12-21, 2000	August 17, 2000	Severe Storms, Flooding & Mudslides
DR-1563	September 18 - October 1, 2004	October 1, 2004	Severe Storms and Flooding
DR-1588	April 1-3, 2005	April 19, 2005	Severe Storms and Flooding
DR-1653	June 23 - July 10, 2006	July 7, 2006	Severe Storms and Flooding
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storms and Inland and Coastal Flooding
DR-4039	September 28 - October 6, 2011	October 14, 2011	Remnants of Tropical Storm Lee
DR-4048	October 29, 2011	November 30, 2011	Severe Storm

Source: FEMA 2020

Table 4.3.11-5. Severe Weather Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
January 4, 2015	Strong Wind	N/A	N/A	Sussex County	A strong cold frontal passage brought strong winds in its wake into New Jersey during the evening and overnight on the 4th. The strongest winds occurred in eastern New Jersey and over the higher terrain of northwest New Jersey. Peak gusts in those locations averaged 50 to 55 mph, while elsewhere most peak gusts were between 40 and 45 mph. The strong winds knocked down weak tree limbs, trees and wires and caused isolated power outages. Peak wind gusts included 54 mph in High Point (Sussex County). $2K in property damage was reported.
January 7-8, 2015	Cold/Wind Chill	N/A	N/A	Sussex County	Narrative The arrival of an arctic air mass brought one of the coldest mornings of the month of January to most of New Jersey. Morning low temperatures were mainly in the single numbers above zero. In addition, gusty northwest winds continued into the morning and lowest hourly wind chill factors reached around degrees below zero throughout the state. Actual low temperatures included 2 degrees below zero in Walpack (Sussex County). Lowest hourly wind chill factors included 11 degrees below zero in Sussex (Sussex County).
February 2, 2015	Strong Wind	N/A	N/A	Sussex County	Strong, gusty northwest winds occurred in the wake of a departing and intensifying low pressure system during the late afternoon into the middle of the evening on the 2nd in New Jersey. Peak wind gusts average around 50 mph and knocked down weak trees, tree limbs and

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					wires. Scattered power outages occurred. This was further exacerbated by snow and ice on tree limbs in the northwest part of the state. Peak winds included 56 mph in Wantage (Sussex County). $7K in property damage was reported.
February 12-13	Strong Wind, Cold/Wind Chill	N/A	N/A	Sussex County	Strong gusty northwest winds occurred behind a secondary cold frontal passage in New Jersey during the evening and overnight on the 12th. Peak wind gusts averaged around 55 mph over the higher terrain of Sussex County. $5K in property damage was reported. Northwest winds that persisted into the morning of the 13th combined with an arctic air mass to produce wind chill factors of around 10 degrees below zero and low temperatures in the positive single numbers throughout most of New Jersey. Actual morning low temperatures included zero in Walpack (Sussex County).
February 15, 2015	High Wind, Cold/Wind Chill	N/A	N/A	Sussex County	The increasing pressure difference (gradient) between a rapidly intensifying low pressure system offshore and an arctic high pressure system moving east from the Great Lakes caused strong to high damaging northwest winds to occur in New Jersey from the late evening of the 14th into the afternoon of the 15th. Strong wind gusts started late in the evening on the 14th, peaked during the morning of the 15th and continued into the afternoon of the 15th. The highest winds occurred in the southern half of the state and in the higher terrain of Sussex County. In these latter locations, peak wind gusts averaged around 60 mph. $10K in property damage was reported. The combination of strong to high winds and an approaching arctic air mass produced wind chill factors of 10 to 15 degrees below zero during the first half of the day on the 15th in New Jersey.
February 19-20, 2015	Cold/Wind Chill	N/A	N/A	Sussex County	The arrival of another arctic air mass brought some of the lowest wind chills as well as the lowest temperatures of the winter season to New Jersey on the 20th and 21st. As far as wind chill factors went, the first half of the day on the 20th was colder with wind chill factors as low as around 20 degrees below zero during the morning. Actual low temperatures were around zero. On the morning of the 21st, little, if any, wind was present as the arctic high pressure system was nearby.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					Low temperatures in more rural inland areas were lower, many were below zero, some well below zero. But, because of the lack of wind, wind chill factors nearly matched the air temperatures and it felt relatively warmer on the morning of the 21st.
February 24, 2015	Cold/Wind Chill	N/A	N/A	Sussex County	The high pressure system responsible for third and last arctic blast of the month of February arrived in New Jersey on the morning of the 24th. Unlike the two previous arctic outbreaks earlier this month, this one was not accompanied by strong winds during the first half of the day. Air and wind chill temperatures were nearly the same. The calm conditions and snow cover combined to give many locations in northwest New Jersey the coldest morning of the winter season and comparably cold to the 20th and 21st weather in the rest of the state. Actual low temperatures included 19 degrees below zero in Walpack (Sussex County) and 15 degrees below zero in Sussex (Sussex County).
April 4, 2015	Strong Wind	N/A	N/A	Sussex County	Strong, gusty northwest winds circulating around an intensifying low pressure system and approaching high pressure system had the greatest impact across northern New Jersey and coastal southern New Jersey during the second half of the morning into the afternoon on the 4th. Peak wind gusts in these areas reached between 45 mph and 50 mph and knocked down weak tree limbs and wires. In the rest of the southern half of the state, while still windy, most peak wind gusts were less than 40 mph. Peak wind gusts included 48 mph in Wantage (Sussex County).
May 16, 2015	Thunderstorm Wind	N/A	N/A	Middleville	A lee side trough coupled with an unseasonably warm air mass helped trigger an area of showers and thunderstorms that moved through New Jersey during the very late afternoon and first half of the evening on the 16th. This included one severe thunderstorm in Sussex County. The thunderstorms caused outages to a couple of thousand homes and businesses, mainly in the northwest part of the state. Jersey Central Power and light reported that 1,600 of its customers were still without power at 11 p.m. EDT on the 16th.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					A severe thunderstorm knocked down large tree limbs and wires in Stillwater Township.
June 12, 2015	Thunderstorm Wind	N/A	N/A	Green Twp, Fredon Twp, Newton	A lee side trough preceding a cold front combined with an unseasonably hot and humid air mass to trigger scattered strong to locally severe thunderstorms in northwest New Jersey during the late afternoon and early evening of the 12th. A severe thunderstorm knocked down trees and wires in Green Township. The same severe thunderstorm knocked down multiple trees in Fredon Township. A severe thunderstorm also knocked down trees and wires in Newton.
June 21, 2015	Thunderstorm Wind	N/A	N/A	Wantage Twp	Scattered strong thunderstorms moved through western New Jersey during the afternoon and evening of the 21st. An isolated severe thunderstorm occurred in Sussex County. A severe thunderstorm tore down power lines in Wantage Township.
June 23, 2015	Thunderstorm Wind	N/A	N/A	Wantage Twp, Veron Twp	A severe thunderstorm knocked down a few trees along Central School Road in Wantage Township. A severe thunderstorm knocked down a few trees in Vernon Township.
July 19, 2015	Heat	N/A	N/A	Sussex County	Unseasonably hot and humid weather affected most of New Jersey on the 19th and 20th. High temperatures in most areas reached into the lower to mid 90s both days. The 19th was slightly hotter and more humid overall. The combination of heat and humidity brought afternoon heat index values as high as 100F to 105F on the 19th. These were some of the highest heat index values of the entire summer. A dissipating cold front on the 20th brought slightly drier air into the region during the afternoon of the 20th and heat index values peaked around 100F . A re-enforcing cold frontal passage on the 21st brought even cooler and drier air into the area and by the 22nd all high temperatures were less than 90 degrees in New Jersey.
January 4-5, 2016	Cold/Wind Chill	N/A	N/A	Sussex County	Northwest winds that persisted into the morning of the 5th, combined with an arctic air mass - the coldest of the season so far - produced wind chill factors between minus 10 and minus 30 degrees below zero. The coldest wind chill factors were located in the higher elevations

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					where the wind was strongest and temperatures the lowest. The lowest hourly wind chill factor at High Point was minus 27 degrees, which occurred at 0310EST, and minus 15 degrees near Flatbrookville, which occurred at 0314EST. Actual morning low temperatures were in the above zero single numbers and included 4 degrees in Sussex, 5 degrees at Sussex Airport, and 6 degrees in Pellettown. The unseasonably cold arctic air mass and low wind chill factors were caused by the strong northwest wind flow over 30 MPH produced by a deepening mid-level trough over the eastern part of the country, and an arctic high pressure system moving east into the region. Cold temperatures were repeated the following night, but with less wind, wind chill factors were closer to the actual air temperatures.
February 13-14, 2016	Extreme Cold/Wind Chill	N/A	N/A	Sussex County	Wind Chill values dropped to 25 degrees below zero at 0553EST at Sussex County Airport, with northwest wind gusts as high as 25 MPH. The actual air temperature at this time was 6 degrees below zero. The highest wind gust reported at this station was 30 MPH at 1353EST Saturday, February 13th. A wind chill value of 46 degrees below zero was reported at a Safetynet site at Highpoint at 0530EST.
February 24, 2016	Strong Wind	N/A	N/A	Wantage	A strong low pressure system moving north through the Great Lakes region, combined with its associated warm front and cold front, copious amounts of moisture, and low level jet, produced strong to severe thunderstorms, heavy rain, flash flooding, and stream flooding in New Jersey late Wednesday afternoon and evening, February 24th, with stream flooding continuing into Thursday, February 25th. Thousands were without power for a period across the state, focused in South Jersey. A 55 MPH thunderstorm wind gust was measured in Wantage.
April 3, 2016	High Wind	N/A	N/A	Sussex County	A strong cold front associated with a low pressure system moving through New York State swept across the area during the late evening hours of April 2nd and early morning hours of April 3rd, accompanied by thunderstorms, very strong convectively driven winds, and small hail. As colder air behind this front

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					drained south, precipitation changed to snow, with up to three inches falling in the higher elevations of northwest New Jersey and lesser amounts in isolated spots through most of New Jersey. The parent low pressure system then quickly intensified as it continued to move northeast away from the area. The gradient between this low pressure system and incoming high pressure produced strong winds gusting over 60 MPH in some localities from late overnight through the morning hours of April 3rd. Numerous reports of downed trees and wires throughout the county due to high winds.
June 5, 2016	Thunderstorm Wind	N/A	N/A	Wantage, Fredon	A cold front moving into an unstable air mass over New Jersey set off numerous showers and thunderstorms during the late afternoon hours on the 5th. Lightning with these thunderstorms was somewhat limited, so straight-line winds and heavy downpours were the major threat as these storms moved through the area. Thousands of people lost power as a result of the storms. Many wind gusts from 60 to over 70 MPH were recorded across the region. The highest gust was in Gloucester TWP at 74 mph. Rainfall amounts across the northern parts of the state did surpass an inch with the highest total 1.58 inches in Wantage. Downed trees due to winds leading to road closures were reported in Wantage. Trees and branches were downed in Fredon.
July 25, 2016	Thunderstorm Wind	N/A	N/A	Five Points	A trough of low pressure led to the development of afternoon and evening showers and thunderstorms which became severe in spots and produced locally heavy rains. 40,000 were left without power across the state. Several trees downed due to thunderstorm winds in Five Points.
August 16, 2016	Thunderstorm Wind	N/A	N/A	Middleville, Montague, Five Points	Trees, poles and wires were taken down due to thunderstorm winds in Middleville Montague, and Five Points.
September 14, 2016	Thunderstorm Wind	N/A	N/A	Newton, Cranberry Lake, Hopatcong, Lake Mohawk, Sparta	A cluster of thunderstorms developed ahead of a cold front and moved across northern New Jersey during the late afternoon hours of the 14th. Some of the thunderstorms produced damaging winds. Trees were downed by thunderstorm wind gusts closing a few roads in Newton. Several trees were taken down due to thunderstorm winds in Cranberry

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					Lake. One large tree fell onto and downed power lines. A 52 kt wind gust was recorded in Hopatcong. A 63 kt wind gust was reported in Lake Mohawk. Several trees taken down due to thunderstorm winds blocking access to the local marina. Two boats broke anchor as the attachment was torn off from thunderstorm winds. Several trees were taken down due to thunderstorm wind gusts in Sparta.
February 13, 2017	High Wind	N/A	N/A	Hopatcong, Byram Twp	High winds blew through the area after a cold frontal passage, enough to lead to downed trees and wires during the day of the 13th and from a severe squall line early on the 13th. Temperatures were also cold enough with the main low pressure system along the front to produce a wintry mix across northern portions of the state. In terms of freezing rain across northern portions of the state, accumulations were generally light with 0.01 inches at the Sussex ASOS. Winds behind the front were also gusty. Several thousand power outages were reported with some lasting 24 hours in Sussex and Morris counties. Wires taken down due to wind throughout the county. A tree fell across Mason Drive and a pole was taken down in Hopatcong on Brooklyn Stanhope Road. A tree fell onto route 613 in Byram Twp.
February 25, 2017	Thunderstorm Wind	N/A	N/A	Middleville, Branchville, Plumsock, Quarryville, Colesville	Several days of record warmth came to an abrupt end as a strong cold front moved through the state. Moisture and instability were sufficient to develop a line of showers and thunderstorms ahead of the front. These showers and thunderstorms produced damaging winds and hail across western portions of the state. The most noteworthy damage was in Sussex county at the Space farm zoo. Several thousand people lost power as well. In Middleville, a tree was downed due to thunderstorm winds onto a house with several trees uprooted as well due to thunderstorm winds. Several large trees were snapped and uprooted in Branchville. A Blacksmith Museum building was flattened and several trees were uprooted due to thunderstorm winds in Plumsock. Some other building had siding and roof damage as well. Trees and wires were downed in Quarryville

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					due to thunderstorm winds. A large pine tree was uprooted in Colesville due to thunderstorm winds. Two metal barn roofs were torn off in Quarryville due to thunderstorm winds.
March 2, 2017	High Wind	N/A	N/A	Sussex County	An unseasonably warm, very moist, and unstable air mass, characterized by temperatures in the 70s and Dew Points in the upper 50s to lower 60s, was conducive to maintaining a line of thunderstorms along a pre-frontal trough, as they crossed the Appalachians and moved through portions of southern NJ. Although there was little in the way of lightning associated with these storms, pockets of significant wind damage occurred. A large tree fell onto a house and fence.
March 14, 2017	High Wind	N/A	N/A	Sussex County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. A wind gust of 51 kts was measured in Sussex County.
June 13, 2017	Hail	N/A	N/A	Maple Grange, Hamburg	A severe thunderstorm impacted Sussex County, NJ. This storm produced a 46 mph wind gust and nickel size hail. Lightning also downed a tree which landed on a house. Another tree was downed due to wind on highway 23. Hail lasted for roughly 5 minutes. Tree downed on highway 23 due to wind at the highway 94 intersection in Hamburg.
August 2, 2017	Thunderstorm Wind	N/A	N/A	Fredon	A hot and humid airmass with weak boundaries led to slow moving strong to severe thunderstorms with damaging winds, hail and flooding. Over 2,000 people lost power. Wires were down on Stillwater Road in Fredon.
October 24, 2017	Strong Wind	N/A	N/A	Pellettown	A strong low pressure system over the Great Lakes and a departing high pressure system to our east lead to a tight pressure gradient and a round of strong winds. Over 25,000 homes and businesses lost power. Several school districts had to close because of the power loss. A CWOP measured gust of 39 kts was reported just southeast of Pellettown.
January 4, 2018	High Wind	N/A	N/A	Sussex County	An area of low pressure tracked up the east coast interacting with a cold front which lead to rapid development of a winter storm across the state. This storm quickly moved out by the 5th. However, snowfall accumulations and gusty winds occurred with the storm. Blizzard

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					conditions occurred along many coastal locations. Top wind gusts were generally around 40 mph across the state. Snow amounts were highest in southern and coastal New Jersey with over 6 inches, totals were only a few inches further northwest. A state of Emergency was declared during the height of the storm. Several hundred vehicles were stranded and hundreds of thousands were without power at some point. Severe cold continued for the next week leading to many locations going to code blue operations and closing of the Cape May Lewes Ferry.
March 2, 2018	High Wind	N/A	N/A	Sussex County	Numerous trees and power lines were knocked down from strong winds. Nearly 30 roads throughout the county were closed because of downed trees. As of 10 PM Saturday, March 3rd, 23,503 customers were still without power. Free water and ice was provided to affected residents. A wind gust of 48 MPH was reported by a NJWXNET weather station at High Point Monument at 1125EST on March 2nd. A 41 year old man was killed on Friday evening at 1845EST when he came in contact with live wires on Lenape Avenue in Andover, NJ that had been knocked down by the strong winds. He was pronounced dead on the scene.
April 4, 2018	High Wind	N/A	N/A	Sussex County	Low pressure developed over the Central Plains on April 3rd, deepening as it moved into the Saint Lawrence Valley on April 3rd and to Prince Edward Island on April 4th, due to a significant contrast in air masses with Continental Polar air to the north and Maritime Tropical air to the south. This lead to a strong cold frontal passage across the region on April 4th. In the wake of this front, colder air moving into the area and a tight pressure gradient lead to widespread damaging west-northwest wind gusts in excess of 50 mph on April 4th. A mesonet site in High Point Monument recorded a wind gust of 58 mph at 4 PM on April 4th.
July 1, 2018	Excessive Heat	N/A	N/A	Sussex County	Temperatures in the middle to upper 90s and dew points in the upper 60s to lower 70s led to excessive heat across portions of southeastern Pennsylvania. Heat indices reached 106 degrees at the Andover Airport AWOS on July 3rd.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
October 2, 2018	Thunderstorm Wind	N/A	N/A	Cranberry Lake, Branchville	Supercellular severe thunderstorms caused 2 tornadoes, wind damage, and hail across the region all part of a record breaking tornado outbreak across Pennsylvania. Cranberry Lake reported localized power outages and trees down. Branchville reported localized tree damage and power outages.
February 25, 2019	High Wind	N/A	N/A	Sussex County	A departing very deep cyclone combined with strong high pressure to the west yielded a strong pressure gradient from the Plains eastward to the northern Mid-Atlantic and New England regions. High winds gusting 50-60 mph resulted in scattered power outages and trees down across the region. Some minor structural damage also occurred.
April 15, 2019	Thunderstorm Wind	N/A	N/A	Stillwater Township	A severe weather outbreak impacted much of the East Coast, causing widespread straight line wind damage and a few tornadoes. An approaching frontal system with strong wind fields moving into an unusually moist April air mass contributed to the formation of a well organized line of severe convection. This line moved through the mid-Atlantic during the predawn hours of April 15. A number of thunderstorm related damage reports were received. Multiple trees and power lines were reported down in Stillwater Twp. The
May 19, 2019	Thunderstorm Wind	N/A	N/A	Sandyston Twp, Lake Owassa	A warm front moved through the mid-Atlantic on the morning of May 19. This set the stage for the warmest day of the year to that point for most of the region. The combination of daytime heating and a pre-frontal trough ahead of an approaching cold front led to thunderstorm development late in the day. Thunderstorms organized into a line which produced pockets of wind damage over eastern Pennsylvania and northern New Jersey. A brief tornado also occurred in Pennsylvania. With the loss of daytime heating, storms weakened as they moved to the northeast. A tree was reported down on Layton-Hainesville Rd. in Sandyston Twp. A tree was reported down on E Shore Rd. near Lake Owassa.
May 28, 2019	Thunderstorm Wind, Tornado	N/A	N/A	Hopatcong, Stanhope	Severe supercellular storms developed and moved into the region from the west during the mid to late afternoon hours. Storms produced large hail, damaging wind gusts, and 2 tornadoes. Tree reported down into a house on Helen Street in Hopatcong.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					A tornado touched down in Stanhope in Sussex County, New Jersey. Damage began near the Lenape Valley Regional High School. Here, several trees were snapped or uprooted. On a field in front of the school, a clear tornadic damage path was seen with three nearby trees snapped or uprooted in a cyclonic fashion. A small but anchored outbuilding was also lifted and flipped over. Further tree damage occurred at a residence across the street from the school. Damage then appeared to briefly abate, indicating the tornado likely lifted for a short time. However, a short distance further southeast, additional tornadic damage was observed with numerous trees snapped or uprooted and several homes and cars sustaining damage from falling trees on and around Unger Avenue. Including the brief time when it likely lifted, the tornado lasted approximately one to one and a half minutes. Thankfully, no injuries were reported as a result of this tornado.
June 29, 2019	Thunderstorm Wind	N/A	N/A	Cranberry Lake, Brookwood	A frontal boundary that had been stalled over the mid-Atlantic had lifted north of the region by the morning of June 29. Later that day and into the evening, the front once again approached, this time as a strong cold front, as low pressure tracked through New England and began to intensify offshore in the Gulf of Maine. The combination of strong frontal forcing and a warm, unstable environment ahead of the front led to widespread severe thunderstorms developing. Numerous reports of damaging wind, as well as some hail, were received in association with these storms. Numerous trees and telephone poles and wires were reported down in the Cranberry Lake area. A tree fell on US-206 north of I-80, closing all lanes in Brookwood.
July 17, 2019	Thunderstorm Wind	N/A	N/A	Hampton Twp, Cranberry Lake, Branchville	The remnants of Hurricane Barry moved near and west of the mid-Atlantic on July 17, in tandem with a frontal system which was absorbing the former tropical cyclone. A hot air mass existed east of this system, and the tropical moisture associated with Barry combined with the heat to create an unstable environment primed for heavy rainfall and severe weather. Widespread convection developed, with a number of storms

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					producing damaging wind. A tree was reported down in Hampton Twp. Tree blown down on N Shore Rd in the Cranberry Lake area.
July 20, 2019	Thunderstorm Wind	N/A	N/A	Branchville, Frankford Twp	An excessively hot air mass was in place over the mid-Atlantic on July 20. While the air mass was hot, the environment was otherwise generally unfavorable for convection due to mid level capping. However, some thunderstorms did develop where the cap was weaker, especially in New York but also as far south as northern New Jersey. These isolated cells produced localized wind damage. Several downed trees blocked CR-519 near Branchville. Numerous trees and power lines were downed in and near Frankford Twp.
July 21, 2019	Thunderstorm Wind	N/A	N/A	Andover Airport, Hopatcong	A slow moving cold front was approaching a very hot air mass over the mid-Atlantic on July 21. Strong instability and high moisture levels were present ahead of the front. Relatively weak shear and some mid-level dry air were limiting factors, but the frontal forcing helped to trigger scattered thunderstorms, some of which became strong to severe and produced areas of wind damage. Downed trees and power lines were reported in the Andover and Hopatcong areas.
July 22, 2019	Thunderstorm Wind	N/A	N/A	Hopatcong	A frontal boundary stalled over the mid-Atlantic on July 22. An approaching upper level trough helped spur the development of a wave of low pressure along the front. A very favorable environment for convection and severe weather developed along and south of this boundary. Extremely high moisture content was present in the air mass, allowing moderate to strong instability to build during the heating of the day. The frontal boundary and developing low also helped to enhance both low level and deep layer shear to respectably strong values for midsummer. The result was a day of widespread severe weather. Discrete storms early in the afternoon gave way to a powerful mesoscale convective system in the evening which produced widespread damaging winds with considerable damage over a large area. Trees and powerlines were downed throughout Hopatcong.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
August 8, 2019	Thunderstorm Wind	N/A	N/A	Newton, Andover	Behind a cold front, an upper level trough moved over the mid-Atlantic on August 8. Multiple shortwave impulses rotated through the broader trough over the day. The upper level energy combined with daytime heating in an otherwise marginally favorable environment to produce scattered showers and thunderstorms. A few storms became strong to severe, producing gusty winds. Tree and wires downed on Swartswood Rd in Newton. Tree and wires downed on Crescent Dr in Andover.
October 31, 2019	Thunderstorm Wind	N/A	N/A	Hopatcong, Beaver Lake	A severe weather outbreak impacted the mid-Atlantic from the evening of October 31 through the pre-dawn hours of November 1. A strong area of low pressure moved through the eastern Great Lakes on the 31st. Ahead of it, strong southerly flow advected an unseasonably warm and moist air mass into the mid-Atlantic. This generated enough instability, combined with extremely strong wind fields, to produce a low topped line of severe convection which tracked across the entire region. Widespread damaging wind occurred as the squall line moved through, along with a couple of short lived embedded tornadoes. A photo in Hopatcong showed a large tree down on power lines. The report also indicated several additional trees down on power lines with multiple transformer fires in the area. A tree was downed on NJ-23 south of Beaver Lake Rd.
February 7, 2020	High Wind	N/A	N/A	Sussex County	Following a mid-morning severe weather outbreak, the weather remained active over the mid-Atlantic into the later morning and afternoon hours on February 7. Explosively intensifying low pressure began to pull away from the region to the north, leading to a cold frontal passage. Rapid height and pressure rises on the back side of the departing low led to a period of strong and in some cases damaging synoptic winds following the damaging convective winds from earlier in the day. Winds were strongest in coastal areas. Winds began to diminish late in the day as the low moved further away and the gradients relaxed.
June 3, 2020	Thunderstorm Wind	N/A	N/A	Libertyville	A derecho developed just southeast of Lake Erie during the early morning hours of June 3, 2020, then moved rapidly southeast across Pennsylvania before

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					exiting the central New Jersey coast during the early afternoon hours, approximately 130 PM. Downed trees and wires were reported near Route 519 and Neilson Road near Wantage. Several reports of tree limbs and power lines down near Route 515 and Vernon Crossing Road near Wawayanda State Park.
June 19, 2020	Thunderstorm Wind	N/A	N/A	Sparta	Several impulses of energy rotating within the flow of a mid-level low produced scattered thunderstorms over northern New Jersey during the mid to late evening hours. While most of these thunderstorms were sub-severe, one or two reports of isolated wind damage were reported. Reports of trees and wires down near Underrock Road near Sparta.
June 28, 2020	Hail, Thunderstorm Wind	N/A	N/A	Colesvile	A cold front approaching from the west, in combination with a pre-frontal lee-side trough parked over the mid-Atlantic region, sparked afternoon and evening thunderstorms across many parts of New Jersey. In addition to strong to severe winds and heavy rain, a few thunderstorms contained large hail. Dime to nickle size hail was reported on River Road in Montague. Several reports of power lines down and power outages in the Vernon Valley area northwest of Wawayanda State Park.
July 3, 2020	Thunderstorm Wind	N/A	N/A	Glenwood, Independence Corner, McAfee	A back door cold front moving south into very hot and moderately humid air touched off showers and thunderstorms, some of them severe. Wires were reported down on McAfee-Glenwood Road in Glenwood. Wires were down on Glenwood Road in Vernon Valley. Downed tree and wires near Tall Timbers Road near Wallkill Lake with power outages in the area. Downed tree on NJ-284 southbound near Layton Road northeast of Sussex. Lane restrictions were put in place. Downed tree into a trailer near Hemlock Drive in Vernon with power lines down in the area. Trees and wires down on Valley View Drive in McAfee.
July 22, 2020	Hail	N/A	N/A	Township of Montague, Colesville	A slow moving frontal boundary was draped across upstate New York and southern New England on July 22 with multiple waves of low pressure tracking along it. The mid-Atlantic was left in a warm sector air mass south of this front. This led to a very hot and humid day on July 22 with air temperatures rising into

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					the 90s and dew point values near 70. This caused strong instability to develop. Shear values were not overly impressive, but an approaching shortwave disturbance from the Midwest did help to increase shear late in the day. This disturbance also served as forcing for convection to develop in the warm and unstable air mass. Widespread thunderstorm development occurred, with storms eventually developing into a mostly solid squall line. This line of storms produced numerous reports of wind damage across eastern Pennsylvania, New Jersey, and Delmarva. 1.25-1.50 inch hail was reported in Montague. 50 knot winds were reported. A large tree was split at a residence on Red Hill Road. A tree was downed on Deckerton Turnpike near the intersection with County Route 675. Several reports of downed trees and wires in Montague Township including near Clove Road and New Road. Reports of downed tree limbs and wires near Lake Marcia in Collesville.
August 18, 2020	Thunderstorm Wind, Hail	N/A	N/A	Township of Montague	A prefrontal trough ahead of a slow moving cold front led to a few thunderstorms developing on the afternoon of August 17. Moderate instability and weak shear generally limited storm coverage and severity, but a cluster of severe thunderstorms with damaging winds impacted portions of the Pennsylvania Poconos and northern New Jersey. Trees and wires were downed on Fox Hollow Rd near Montague.
August 25, 2020	Thunderstorm Wind	N/A	N/A	Colesville, Owens, Vernon	A strong cold front along with a mid-level shortwave trough approached the mid-Atlantic on August 25. Ahead of the disturbances, wind shear increased significantly and surface temperatures warmed, increasing instability. While some ingredients were in place for a major severe weather event, an offset in timing between the shortwave and the front, combined with greater than expected mid-level dry air, caused storms to generally struggle to develop over the mid-Atlantic. Greater storm coverage was found in more favorable environments over both New England and the Ohio Valley. However, the environment over the mid-Atlantic was still highly favorable for damaging winds, so the few

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					storms that did develop produced some instances of wind damage. A wind gust of 53 knots was measured at High Point monument in Colesville. Several reports of downed trees and wires near Mount Salem Road and Moore Road in Quarryville. Several reports of downed trees and wires near Glenwood Mount Road in Owens. Trees and wires were downed near Pondeddy Road in Vernon.

Source: FEMA 2020; NOAA-NCEI 2020; NWS 2020; SPC 2020; NJOEM 2019; NHC 2020
DR Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
N/A Not Applicable

Probability of Future Occurrences

It is anticipated that Sussex County will continue to experience direct and indirect impacts of severe weather events annually that may induce secondary hazards such as flooding, infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences.

Extreme temperatures are expected to occur more frequently as part of regular seasons. Specifically, extreme heat will continue to impact New Jersey and its counties and, based upon data presented, will increase in the next several decades. As previously stated, several extreme temperature events occur each year in Sussex County. It is estimated that the county will continue to experience these events annually.

According to the NOAA National Climate Data Center (NCDC), Sussex County has experienced 402 severe weather events between 1950 and 2020. This data was used to determine the recurrence interval and the average annual number of events for the county. The table below summarizes these statistics, as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year (NOAA NCDC 2020).

Table 4.3.11-6. Probability of Future Severe Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Extreme Temperature	84	1.20	0.85	1.2	100%
Hail	32	0.46	2.2	0.45	45.1%
High/Strong Wind	137	1.96	0.52	1.9	100%
Lightning	19	0.27	3.7	0.27	26.8%
Thunderstorm Wind	134	1.91	0.53	1.9	100%
Tornado / Funnel Cloud	6	0.09	11.8	0.08	8.5%

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Total	412	5.89	0.17	5.8	100%

Source: NOAA-NCEI 2020

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for severe weather in the county is considered 'frequent' (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the severe weather hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

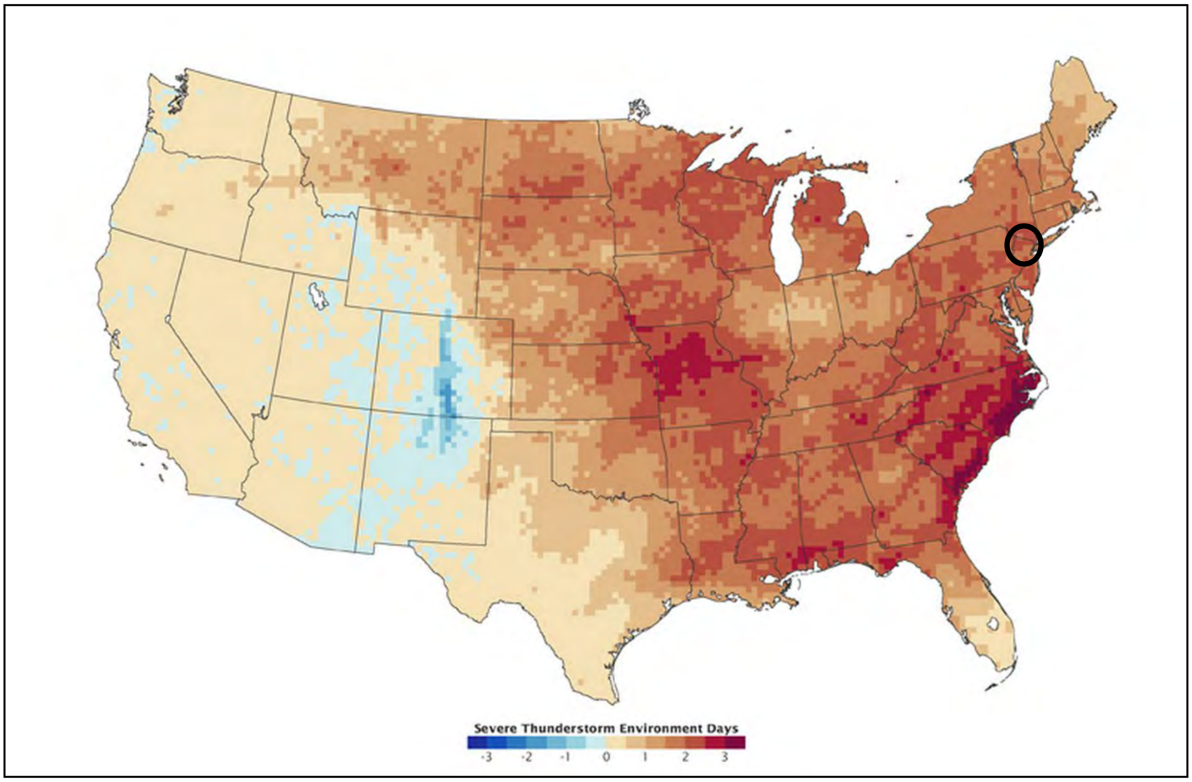
Climate change includes changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State's average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017). Also, small decreases in the amount of precipitation may occur in the summer months, resulting in greater potential for more frequent and prolonged droughts (Trenberth 2011). New Jersey could also experience an increase in the number of flood events (Broccoli et al. 2020).

A warmer atmosphere means storms have the potential to be more intense (Guilbert et al. 2015) and occur more often (Coumou and Rahmstorf 2012, Marquardt Collow et al. 2016, Broccoli et al. 2020). In New Jersey, extreme storms typically include coastal nor'easters, snowstorms, spring and summer thunderstorms, tropical storms, and on rare occasions hurricanes. Most of these events occur in the warmer months between April and October, with nor'easters occurring between September and April. Over the last 50 years, in New Jersey, storms that resulted in extreme rain increased by 71% (Walsh et al. 2014) which is a faster rate than anywhere else in the United States (Huang et al. 2017).

Figure 4.3.11-11 illustrates the predicted change in severe thunderstorm days; overall it is anticipated New Jersey will experience an increase.

Figure 4.3.11-5. Predicted Change in Severe Thunderstorm Environment Days from the 1962-1989 Period to the 2072-2099 Period



Source: Trapp et. al. 2007
Note: The approximate location of Sussex County is indicated by the black circle

Vulnerability Assessment

A qualitative assessment was conducted to analyze the severe weather hazard for Sussex County. A probabilistic assessment was conducted for the 100- and 500-year MRPs to analyze the wind hazard and provide a range of loss estimates. These estimates are detailed in Section 4.3.8 (Hurricane and Tropical Storm).

Impact on Life, Health and Safety

The impact of severe weather events on life, health, and safety is dependent upon several factors including the severity of the event and whether adequate warning time was provided to residents. The entire population of Sussex County (142,298 people) is exposed to severe storm events (American Community Survey 2018). Residents may be displaced or require temporary to long-term sheltering due to severe weather events. The number of households displaced by severe wind events is summarized in Section 4.3.8 (Hurricane and Tropical Storms). In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life.

Socially vulnerable populations are most susceptible, based on a number of factors including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. Vulnerable populations include homeless persons, elderly (over 65 years old), low income or linguistically isolated populations, people with life-threatening illnesses, and residents living in areas that are isolated from major roads. According to the 2018 5-year American Community Survey population data, there are 7,191 persons living below the poverty level and 22,889 persons over the age of 65 within Sussex County.

Lightning can be responsible for deaths, injuries, and property damage. Lightning-based deaths and injuries typically involve heart damage, inflated lungs, or brain damage, as well as loss of consciousness, amnesia, paralysis, and burns, depending on the severity of the strike. Additionally, most people struck by lightning survive, although they may have severe burns and internal damage. People located outdoors (i.e., recreational activities and farming) are considered most vulnerable to hailstorms, thunderstorms, and tornadoes because there is little to no warning, and shelter might not be available. Moving to a lower risk location will decrease a person's vulnerability.

Impact on General Building Stock

Damage to buildings depends on several factors, including the type of event, wind speed, presence and size of hail, storm duration, path of the storm track or tornado, and distance from the tornado funnel. Several thousand dollars of reported damages have occurred in Sussex County due to severe storm events. Estimated wind-related building damages are discussed further in Section 4.3.8 (Hurricane and Tropical Storms).

Impact on Critical Facilities and Lifelines

Utility infrastructure could suffer damage from high winds associated with falling tree limbs or other debris, resulting in the loss of power or other utility service. Loss of service can impact residents, critical facilities, and business operations alike. Interruptions in heating or cooling utilities can affect populations, such the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can also impact other public utilities, including potable water, wastewater treatment, and communications. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effectively respond to an event and maintain the safety of its residents.

Impact on Economy

Severe storm events can have short- and long-lasting impacts on the economy. When a business is closed during storm recovery, there is lost economic activity in the form of day-to-day business and wages to employees. The longer the business is closed, the less likely they are to reopen. Overall, economic impacts include the loss of business function (e.g., tourism, recreation), damage to inventory, relocation costs, wage loss and rental loss due to the repair/replacement of buildings.

Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting and goods transport) transportation needs. Utility infrastructure (power lines, gas lines, electrical systems) could suffer damage and impacts can result in the loss of power, which can impact business operations and can impact heating or cooling provision to the population.

Section 4.3.8 (Hurricane and Tropical Storms) estimates the total economic loss caused by severe wind events. These losses include direct building losses and business interruption losses, which are the estimated costs to repair or replace the damage caused to the building and the losses associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event, respectively.

Impact on Environment

The impact of severe storm events on the environment varies, but researchers are finding that the long-term impacts of more severe weather can be destructive to the natural and local environment. National organizations such as USGS and NOAA have been studying and monitoring the impacts of extreme weather phenomena as it impacts long term climate change, streamflow, river levels, reservoir elevations, rainfall, floods, landslides, erosion, etc. (USGS 2020, NOAA n.d.). For example, severe weather that creates longer periods of rainfall can erode natural banks along waterways and degrade soil stability for terrestrial species. Tornadoes can tear apart habitats causing fragmentation across ecosystems. Researchers also believe that a greater number of diseases will spread across ecosystems because of impacts that severe weather and climate change will have on water supplies (USGS 2020, NOAA n.d.). Overall, as the physical environment becomes more altered, species will begin to contract or migrate in response, which may cause additional stressors to the entire ecosystem within Sussex County. Refer to Section 4.3.9 (Infestation and Invasive Species) for more information about these stressors.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. Changes in the natural environment and built environment and how they interact can also provide insight about ways to plan for the future.

Projected Development

As discussed in Section 4, areas targeted for future growth and development have been identified across the County. Any areas of growth throughout the County are vulnerable to severe storm events. New development sites should adhere to the proper building codes to protect against severe storm event elements such as high wind protection and/or flood proofing measures.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population can create issues for local residents during evacuation of a natural hazard severe storm event. Historically, flooding and debris with associated severe storm events have severely impacted transportation corridors as well as infrastructure. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures and precipitation. Annual precipitation amounts in the region are projected to increase, primarily in the form of heavy rainfalls, which have the potential to increase the risk of storm surge, and flood critical transportation corridors and infrastructure. Increases in precipitation may alter and expand the floodplain boundaries of storm surge areas and runoff patterns, resulting in the exposure of populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Furthermore, climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events like hurricanes. While predicting changes to the prevalence or intensity of severe storms under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. EPA 2020).

Change of Vulnerability Since the 2016 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to severe weather events.

4.3.12 SEVERE WINTER WEATHER

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 severe winter weather hazard in Sussex County.

2021 HMP Changes

- Previous occurrences were updated with events that occurred between 2015 and 2020.
- A vulnerability assessment was conducted for the severe winter weather hazard utilizing updated building data.

Profile

Hazard Description

A winter storm is considered a storm with significant snowfall, ice, and/or freezing rain. The quantity of precipitation varies by elevation. Heavy snowfall in non-mountainous areas is four inches or more in a 12-hour period, or six inches or more in a 24-hour period. In mountainous areas, heavy snowfall is considered 12 inches or more in a 12-hour period or 18 inches or more in a 24-hour period. Blizzards are storms with considerable falling and/or blowing snow combined with sustained winds or frequent wind gusts of 35 mph or greater that frequently reduce visibility to less than 0.25 mile for at least three hours.

Some winter storms are large enough to immobilize an entire region while others may only affect a single community. Winter storms are typically accompanied by low temperatures, high winds, freezing rain or sleet, and heavy snowfall. The aftermath of a winter storm can have an impact on a community or region for days, weeks, or even months; potentially causing cold temperatures, flooding, storm surge, closed and/or blocked roadways, downed utility lines, and power outages. In Sussex County, winter storms include blizzards, snowstorms, Nor'Easters and ice storms. Extreme cold temperatures, wind chills and Nor'Easters are also associated with winter storms; however, based on input from the Planning Committee, these events are further discussed in this plan in Section 4.3.10 (Nor'Easters) and Section 4.3.11 (Severe Weather).

Heavy Snow

According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32 degrees Fahrenheit [°F]), when water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellets, which then fall to the earth. Snow falls in different forms, such as snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets that are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. A heavy snowstorm is defined as a snowstorm with accumulations of 4 inches or more of snow in a 6-hour period, or 6 inches of snow in a 12-hour period (NWS 2009).

Blizzards

A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 mph or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile. These conditions must be the predominant over a 3-hour period. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard, created by the combination of snow, wind, and low visibility, significantly increases when temperatures are below 20°F. A severe blizzard is categorized as having temperatures near or below 10°F, winds exceeding 45 mph, and visibility reduced by snow to near zero. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm, moister air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (The Weather Channel 2012).

Sleet

Sleet is made up of drops of rain that freeze into ice as they fall. They are usually smaller than 0.30 inch in diameter (NSIDC 2013). A sleet storm involves significant accumulations of solid pellets, which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists (NWS 2009).

Freezing Rain

Freezing rain occurs when rain falls into areas that are below freezing. In order for this to occur, ground-level temperatures must be colder than temperatures aloft. Freezing rain can also occur when the air temperature is slightly above freezing but the surface that the rain lands upon is still below freezing from prior cold air temperatures (NWS 2009).

An ice storm is an event caused by damaging accumulations of ice during freezing rain events. An ice storm involves significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations (NWS 2009). Significant ice accumulations are typically 0.25 inch or greater (National Weather Service [NWS] 2013).

Location

Snow and Blizzards

The trajectory of the storm center—whether it passes close to the New Jersey coast or at a distance—largely determines both the intensity and the duration of the snowfall over the State. Winter storms tend to have the heaviest snowfall within a 150-mile wide swath to the northwest of what are generally southwest to northeast moving storms. Depending on whether all or a portion of New Jersey falls within this swath, the trajectory determines which portion of the State (or all of the State) receives the heaviest amount of snow. According to the ONJSC, normal seasonal snowfall in Sussex County is approximately 40 to 50 inches (ONJSC n.d).

Ice Storms

All regions of New Jersey are subject to ice storms. The distribution of ice storms often coincides with general distribution of snow within several zones in the State. A cold rain may be falling over the southern portion of the State, freezing rain over the central region, and snow over the northern counties as a coastal storm moves northeastward offshore. A locality’s distance to the passing storm center is often the crucial factor in determining the temperature and type of precipitation during a winter storm. Based on data from 1948–2000, Sussex County can anticipate 5-6 days with freezing rain per year (Changnon & Karl. 2003). Based on data from 1932–2001, the County can anticipate 9-12 total hours of freezing rain per year (Changnon 2004).

Extent

The magnitude or severity of a severe winter storm depends on several factors, including a region’s climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day (for example, weekday versus weekend), and time of season. While sleet accumulation is measured and tracked in a method similar to snow events, the extent or severity of freezing rain or an ice storm requires a different and sometimes more challenging process. According to NWS, ice accumulation does not coat the surface of an object evenly, as gravity typically forces rainwater to the underside of an object before it freezes. Wind can also force rainwater downward prior to freezing, resulting in a thicker coating of ice on one side of the object than the other side. Ice mass is then determined by taking the average from the thickest and thinnest portions of ice on the sample used for measurement.

NOAA's National Climatic Data Center (NCDC) produces the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from Category 1 to 5, which is similar to the Enhanced Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes. RSI is based on the spatial extent of the storm, the amount of snowfall, and the combination of the extent and snowfall totals with population (based on the 2000 Census). The NCDC has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCEI 2018). Table 4.3.12-1 presents the five RSI ranking categories.

Table 4.3.12-1. RSI Ranking Categories

Category	Description	RSI Value
1	Notable	1-3
2	Significant	3-6
3	Major	6-10
4	Crippling	10-18
5	Extreme	18.0+

Source: NOAA-NCEI 2018
Note: RSI = Regional Snowfall Index

The NWS operates a widespread network of observing systems such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into what will happen next, ranging from hours to days. The models are then analyzed by NWS meteorologists who then write and disseminate forecasts (NWS 2013). While winter weather is normal during the winter season for Sussex County, the NWS uses winter weather watches, warnings, and advisories to help people anticipate what to expect in the days and hours prior to an approaching storm.

- A ***winter storm watch*** is issued when severe winter conditions (heavy snow, ice, etc.) may affect a certain area, but its occurrence, location, and timing are uncertain. A watch is issued to provide 24 to 72 hours of notice of the possibility of severe winter weather.
- A ***winter storm warning*** is issued when hazardous winter weather, in the form of heavy snow, heavy freezing rain, or heavy sleet, is imminent or occurring. A warning is usually issued 12 to 24 hours before the event is expected to begin.
- A ***winter weather advisory*** is issued when a hazardous winter weather event is occurring, is imminent, or has a greater than 80 percent chance of occurrence. Advisories are used to inform people that winter weather conditions are expected to cause significant inconveniences and that conditions may be hazardous. These conditions may refer to sleet, freezing rain, or ice storms, in addition to snow events.

NWS may also issue a ***blizzard warning*** when snow and strong winds combine to produce the potential for blinding snow, deep drifts, and wind chill (NWS n.d.).

Previous Occurrences and Losses

The NOAA NCEI Storm Events database records and defines severe winter storm events as follows:

- Blizzard is reported in the NOAA-NCEI database when a winter storm which produces the following conditions for 3 consecutive hours or longer: (1) sustained winds or frequent gusts 30 knots (35 mph) or greater, and (2) falling and/or blowing snow reducing visibility frequently to less than 1/4 mile.
- Heavy snow is reported in the NOAA-NCEI database whenever snow accumulation meets or exceed locally/regionally defined 12 and/or 24 hour warning criteria.
- Ice storm is reported in the NOAA-NCEI database when ice accretion meets or exceed locally/regionally defined warning criteria (typical value is 1/4 or 1/2 inch or more).
- Sleet is reported in the NOAA-NCEI database whenever sleet accumulations meet or exceed locally/regionally defined warning criteria (typical value is ½ inch or more).
- Winter storm is reported in the NOAA-NCEI database whenever a winter weather event has more than one significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12 and/or 24 hour warning criteria for at least one of the precipitation elements.
- Winter weather is reported in the NOAA-NCEI database when a winter precipitation event causes a death, injury, or a significant impact to commerce or transportation, but does not meet locally/regionally defined warning criteria.

Between 1954 and 2020, FEMA declared that the State of New Jersey experienced six winter storm-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: severe winter storm, severe storm, snowstorm, blizzard, and ice conditions. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Sussex County was included in three of these declarations.

Agriculture-related drought disasters are quite common. The USDA Secretary of Agriculture 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. From 2015-2020, Sussex County was not included in any USDA disaster declarations for winter storm events (USDA 2020, USDA 2020a).

For this 2021 HMP update, winter weather events were summarized from 2015 to 2020. For information regarding severe winter weather events prior to 2015, refer to the Appendix E (Risk Assessment Supplement). For detailed information on damages and impacts to each municipality, refer to Section 9 (jurisdictional annexes).

Table 4.3.12-2. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2020

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Blizzard of 96 (Severe Snowstorm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow

Source: FEMA 2020

Table 4.3.12-3. Severe Winter Weather Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
January 24, 2015	Heavy Snow	N/A	N/A	Sussex County	A winter storm dropped heavy snow in Northwest New Jersey and a mixture of snow, sleet and freezing rain in the central and southwest part of New Jersey on the evening of the 23rd into the morning of the 24th. Overall less wintry precipitation (a faster switch to rain) occurred progressively farther to the south and southeast in the state. Snowfall averaged 5 to 9 inches in northwest New Jersey; 2 to 5 inches in central New Jersey and less than two inches across southwest New Jersey. No snow fell in southeast New Jersey. Ice accumulations were generally around a trace. The snow caused traveling difficulties as well as postponement of social activities on the 24th. There were over 100 reported accidents in the state. The snow and accidents caused about 2,000 homes and businesses to lose power. New Jersey Transit cross-honored all commuting tickets. The onshore flow from the winter storm also caused minor tidal flooding in southern New Jersey during the morning high tide cycle on the 24th. Precipitation started as snow on the evening of the 23rd from southwest New Jersey northward between 9 p.m. EST and Midnight EST. In Northwest New Jersey, the snow fell at its heaviest during the pre-dawn hours on the 24th and ended between 8 a.m. EST and 10 a.m. EST on the 24th. In the Raritan Valley, snow also fell at its heaviest during the pre-dawn hours on the 24th, but then changed to freezing rain and sleet between 4 a.m. EST and 6 a.m. EST on the 24th. Precipitation in some areas changed to plain rain before ending later that morning. In the central third of New Jersey, a change to rain (with some sleet at the transition time) worked its way to the northwest from coastal areas and occurred between 1 a.m. EST and 5 a.m. EST on the 24th and remained rain until it ended around 8 a.m. EST on the 24th. Throughout the state, about 20 high schools postponed SAT testing. Representative snowfall included 9.0 inches in Highland Lakes (Sussex County).
February 1-2, 2015	Winter Storm	N/A	N/A	Sussex County	A winter storm brought a heavy mixture of snow, some sleet and freezing rain to the Raritan Valley and northwest New Jersey with less of a wintry impact to the rest of central and southwest New Jersey on the first into the second. The storm greatly impacted the morning commute on the 2nd in the northwest part of the state. Precipitation started as snow throughout the northern half and southwest part of New Jersey during the evening of the 1st.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					Precipitation fell as rain in the southeast part of the state throughout the event. In southwest New Jersey, the snow transitioned briefly to sleet and then rain early on the 2nd. The rain briefly changed to snow before ending in the mid afternoon on the 2nd. In the Raritan Valley and in Mercer and Monmouth Counties, precipitation transitioned to rain during the early morning on the 2nd and then changed back to freezing rain, then sleet and ultimately snow during the second half of the morning and early afternoon. The snow ended during the mid afternoon on the 2nd. In northwest New Jersey including the Passaic Basin, the snow transitioned to a sleet and/or freezing rain mixture during the morning of the 2nd, then changed back to snow by early afternoon and ended during the middle of the afternoon on the 2nd. Speed restrictions were in place on most major roadways in central and northern New Jersey on the 2nd. Many schools in northwest New Jersey were closed on the 2nd. Representative snowfall included 8.0 inches in Montague (Sussex County).
January 22-24, 2016	Winter Storm	DR-4264	No	Sussex County	An impulse from the west coast traversed the midsection of the country, then developed into a low pressure system as it tracked across the Gulf states before intensifying along the Carolina coast into a major nor'easter, producing record snowfall in parts of New Jersey on January 23rd. It then moved out to sea after passing by the mid-Atlantic coast early on January 24th. Snow began falling during the Friday afternoon commute on January 22nd, then continued, heavy at times, Friday night into early Sunday morning. Wind gusts up to 60 MPH produced blizzard conditions as visibilities dropped to one-quarter mile or less in spots. Representative snowfall totals include 16.0 inches in Stockholm (Sussex).
November 20, 2016	Heavy Snow	N/A	N/A	Sussex County	An area of low pressure near James Bay Canada lead to a strong cold frontal passage across the middle Atlantic Saturday evening November 19. Northwesterly winds increased substantially immediately following the cold frontal passage, with several reports of gusts generally in the 45 to 55 mph range over New Jersey. These strong wind gusts persisted around 48 hours, through Monday November 21. The High Point, NJ mesonet site recorded a peak wind gust of 60 mph at 14:40EST on November 21. Following the cold frontal passage Saturday evening November 19, low pressure developed over New England, and provided a sufficiently cold and moist air mass to produce the seasons first significant snowfall. Snow overspread portions of the middle Atlantic late Saturday evening November 19, shortly after the cold frontal passage. By 01:00EST Sunday November 20, some of the higher terrain of northern New Jersey received around two inches of snowfall. The highest amount as of this time was 2.0 inches in Highland Lakes, New Jersey. The snow continued to fall into Sunday morning November 20. Around 08:00EST, amounts up to around 6 inches were observed across the higher terrain of Sussex county New Jersey.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
February 9, 2017	Winter Storm	N/A	N/A	Sussex County	A strong cold front moved through the region with a temperature drop from the 50's and 60's all the way down close to freezing. Low pressure developed along the front with precipitation northwest of the boundary. The precipitation changed to snow across most of the state. Northern locations had all snow with higher totals. Further south the precipitation was mainly rain for an extended period resulting in much lower accumulations. Gusty winds also occurred as the low departed the region. Some higher snowfall amounts include 11.1 inches in Highland Lakes, 10.3 inches in Wantage, 10.0 inches in Vernon, and 9.0 inches in Stockholm.
March 14, 2017	Blizzard	N/A	N/A	Sussex County	Low pressure systems across the Ohio Valley and Carolinas phased. This led to a rapidly developing storm which tracked just offshore. Wind and a foot of snow were reported across Sussex County.
January 17, 2018	Winter Storm	N/A	N/A	Sussex County	Several inches of snow fell across the northern portions of the state. Snowfall averaged around 6 inches of snow in Sussex county. Further south, across most of Northern Jersey totals ranged from 3-5 inches with totals closer to an inch in southern portions of the state. Several area schools closed due to the storm. A few hundred people also lost power in Sussex county. Snowfall averaged around 6 inches in the county.
March 2, 2018	Winter Storm	N/A	N/A	Sussex County	A heavy, wet snow accumulated to a depth of over 16 inches in the higher elevations of the county, and around 6 inches or so in the valleys. Some snowfall totals include 16.5 inches in Branchville, 14.0 inches in Highland Lakes, 13.5 inches at High Point, 8 inches near Wantage, 7.0 inches in Stockholm, and 2.3 inches near Sussex. A wind gust of 48 MPH was reported at High Point Monument at 1125EST on the 2nd. Blowing and drifting snow made travel hazardous Friday afternoon and evening. Numerous power outages, some lasting over two weeks, were widespread throughout the county due to tree and wire damage. Warming centers were established around the county for affected residents.
March 7, 2018	Winter Storm	DR-4368	No	Sussex County	Narrative A broad area of low pressure extending from the Ohio Valley to the Piedmont of South Carolina consolidated off the Virginia Capes during the early morning of March 7th. This new primary low moved northeast and gradually deepened as it passed east of the Delaware and New Jersey coasts on March 7th. The snow contained large amounts of liquid, making it heavy and wet. This resulted in downed trees, limbs, and wires, leading to numerous power outages across portions of New Jersey, especially where the heaviest snow was reported. Many customers were still without power from the previous storm when this storm struck. Governor Murphy estimated about 350,000 customers state-wide lost power as a result of this second storm. Although all portions of the county experienced significant snowfall from this event, the higher amounts occurred over the central and eastern portions of the county which were closer to the low pressure system. Some reported snowfall totals include: 21.0 inches in Highland Lakes, 17.0 inches in Stockholm, 16.0

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
					inches in Sparta, 15.5 inches in Hardyston Township, 15.0 inches in Vernon, 13.5 inches in Wantage, 12.7 inches in Montague, and 12.0 inches in Newton.
March 21-22, 2018	Winter Storm	N/A	N/A	Sussex County	A complex area of low pressure over the middle Atlantic, which involved several individual centers, slowly consolidated off the Virginia Capes Tuesday morning, March 20th into Wednesday March 21st along a frontal boundary. This primary low, the fourth nor'easter of March, gradually moved northeast Wednesday night, to a position southeast of the 40 North/70 West Benchmark coordinates on Thursday morning. Precipitation began as a wet, heavy snow during the evening hours on March 20th. After a lull during the overnight hours, a drier snow began falling, heavy at times, during the afternoon and evening hours on March 21st. The heaviest snow from this event fell in the southern one-half of the county, with a sharp drop off in the far north. Some snowfall reports include: 10.0 inches in both Stockholm and Byram Township, 9.5 inches in Fredon, 8.5 inches in both Hardyston Township and Newton, 7.0 inches in Ogdensburg, 7.0 inches in Andover, Sparta, and Franklin, 2.5 inches in Vernon Valley, 1.3 inches in Sussex, 1.1 inches in Wantage, and 0.2 inches in Montague.
April 2, 2018	Winter Storm	N/A	N/A	Sussex County	Despite high temperatures in the 50's and 60's across the region on April 1st, a cold front moving though the area during the morning gradually brought in colder air, which moved into the region by April 2nd. Meanwhile, a weak wave of low pressure developed along this front, and tracked south of the area. To the north of this low and where temperatures were cold enough, snow accumulated, especially near the Interstate 195 corridor and points north. The snow began after midnight on April 2nd and continued into the mid-morning hours. Snowfall amounts ranged from 4 to around 8 inches north of the Interstate 78 corridor. South of here, 1 to 4 inch amounts were common to the Interstate 195 corridor. To the south of the Interstate 195 corridor, amounts tapered down from 1 inch in a southerly direction, with Atlantic City New Jersey reporting a Trace of snowfall. A trained spotter reported 7.4 inches of snow in Highland Lakes. An NWS employee reported 5.5 inches of snow 4 miles southwest of Wantage.
November 15-16, 2018	Winter Storm	N/A	N/A	Sussex County	Early season winter storm. Additional trace amounts of snow were reported in Cape May County. Totals ranged from 12.6 in Montague to 6.5 in Sparta Township.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
February 12-13, 2019	Winter Storm	N/A	N/A	Sussex County	This event was the second part of a multi-day storm that impacted the region with light snow changing to a wintry mix and then to rain. Snow and ice totals were less across Delmarva than other locations farther north and west. A trained spotter reported 3.0 of snow in Lebanon. 0.04 of ice was reported at the Sussex County Airport.
March 3-4, 2019	Winter Storm	N/A	N/A	Sussex County	An offshore low pressure system brought a period of heavy precipitation to the mid-Atlantic. A mix of rain, sleet, and snow was observed, with snow confined mainly to interior areas and sleet and rain more abundant near the coast. Snowfall totals inland approached 10, with snowfall rates exceeding one inch per hour for several hours. A sharp gradient in snowfall with a steep drop in snow totals was observed just west of the Interstate 95 corridor. A trained spotter in Highland Lakes reported 8.2 inches of snow.
December 1-3, 2019	Winter Storm	N/A	N/A	Sussex County	A complex, long duration winter storm impacted parts of the mid-Atlantic over the first three days of December. Impacts from the storm came mainly in two phases. Initially, weakening low pressure moved into the Midwest and Great Lakes region on December 1, bringing a widespread area of overrunning precipitation to the mid-Atlantic. Cold air in place ahead of the precipitation led to heavy mixed precipitation in interior areas, with most though not all areas eventually seeing a gradual change to rain. On December 2nd, developing secondary low pressure brought additional precipitation to the region, which took the form of rain changing to snow. The rapidly strengthening secondary low finally pulled away from the area during the early hours of December 3rd. A heavy mix of snow, sleet, and freezing rain occurred. The highest snowfall report was 14.3 inches in Highland Lakes, with a widespread 8 to 12 inches of snow throughout the county. Up to a third of an inch of glaze ice also fell. The Sussex Airport ASOS (KFWN) measured 0.32 inches of glaze ice. Widespread power outages occurred with a number of downed trees and wires, including the KFWN ASOS which failed late in the storm's duration due to loss of power.
December 16-17, 2019	Winter Storm	N/A	N/A	Sussex County	Low pressure developed along a stationary boundary over the Southeast US on December 16. The low pressure tracked into the Appalachians before beginning to develop near the southern New Jersey coast early on December 17. This brought widespread precipitation to the mid-Atlantic. Surface temperatures were initially cold enough for frozen precipitation in some areas, but a surge of low level warm air caused most of the frozen precipitation to fall as sleet and freezing rain, with most areas eventually seeing a change to all rain. In some places, impacts due to icing were significant. The Sussex, NJ Airport ASOS (KFWN) measured 0.44 inches of ice accretion. Some sleet also occurred. A number of reports of downed trees and power lines were received.

Source: NOAA-NCDC 2020; NJOEM 2019; NWS 2020; FEMA 2020
DR Disaster Declaration
FEMA Federal Emergency Management Agency
N/A Not Applicable

NCDC National Climatic Data Center
NOAA National Oceanic and Atmospheric Administration
NWS National Weather Service

Probability of Future Occurrences

Severe winter weather is a common occurrence each winter season in New Jersey. The majority of the State will receive at least one measurable snow event during the winter months. The months of January, February, March, April, October, November and December are typically when a vast majority of New Jersey has been observed to receive measurable snow. Generally, counties in the northern region experience more snow events than those in the southern region. It is estimated that Sussex County will continue to experience the direct and indirect impacts of severe winter weather events annually that many induce secondary hazards such as: structural damage (snow and ice load), wind damage, impact to life safety, disruption of traffic, loss of productivity, economic impact, loss of ability to evacuate, taxing first-responder capabilities, service disruption (power, water, etc.), and communication disruption.

According to the NOAA NCEI storm events database, Sussex County has been impacted by 135 severe winter storm events between 1950 and 2020 (Table 4.3.12-4). While no events resulted in deaths or crop damage, $3.65M in property damages and four injuries were reported.

Table 4.3.12-4. Probability of Future Occurrence of Severe Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2020	Annual Number of Events (average)	Recurrence Interval* (in years)	Probability of Event Occurring in Any Given Year	Percent Chance of Occurring in Any Given Year
Blizzard	2	0.03	35.5	0.03	2.8%
Heavy Snow	47	0.67	1.51	0.66	66.2%
Ice Storm	10	0.14	7.10	0.14	14.1%
Sleet	4	0.06	17.9	0.06	5.6%
Winter Storm	72	1.03	0.99	1.01	100%
Total	**135**	**1.9**	**0.53**	**1.90**	**100%**

Note: Not all events that have occurred in Sussex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
Source: NOAA-NCEI 2020

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for severe winter weather in the county is considered ‘frequent’ (100 percent annual probability; a hazard event may occur multiple times per year, as presented in Table 4.4-1). The ranking of the severe winter weather hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

Climate change includes major changes in temperature, precipitation, or wind patterns, which occur over several decades or longer. Due to the increase in greenhouse gas concentrations since the end of the 1890s, New Jersey has experienced a 3.5° F (1.9° C) increase in the State’s average temperature (Office of the New Jersey State Climatologist 2020), which is faster than the rest of the Northeast region (2° F [1.1° C]) (Melillo et al. 2014) and the world (1.5° F [0.8° C]) (IPCC 2014). This warming trend is expected to continue. By 2050, temperatures in New Jersey are expected to increase by 4.1 to 5.7° F (2.3° C to 3.2° C) (Horton et al. 2015). Thus, New Jersey can expect to experience an average annual temperature that is warmer than any to date (low emissions scenario) and future temperatures could be as much as 10° F (5.6° C) warmer (high emissions scenario) (Runkle et al. 2017). New Jersey can also expect that by the middle of the 21st century, 70% of summers will be hotter than the warmest summer experienced to date (Runkle et al. 2017). The increase in temperatures is expected to be felt more during the winter months (December, January, and February), resulting in less intense cold waves, fewer sub-freezing days, and less snow accumulation.

As temperatures increase, Earth's atmosphere can hold more water vapor which leads to a greater potential for precipitation. Currently, New Jersey receives an average of 46 inches of precipitation each year (Office of the New Jersey State Climatologist 2020). Since the end of the twentieth century, New Jersey has experienced slight increases in the amount of precipitation it receives each year, and over the last 10 years there has been a 7.9% increase. By 2050, annual precipitation in New Jersey could increase by 4% to 11% (Horton et al. 2015). By the end of this century, heavy precipitation events are projected to occur two to five times more often (Walsh et al. 2014) and with more intensity (Huang et al. 2017) than in the last century. New Jersey will experience more intense rain events, less snow, and more rainfalls (Fan et al. 2014, Demaria et al. 2016, Runkle et al. 2017).

Vulnerability Assessment

All of Sussex County is vulnerable to severe winter storm events. The following subsections discuss Sussex County's vulnerability, in a qualitative nature, to the severe winter weather hazard.

Impact on Life, Health and Safety

According to the NOAA National Severe Storms Laboratory (NSSL); every year, winter weather indirectly and deceptively kills hundreds of people in the U.S., primarily from automobile accidents, overexertion and exposure (NSSL 2020). Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow and extreme cold temperatures and dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. People can die in traffic accidents on icy roads, heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold. Heavy accumulations of ice can bring down trees and power lines, disabling electric power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services. Storms near the coast can cause coastal flooding and beach erosion as well as sink ships at sea. The economic impact of winter weather each year is huge, with costs for snow removal, damage and loss of business in the millions (NOAA 2017).

The entire population of Sussex County (149,265 people) is exposed to severe winter storm events (U.S. Census, 2010). Snow accumulation and frozen/slippery road surfaces increase the frequency and impact of traffic accidents for the general population, resulting in personal injuries.

The homeless and residents below the poverty level may not have access to housing or their housing could be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). Residents with low incomes might not have access to housing or their housing can be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). In Sussex County, area with the highest concentration of population below the poverty level are located in Newton (10% of the total population). Refer to Section 3 (County Profile) that displays the densities of low-income populations in Sussex County.

Impact on General Building Stock

The entire general building stock inventory 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 this hazard. As an alternate approach, this plan considers percentage damages that could result from severe winter storm conditions. Table 4.3.12-5 summarizes percent damages to buildings that could result from severe winter storm conditions. Given professional knowledge and the currently available information, the potential loss for this hazard is many times considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place, etc.). Therefore, the following information should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 4.3.12-5 General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

Municipality	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Borough of Andover	$110,720,294	$1,107,202.94	$5,536,014.70	$11,072,029.40
Township of Andover	$797,432,934	$7,974,329.34	$39,871,646.70	$79,743,293.40
Borough of Branchville	$105,787,947	$1,057,879.47	$5,289,397.35	$10,578,794.70
Township of Byram	$1,001,139,850	$10,011,398.50	$50,056,992.50	$100,113,985.00
Township of Frankford	$1,028,566,798	$10,285,667.98	$51,428,339.90	$102,856,679.80
Borough of Franklin	$555,083,580	$5,550,835.80	$27,754,179.00	$55,508,358.00
Township of Fredon	$524,017,917	$5,240,179.17	$26,200,895.85	$52,401,791.70
Township of Green	$617,892,936	$6,178,929.36	$30,894,646.80	$61,789,293.60
Borough of Hamburg	$478,777,394	$4,787,773.94	$23,938,869.70	$47,877,739.40
Township of Hampton	$898,127,786	$8,981,277.86	$44,906,389.30	$89,812,778.60
Township of Hardyston	$1,058,804,064	$10,588,040.64	$52,940,203.20	$105,880,406.40
Borough of Hopatcong	$1,459,447,874	$14,594,478.74	$72,972,393.70	$145,944,787.40
Township of Lafayette	$484,326,532	$4,843,265.32	$24,216,326.60	$48,432,653.20
Township of Montague	$550,631,281	$5,506,312.81	$27,531,564.05	$55,063,128.10
Town of Newton	$926,551,970	$9,265,519.70	$46,327,598.50	$92,655,197.00
Borough of Ogdensburg	$250,464,374	$2,504,643.74	$12,523,218.70	$25,046,437.40
Township of Sandyston	$359,643,031	$3,596,430.31	$17,982,151.55	$35,964,303.10
Township of Sparta	$3,083,993,131	$30,839,931.31	$154,199,656.55	$308,399,313.10
Borough of Stanhope	$557,098,000	$5,570,980.00	$27,854,900.00	$55,709,800.00
Township of Stillwater	$581,254,607	$5,812,546.07	$29,062,730.35	$58,125,460.70
Borough of Sussex	$259,651,457	$2,596,514.57	$12,982,572.85	$25,965,145.70
Township of Vernon	$3,063,072,948	$30,630,729.48	$153,153,647.40	$306,307,294.80
Township of Walpack	$8,710,816	$87,108.16	$435,540.80	$871,081.60
Township of Wantage	$1,396,272,081	$13,962,720.81	$69,813,604.05	$139,627,208.10
Sussex County (Total)	**$20,157,469,603**	**$201,574,696.03**	**$1,007,873,480.15**	**$2,015,746,960.30**

Source: Sussex County GIS 2020; RS Means 2020
Values represent estimated replacement cost.

A specific area that is vulnerable to the severe winter storm hazard is the floodplain. Severe winter storms can cause flooding through blockage of streams or through snow melt. At-risk residential infrastructures are presented in the flood hazard profile (Section 4.3.5). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 100-year flood. Please refer to the Severe Weather (Section 4.3.11) profile for losses resulting from high winds which may also accompany severe winter weather.

Impact on Critical Facilities and Lifelines

Full functionality of critical facilities such as police, fire and medical facilities is essential for response during and after a severe winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended. Infrastructure at risk for this hazard includes roadways that could be damaged due to the application of salt and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires the clearing roadways and alerting citizens to dangerous conditions; following the winter season, resources for road maintenance and repair are required.

Heavy snow can immobilize a region and paralyze a city, stranding commuters, stopping the flow of supplies, and disrupting emergency and medical services. Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2020).

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Another impact on the economy includes impacts on commuting into, or out of, the area for work or school. The loss of power and closure of roads prevents the commuter population traveling to work within and outside of the County. During the 2019-2020 winter season, the State of New Jersey Department of Transportation has budgeted winter maintenance expenditures at $36.9 million, which includes costs for salt (124,911 tons), liquid calcium chloride (247,424 gallons), and brine (270,820 gallons) (NJDOT 2020).

Impact on the Environment

Severe winter weather can have a major impact on the environment. Not only does winter weather create changes in natural processes, the residual impacts of a community's methods to maintain its infrastructure through winter weather maintenance may also have an impact on the environment. For example, an excess amount of snowfall and earlier warming periods may affect natural processes such as flow within water resources. Rain-on-snow events can also exacerbate runoff rates with warming winter weather. Consequentially, these flow rates and excess volumes of water can erode banks, tear apart habitat along the banks and coastline, and disrupt terrestrial plants and animals.

Furthermore, chemically based winter maintenance practices have its own effect on the natural environment. Melting snow and ice that carry deicing chemicals onto vegetation and into soils can contaminate the local waterways. Elevated salt levels may hinder vegetation from absorbing nutrients, slowing plant growth (UMass Extension 2020).

Future Growth and Development

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

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

Projected Development

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Sussex County. Any areas of growth could be potentially impacted by the severe winter storm hazard because the entire planning area is exposed and vulnerable. However, due to increased standards and codes, new development may be less vulnerable to the severe winter weather hazard compared with the aging building stock in the County.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population can create issues for local residents during evacuation of a severe winter storm event. Furthermore, if the density or number of persons over 65 increases in the County, more persons will be vulnerability to severe winter weather events. Refer to Section 3 (County Profile), which includes a discussion on population trends for the County.

Climate Change

Climate is defined not simply as average temperature and precipitation but also by the type, frequency and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of extremes such winter storms. While predicting changes of winter storm events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA], 2020).

Both northern and southern New Jersey have become wetter over the past century. In terms of long-term changes in snowfall and ice storms in New Jersey, there is a lack of quantitative data to predict how future climate change will affect this hazard. It is likely that the number of winter weather events may decrease, and the winter weather season may shorten; however, it is also possible that the intensity of winter storms may increase. The exact effect on winter weather is still highly uncertain.

An increase in the frequency and severity of severe winter storms could result in an increase of snow loads on the County's building stock and infrastructure, putting each building at risk to structural damage. More frequent and severe events also will result in increased resources spent to prepare for and clean-up after an event. However, as winter temperatures continue to rise, climate projections indicate the increase in precipitation is likely to occur during the winter months as rain. Increased rain on snowpack or frozen or saturated soils can lead to increased flooding and related impacts on the County's assets.

Change of Vulnerability

Overall, the County's exposure and vulnerability have not changed, and the entire County will continue to be exposed and vulnerable to severe winter storm events.

4.3.13 WILDFIRE

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 wildfire hazard in Sussex County.

2021 HMP Changes

- Previous occurrences were updated with events that occurred between 2015 and 2020.
- The vulnerability assessment was conducted using updated population, building and critical facility/lifeline spatial data to determine exposure to the wildfire hazard.

Profile

Hazard Description

A wildland fire can be defined as any non-structural fire that occurs in the wildland. Three distinct types of wildland fires have been defined and include: naturally occurring wildfire, human-caused wildfire, and prescribed fire. Many of these are highly destructive and can be difficult to control. They occur in forested, semi-forested, or less developed areas. Wildland fires can be caused by lightning, human carelessness, and arson. Most frequently, wildland fires in the State of New Jersey are caused by humans. Wildfires result in the uncontrolled destruction of forests, brush, field crops, grasslands, real estate, and personal property, and have secondary impacts on other hazards such as flooding, by removing vegetation and destroying watersheds.

Wildfires can increase the probability of other natural disasters, specifically floods and mudflows. Wildfires, particular large-scale fires, can dramatically alter the terrain and ground conditions, making land already devastated by fire susceptible to floods. Lands impacted by wildfire increase the risk of flooding and mudflow in those areas impacted by wildfire. Normally, vegetation absorbs rainfall, reducing runoff. However, wildfires leave the ground charred, barren, and unable to absorb water; thus, creating conditions perfect for flash flooding and mudflows. Flood risk in these impacted areas remain significantly higher until vegetation is restored, which can take up to five years after a wildfire (FEMA 2013).

Flooding after a wildfire is often more severe, as debris and ash left from the fire can form mudflows. During and after a rain event, as water moves across charred and denuded ground, it can also pick up soil and sediment and carry it in a stream of floodwaters. These mudflows have the potential to cause significant damage to impacted areas. Areas directly affected by fires and those located below or downstream of burn areas are most at risk for flooding (FEMA 2013). For detailed information regarding flooding, see Section 4.3.6 (Flood).

The height of wildland fire season in New Jersey is typically in spring (March through May) and culminates in early May, corresponding with the driest live fuel moisture periods of the year. Although the spring months are the most severe, the summer and fall months may also experience extensive fires in the state. While the spring season is historically the period in which wildfire danger is the highest, wildland fires can occur every month of the year. Drought, snow pack, and local weather conditions can expand the length of the fire season. The early and late shoulders of the fire season usually are associated with human-caused fires. Lightning generally is the cause of most fires in the peak season.

Location

According to the U.S. Fire Administration (USFA), the fire problem in the U.S. varies from region to region. This often is a result of climate, poverty, education, demographics, and other causal factors (USFA 2012). In Sussex County, wildfires have the potential to occur anywhere in the County.

The New Jersey Forest Fire Service (NJFFS), a division of the New Jersey Department of Environmental Protection (NJDEP), is responsible for protecting the 3.25 million acres of wildland in the State. NJFFS is under the direction of the State fire warden and is headquartered in Trenton. NJFFS has 85 full-time employees that provide an array of services including staffing the State's 21 fire towers, which are operational during the months of March, April, May, October, and November.

NJFFS divides the State into three regions (Northern, Central, Southern) each totaling about 1,250,000 acres. There are 29 125,000 acre sections with a dedicated forest fire warden in each; and 269 districts each consisting of 15,000-20,000 acres In total, 29 section forest fire wardens, 269 district forest fire wardens and 2,000 trained crew members respond to fires on an as-needed basis (NJFFS 2013). Figure 4.3.13-1 illustrates the NJFFS region divisions within the State. Sussex County is located in Division A (Northern NJ).

Wildfire Fuel Hazard Areas

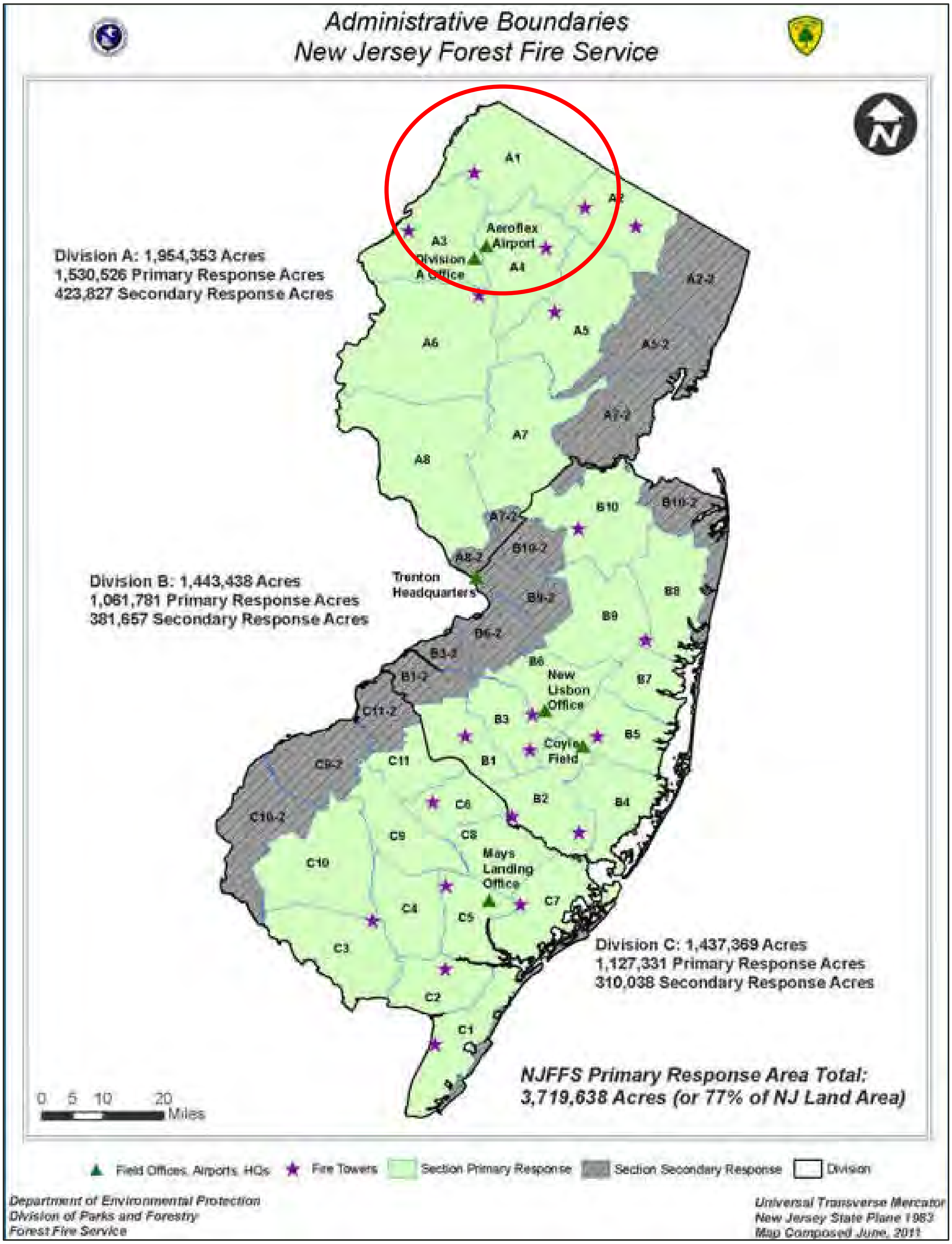
NJFFS developed Wildfire Fuel Hazard data for the entire state based on NJDEP data. For details on the information was developed, refer to: https://www.state.nj.us/dep/gis/njfh.html. Refer to Figure 4.3.13-2 for the fuel hazards located in Sussex County; and Figure 4.3.13-3 for the fire risk in Sussex County. Every municipality in Sussex County has at least a small portion of the community located within the high to extreme risk area, with Township of Walpack having largest percentage of land within the high to extreme risk area (29.8-percent) due to the large areas of parkland. Table 4.3.13-1 summarizes the amount of land in each of the wildfire fuel hazard ranking zones for Sussex County. Table 4.3.13-2 summarizes the approximate area in the NJFFS risk areas in the County.

Table 4.3.13-1. Area in the Wildfire Fuel Hazard Ranking Zones in Sussex County

Hazard Area	Area (Square Miles)
Extreme	32.1
Very High	11.8
High	25.6
Moderate	98.3
Low	248.6

Source: NJDEP 2009

Figure 4.3.13-1. Fire Divisions of New Jersey



Source: NJDEP 2013

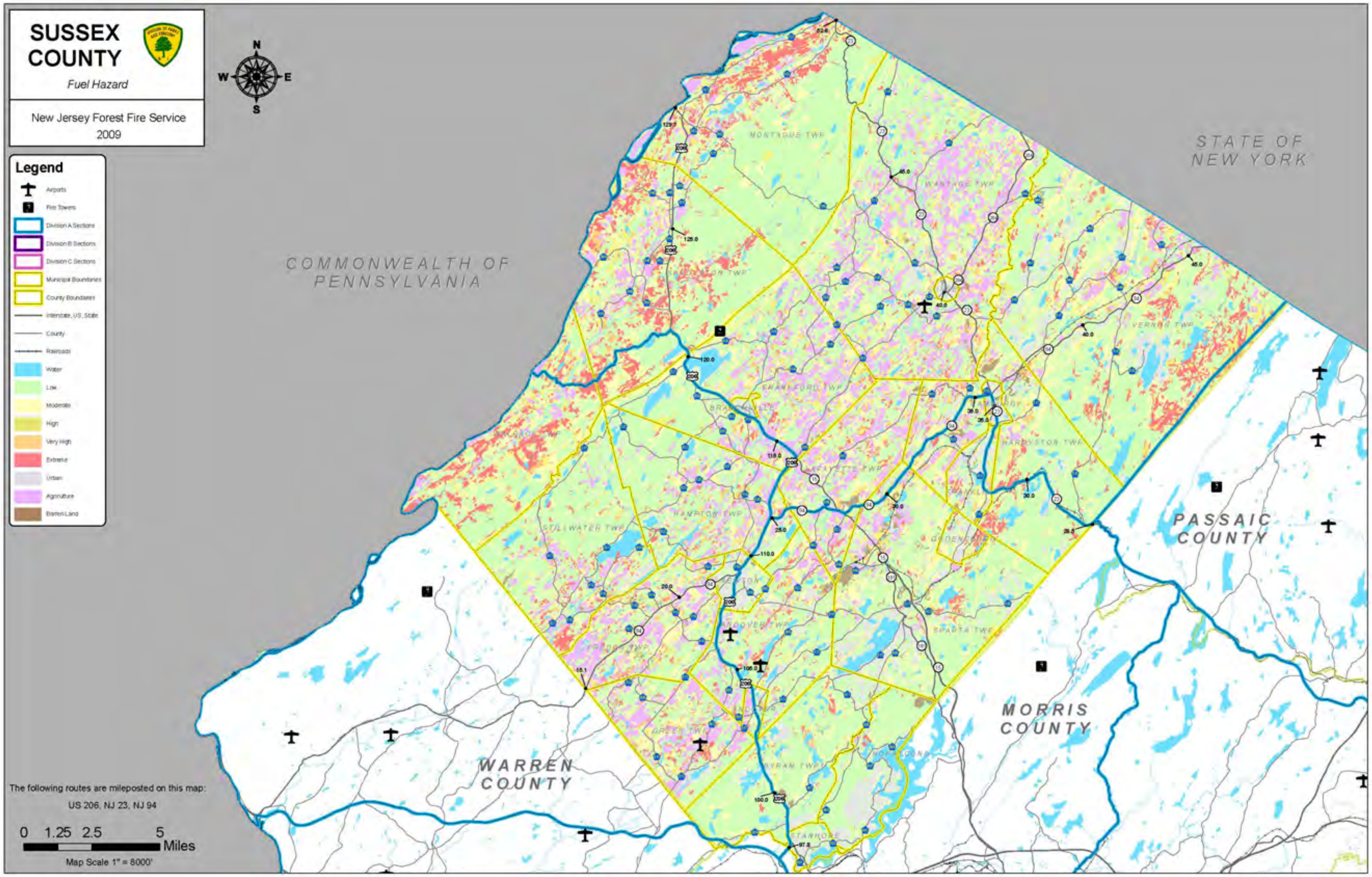
Note: The red circle indicates the location of Sussex County. The County is located in Fire Division A.

Table 4.3.13-2. Approximate Area in Wildfire Fuel Hazard Ranking Zones in Sussex County

Municipality	Total Area (Square Miles)	New Jersey Forest Fire Service Risk Areas			
		Low to Moderate	Percent in Hazard Area	High to Extreme	Percent in Hazard Area
Andover (B)	1.4	0.7	48.0%	0.1	8.9%
Andover (Twp)	20.8	13.5	64.9%	2.3	10.9%
Branchville (B)	0.6	0.2	38.3%	0.0	5.3%
Byram (Twp)	22.7	17.7	78.1%	0.8	3.5%
Frankford (Twp)	35.3	21.1	59.7%	3.9	11.0%
Franklin (B)	4.4	2.0	45.9%	0.6	14.1%
Fredon (Twp)	17.9	10.0	55.9%	2.6	14.5%
Green (Twp)	16.3	9.0	55.1%	2.1	12.6%
Hamburg (B)	1.2	0.3	28.8%	0.1	10.5%
Hampton (Twp)	25.5	16.8	66.1%	2.4	9.6%
Hardyston (Twp)	32.6	23.4	71.8%	3.8	11.7%
Hopatcong (B)	12.4	7.2	57.9%	0.2	1.5%
Lafayette (Twp)	18.0	9.5	52.9%	2.5	13.9%
Montague (Twp)	46.6	34.7	74.5%	6.7	14.5%
Newton (T)	3.4	1.5	44.8%	0.1	3.5%
Ogdensburg (B)	2.2	1.0	46.5%	0.5	20.1%
Sandyston (Twp)	42.1	27.7	65.9%	9.9	23.6%
Sparta (Twp)	38.8	25.6	65.9%	2.9	7.6%
Stanhope (B)	2.1	1.0	49.0%	0.0	1.0%
Stillwater (Twp)	28.2	19.9	70.4%	3.0	10.7%
Sussex (B)	0.6	0.1	22.4%	0.0	1.3%
Vernon (Twp)	70.0	46.4	66.3%	10.7	15.2%
Walpack (Twp)	24.9	15.3	61.2%	7.4	29.8%
Wantage (Twp)	67.5	40.8	60.5%	6.2	9.2%
Sussex County (Total)	**535.5**	**345.6**	**64.5%**	**68.9**	**12.9%**

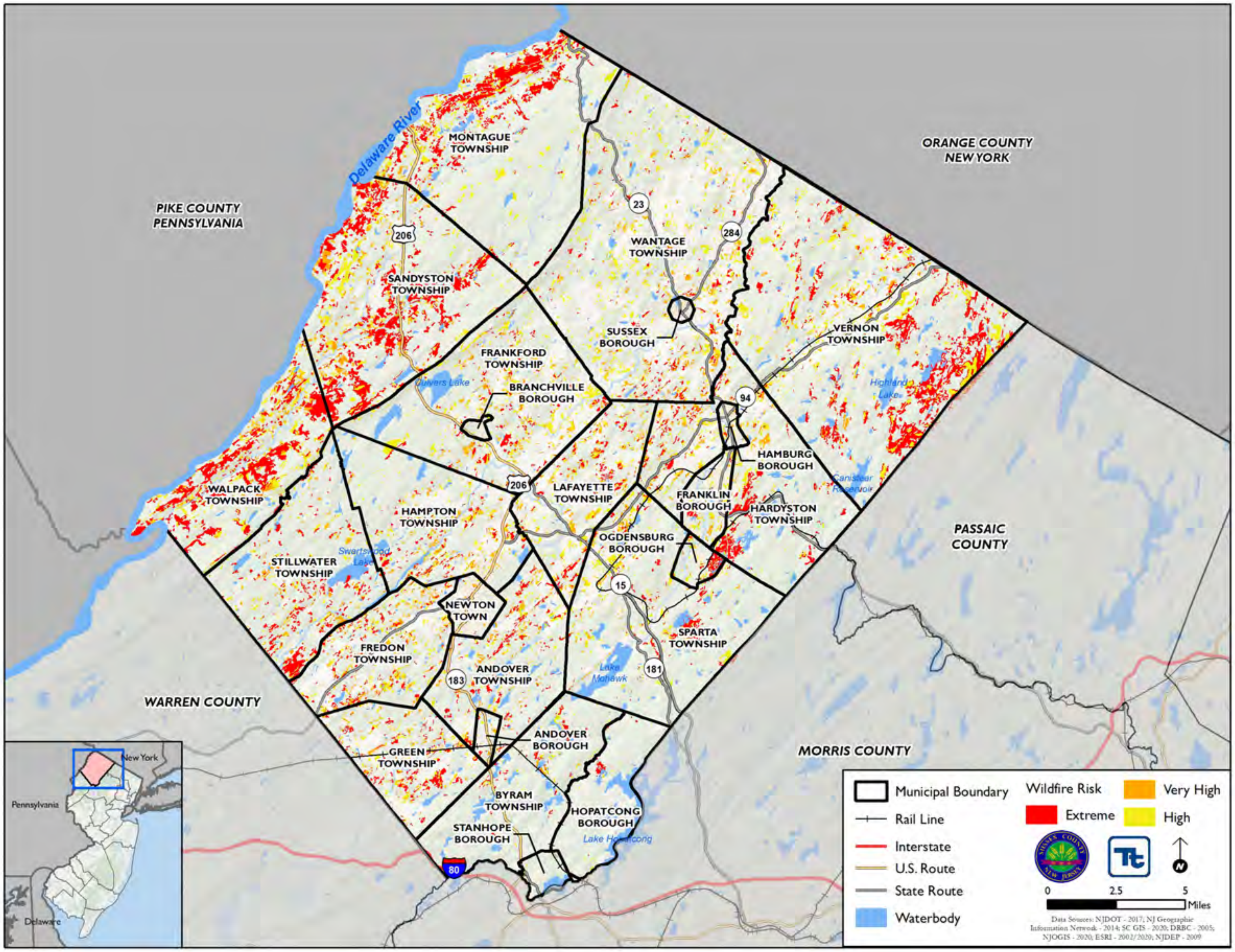
Source: NJDEP 2009
Note: B – Borough; T – Town; Twp – Township; % - Percent

Figure 4.3.13-2. Wildfire Fuel Hazard for Sussex County



Source: New Jersey Forest Fire Service 2009

Figure 4.3.13-3. Wildfire Risk for Sussex County as Defined by NJFFS



Extent

The extent (that is, magnitude or severity) of wildfires depends on weather (dryness/drought) and human activity. To determine the potential for wildfires, the NJFFS uses two indices to measure and monitor the dryness of forest fuels and the possibility of fire ignitions becoming wildfires. This includes the National Fire Danger Rating Systems Buildup Index and the Keetch-Byram Drought Index. Both are used for fire preparedness planning, which includes the following initiatives: campfire and burning restrictions, fire patrol assignments, staffing of fire lookout towers, and readiness status for both observation and firefighting aircraft.

- The ***Buildup Index*** is a number that reflects the combined cumulative effects of daily drying and precipitation fuels with a 10-day time lag constant. It is a rating of the total amount of fuel available for combustion.
- The ***Keetch-Byram Drought Index*** (KBDI) is an index used to determining forest fire potential. The drought index is based on a daily water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of 8-inches) and is expressed in hundredths of an inch of soil moisture depletion.

In addition to the two indices, the NJFFS uses the National Fire Danger Rating System (NFDRS) to provide a measure of relative seriousness of burning conditions and threat of fire in the State. It allows the NJFFS to estimate the daily fire danger for a given area. The NFDRS uses a five-color coded system to help the public understand fire potential. The NJFFS slightly adapted the color system for their purposes. The NFDRS, with the NFFS color scheme, is as follows in Table 4.3.13-3:

Table 4.3.13-3. Fire Danger Rating and Color Code

Fire Danger Rating and Color Code	Description
Low (L) (Green)	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
Moderate (M) (Blue)	Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open-cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
High (H) (Yellow)	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
Very High (VH) (Orange)	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.
Extreme (E) (Red)	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash (trunks, branches, and tree tops) or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Source: NJFFS 2020

Previous Occurrences and Losses

According to the NJ State Forestry, for 2019, 77 wildfires have occurred in Sussex County with an average size of 7.5 acres. Roughly 50 fires have threatened homes or other buildings. The NJ State Forestry has also responded to roughly 150 other incidents responses (SARs, Open Burns, IMT assignments, Storm Responses).

Between 1954 and 2020, New Jersey was included in two FEMA fire management assistance (FMA) declarations. Generally, these disasters cover a wide range of the State; therefore, the disaster may have impacted many counties. Sussex County was not included in either FEMA FMA declaration.

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 2015 and 2020, Sussex County was not included in any USDA disaster declarations.

Major wildfire events that have impacted Sussex County between 2015 and 2020 are identified in Tables 4.3.13-4. With severe weather documentation for New Jersey and Sussex County being so extensive, not all sources have been identified or researched. Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Table 4.3.13-4. Flooding Events in Sussex County, 2015 to 2020

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Sussex County Designated?	Location	Description
May 12, 2015	Wildfire	N/A	N/A	Montague Twp	A wildfire destroyed a home on Doremus Lane in Montague Township in Sussex County on the 12th. The wildfire started shortly after 530 p.m. EDT on the 12th. In addition to the home being destroyed, the wildfire consumed more than 6 acres before it was brought under control shortly after 8 p.m. EDT on the 12th. May 12th was an unseasonably warm and windy day which made it easy for wildfires to spread more rapidly. The peak wind gust at Wantage was 40 mph and the minimum relative humidity was 22 percent. No serious injuries were reported.

Source: FEMA 2020; NOAA-NCEI 2020; NJOEM 2019
Note: Not all events that have occurred in Sussex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
K: Thousand
DR Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
N/A Not Applicable

Probability of Future Occurrences

Estimating the approximate number of wildfires to occur in Sussex County is difficult to predict in a probabilistic manner. This is because a number of variable factors impact the potential for a fire to occur and because some conditions (for example, ongoing land use development patterns, location, fuel sources, and construction sites) exert increasing pressure on the wildfire urban interface (WUI). Based on available data, urban fires and wildfires will continue to present a risk to Sussex County. Given the numerous factors that can impact urban fire and wildfire potential, the likelihood of a fire event starting and sustaining itself should be gauged by professional fire managers on a daily basis.

According to the NOAA NCEI, Sussex County experienced 12 wildfire events between 1950 and 2020. The table below shows these statistics, as well as the annual average number of events and the percent chance of the wildfire occurring in Sussex County in future years (NOAA NCEI 2020).

Table 4.3.13-5. Probability of Future Occurrence of Wildfire Events

Hazard Type	Number of Occurrences Between 1950 and 2020	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Wildfire	12	0.17	5.9	0.17	16.9%

Source: NOAA-NCEI 2020

In Section 4.4, the identified hazards of concern for Sussex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Partnership, the probability of occurrence for wildfire in the County is considered ‘occasional’ (between 10 and 100 percent annual probability of a hazard event occurring., as presented in Table 4.4-1) with major impacts. The ranking of the wildfire hazard for individual municipalities is presented in the jurisdictional annexes.

Climate Change Impacts

A gradual change in temperatures will alter the growing environment of many tree species throughout the United States and New Jersey, reducing the growth of some trees and increasing the growth of others. Tree growth and regeneration may be affected more by extreme weather events and climatic conditions than by gradual changes in temperature or precipitation. Warmer temperatures may lead to longer dry seasons and multi-year droughts, creating triggers for wildfires, insects, and invasive species. Increased temperature and change in precipitation will also affect fuel moisture during wildfire season and the length of time during while wildfires can burn during a given year (U.S. Department of Agriculture [USDA] 2012). Climate change may also increase the frequency of lightning strikes. A warmer atmosphere holds more moisture which is one of the key items for triggering a lightning strike. Lightning strikes cause approximately half the wildfires in the United States. If the frequency of lightning strikes increases, the potential for wildfires from these strikes also increases (Lee 2014). Wildfire incidents are predicted to increase throughout the United States due to climate change, causing at least a doubling of areas burned within the next century (USDA 2012).

According to the temperature projections for Northern New Jersey, including Sussex County, this area can expect warmer and drier conditions which may increase the frequency and intensity of wildfires. Higher temperatures are expected to increase the amount of moisture that evaporates from land and water. These changes have the potential to lead to more frequent and severe droughts, which, in turn, increases the likelihood of wildfires (U.S. EPA 2009).

Vulnerability Assessment

A spatial analysis was conducted using the 2009 NJDEP Wildfire Fuel Hazard spatial layer**.** For the purposes of the assessment, an asset **(**population, structures, critical facilities, and lifelines) is considered exposed and potentially vulnerable to the wildfire hazard if it is located in the ‘extreme’, ‘very high’ and ‘high’ wildfire fuel hazard areas. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess wildfire risk.

Impact on Life, Health, and Safety

Wildfires have the potential to impact human health and life of residents and responders, structures, infrastructure, and natural resources. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment. First responders are exposed to the dangers from the initial incident and after-effects from smoke inhalation and heat stroke. Table 4.3.13-6 summarizes the estimated population exposed to the wildfire hazard by municipality.

Based on the analysis, an estimated 2,933 residents, or 2.1-percent of the County's population, live in the extreme, high, and very high wildfire fuel hazard areas. Overall, the Township of Hardyston has the greatest number of individuals located in the extreme, very high, and high fuel hazard areas (i.e., 525 persons).

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. In Sussex County, there are 7,191 persons living below the poverty level and 22,889 persons over 65 years old. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on net economic impacts on their families. The population over age 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available due to isolation during a wildfire event, and they may have more difficulty evacuating.

Table 4.3.13-6. Population in Wildfire Fuel Hazard Areas

Jurisdiction	Total Population	Population Exposure to The Wildfire Fuel Hazard Area (Extreme High, Very High, High)	
		Number of People	Percent of Total
Andover (B)	594	0	0.0%
Andover (Twp)	5,996	117	2.0%
Branchville (B)	896	5	0.6%
Byram (Twp)	8,010	29	0.4%
Frankford (Twp)	5,361	121	2.3%
Franklin (B)	4,807	32	0.7%
Fredon (Twp)	3,214	156	4.9%
Green (Twp)	3,495	127	3.6%
Hamburg (B)	3,152	175	5.6%
Hampton (Twp)	4,916	53	1.1%
Hardyston (Twp)	7,886	525	6.7%
Hopatcong (B)	14,362	24	0.2%
Lafayette (Twp)	2,390	47	2.0%
Montague (Twp)	3,716	258	7.0%
Newton (T)	7,895	4	0.0%
Ogdensburg (B)	2,314	28	1.2%
Sandyston (Twp)	1,925	97	5.0%

Jurisdiction	Total Population	Population Exposure to The Wildfire Fuel Hazard Area (Extreme High, Very High, High)	
		Number of People	Percent of Total
Sparta (Twp)	18,841	273	1.4%
Stanhope (B)	3,377	0	0.0%
Stillwater (Twp)	3,936	108	2.7%
Sussex (B)	1,854	7	0.4%
Vernon (Twp)	22,369	326	1.5%
Walpack (Twp)	6	0	0.0%
Wantage (Twp)	10,986	419	3.8%
Sussex County (Total)	**142,298**	**2,933**	**2.1%**

Source: American Community Survey 2018 5-year estimates; NJDEP 2009
Note: B – Borough; T – Town; Twp – Township; % - Percent

Impact on General Building Stock

Buildings located within the NJFFS identified extreme, very high or high fuel hazard areas are exposed and considered vulnerable to the wildfire hazard. Buildings constructed of wood or vinyl siding are generally more likely to be impacted by the fire hazard than buildings constructed of brick or concrete. Table 4.3.13-7 summarizes the estimated building stock inventory located in the defined hazard area by municipality. Approximately 3.7-percent ($2.2 million) of the County's building replacement cost value is located in the extreme/very high/high hazard area. The Township of Hardyston has the greatest number of buildings located in the wildfire hazard area (277 structures – 6.3-percent of its total).

Table 4.3.13-7. Probability of Future Occurrence of Wildfire Events

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to The Wildfire Fuel Hazard Area (Extreme High, Very High, High)			
			Number of Buildings	Percent of Total	Replacement Cost Value (RCV)	Percent of Total
Andover (B)	328	$628,463,030	0	0.0%	$0	0.0%
Andover (Twp)	2,584	$3,609,679,724	53	2.1%	$96,760,223	2.7%
Branchville (B)	426	$532,377,368	2	0.5%	$954,087	0.2%
Byram (Twp)	3,676	$2,746,550,446	18	0.5%	$14,547,815	0.5%
Frankford (Twp)	3,537	$3,129,888,305	85	2.4%	$213,384,750	6.8%
Franklin (B)	2,061	$1,921,211,856	12	0.6%	$4,979,832	0.3%
Fredon (Twp)	1,615	$1,372,050,934	66	4.1%	$44,807,505	3.3%
Green (Twp)	1,698	$1,598,635,804	56	3.3%	$89,473,403	5.6%
Hamburg (B)	1,594	$1,588,049,291	83	5.2%	$30,256,179	1.9%
Hampton (Twp)	2,763	$2,196,131,598	38	1.4%	$43,529,892	2.0%
Hardyston (Twp)	4,403	$3,183,033,542	277	6.3%	$150,248,545	4.7%
Hopatcong (B)	8,040	$2,888,571,676	17	0.2%	$5,875,484	0.2%
Lafayette (Twp)	1,462	$1,958,174,065	27	1.8%	$33,525,478	1.7%

Jurisdiction	Total Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed to The Wildfire Fuel Hazard Area (Extreme High, Very High, High)			
			Number of Buildings	Percent of Total	Replacement Cost Value (RCV)	Percent of Total
Montague (Twp)	2,175	$1,459,611,020	141	6.5%	$145,007,235	9.9%
Newton (T)	2,679	$5,093,275,807	5	0.2%	$38,880,823	0.8%
Ogdensburg (B)	992	$819,879,629	12	1.2%	$4,826,290	0.6%
Sandyston (Twp)	1,528	$1,212,626,664	67	4.4%	$83,899,043	6.9%
Sparta (Twp)	8,132	$9,070,094,285	143	1.8%	$743,896,647	8.2%
Stanhope (B)	1,557	$1,051,183,581	1	0.1%	$33,458	<0.1%
Stillwater (Twp)	2,493	$1,417,579,398	64	2.6%	$20,291,206	1.4%
Sussex (B)	678	$1,945,578,916	2	0.3%	$1,326,154	0.1%
Vernon (Twp)	12,039	$5,658,971,163	182	1.5%	$248,943,139	4.4%
Walpack (Twp)	51	$63,691,550	8	15.7%	$20,753,211	32.6%
Wantage (Twp)	5,510	$4,877,543,885	198	3.6%	$192,791,167	4.0%
Sussex County (Total)	**72,021**	**$60,022,853,539**	**1,557**	**2.2%**	**$2,228,991,567**	**3.7%**

Source: Sussex County GIS 2020; RS Means 2020; NJDEP 2009
Note: B – Borough; T – Town; Twp – Township; % - Percent

Impact on Critical Facilities and Lifelines

In Sussex County, there are 22 critical facilities and lifelines located in the wildfire hazard area. Township of Sparta has the greatest number of critical facilities exposed to the wildfire fuel hazard areas (74). Refer to Table 4.3.13-8 which summarizes the number of exposed critical facilities and lifelines by jurisdiction.

Additionally, Table 4.3.13-9 summarizes the distribution of critical facilities exposed to the wildfire fuel hazard area. The majority of critical facilities exposed to the wildfire fuel hazard area are dams (i.e. 14). Additionally, most of the critical facilities exposed to the wildfire hazard area are categorized as safety and security lifelines for the County. As mentioned previously, wildfires can have an impact on the water supplies throughout the County because of residual pollutants like char or debris landing in water resources which can clog wastewater pipes, culverts, etc.

Table 4.3.13-8. Estimated Number of Critical Facilities and Lifelines Located in the Wildfire Fuel Hazard Area

Jurisdiction	Total Critical Facilities and Lifelines Located in Jurisdiction	Wildfire Fuel Hazard Area (Extreme High, Very High, High)	
		Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines
Andover (B)	12	1	8.3%
Andover (Twp)	37	1	2.7%
Branchville (B)	4	0	0.0%
Byram (Twp)	37	2	5.4%
Frankford (Twp)	23	0	0.0%
Franklin (B)	10	0	0.0%

Jurisdiction	Total Critical Facilities and Lifelines Located in Jurisdiction	Wildfire Fuel Hazard Area (Extreme High, Very High, High)	
		Critical Facilities and Lifelines	Percent of Total Critical Facilities and Lifelines
Fredon (Twp)	17	2	11.8%
Green (Twp)	21	0	0.0%
Hamburg (B)	19	0	0.0%
Hampton (Twp)	20	1	5.0%
Hardyston (Twp)	27	2	7.4%
Hopatcong (B)	22	0	0.0%
Lafayette (Twp)	14	0	0.0%
Montague (Twp)	32	1	3.1%
Newton (T)	39	0	0.0%
Ogdensburg (B)	7	1	14.3%
Sandyston (Twp)	28	2	7.1%
Sparta (Twp)	74	5	6.8%
Stanhope (B)	7	0	0.0%
Stillwater (Twp)	24	0	0.0%
Sussex (B)	8	0	0.0%
Vernon (Twp)	74	3	4.1%
Walpack (Twp)	11	0	0.0%
Wantage (Twp)	29	1	3.4%
Sussex County (Total)	**596**	**22**	**3.7%**

Source: Sussex County GIS 2020; NJDEP 2009
Note: B – Borough; T – Town; Twp – Township; % - Percent

Table 4.3.13-9. Distribution of Critical Facilities Located in the Wildfire Fuel Hazard Area by Type

Jurisdiction	Facility Types								
	Dam	DPW	Government Building	Hazardous Material Facility	Health/Medical Center	Potable Pump Station	Secondary Education	Wastewater Treatment	Well
Andover (B)	1	0	0	0	0	0	0	0	0
Andover (Twp)	1	0	0	0	0	0	0	0	0
Branchville (B)	0	0	0	0	0	0	0	0	0
Byram (Twp)	2	0	0	0	0	0	0	0	0
Frankford (Twp)	0	0	0	0	0	0	0	0	0
Franklin (B)	0	0	0	0	0	0	0	0	0
Fredon (Twp)	2	0	0	0	0	0	0	0	0
Green (Twp)	0	0	0	0	0	0	0	0	0

Jurisdiction	Facility Types								
	Dam	DPW	Government Building	Hazardous Material Facility	Health/Medical Center	Potable Pump Station	Secondary Education	Wastewater Treatment	Well
Hamburg (B)	0	0	0	0	0	0	0	0	0
Hampton (Twp)	1	0	0	0	0	0	0	0	0
Hardyston (Twp)	0	0	1	0	1	0	0	0	0
Hopatcong (B)	0	0	0	0	0	0	0	0	0
Lafayette (Twp)	0	0	0	0	0	0	0	0	0
Montague (Twp)	0	0	0	0	0	0	0	0	1
Newton (T)	0	0	0	0	0	0	0	0	0
Ogdensburg (B)	1	0	0	0	0	0	0	0	0
Sandyston (Twp)	2	0	0	0	0	0	0	0	0
Sparta (Twp)	1	1	0	0	0	1	1	1	0
Stanhope (B)	0	0	0	0	0	0	0	0	0
Stillwater (Twp)	0	0	0	0	0	0	0	0	0
Sussex (B)	0	0	0	0	0	0	0	0	0
Vernon (Twp)	3	0	0	0	0	0	0	0	0
Walpack (Twp)	0	0	0	0	0	0	0	0	0
Wantage (Twp)	0	0	0	1	0	0	0	0	0
Sussex County (Total)	**14**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**1**

Source: Sussex County GIS 2020; NJDEP 2009
Note: B – Borough; T – Town; Twp – Township

Table 4.3.13-10. Estimated Number of Lifelines Located in the Wildfire Fuel Hazard Area

FEMA Lifeline Category	Number of Lifelines	Number of Lifelines Exposed to The Wildfire Fuel Hazard Area (Extreme High, Very High, High)
Communications	9	0
Energy	12	0
Food, Water, Shelter	75	3
Hazardous Materials	20	1
Health and Medical	15	1
Safety and Security	463	17
Transportation	2	0
Sussex County (Total)	**596**	**22**

Source: Sussex County GIS 2020; NJDEP 2009; FEMA 2020

As mentioned previously, wildfires can have an impact on the water supplies throughout the County because of residual pollutants like char or debris landing in water resources which can clog wastewater pipes, culverts, etc.

Wildfires may also impact transportation routes, blocking residents and commuters from getting in and out of the County during a wildfire event because of char and debris polluting the air making it difficult to drive, or the flames having close proximity to the roadways making the route an unsafe passageway. Table 4.3.13-11 summarizes the number of miles roadways are built in the wildfire fuel hazard areas. Overall, 8.4-percent of the major roadways in the County are built within the wildfire fuel hazard area. Roads and bridges surrounding the areas of fire risk are important because they provide ingress and egress to large areas and, in some cases, to isolated neighborhoods. Fires can create conditions that block or prevent access and can isolate residents and emergency service providers

Table. 4.3.13-11. Major Transportation Routes Exposed to the Wildfire Fuel Hazard Areas

Road Type	Total Miles for County	Roadway Miles Exposed to the Wildfire Hazard Areas	
		Miles	Percent of Total
Local and Private Roads	1,337	103	7.7%
County Roads	313	33	10.6%
State Routes	86	8	9.2%
US Highways	34	4	11.9%
Interstate	1	0	0.0%
Sussex County (Total)	**1,771**	**148**	**8.4%**

Source: Sussex County GIS 2020; NJDEP 2009, NJDOT 2019

Impact on the Economy

Wildfire events can have major economic impacts on a community from the initial loss of structures and the subsequent loss of revenue from destroyed business. These events may cost thousands of taxpayer dollars to suppress and control and may involve hundreds of operating hours on fire apparatus and thousands of volunteer man hours from the volunteer firefighters. There are also many direct and indirect costs to local businesses that excuse volunteers from working to fight these fires.

Due to a lack of data regarding past structural and economic losses specific to Sussex County or its municipalities, it is not possible to estimate future losses due to wildfire events currently.

Impact on the Environment

According to the USGS, post-fire runoff polluted with debris and contaminates can be extremely harmful to ecosystem and aquatic life (USGS 2018). Studies show that urban fires in particular are more harmful to the environment compared to forest fires (USGS 2018). The age and density of infrastructure within Sussex County can exacerbate consequences of fires on the environment because of the increased amount of chemicals and contaminates that would be released from burning infrastructure. These chemicals, such as iron lead, and zinc, may leach into the storm water, contaminate nearby streams, and impair aquatic life.

Future Changes That May Impact Vulnerability

Understanding future changes that effect vulnerability in the County can assist in planning for future development and ensure establishment of appropriate mitigation, planning, and preparedness measures. Changes in the natural environment and built environment and how they interact can also provide insight about ways to plan for the future.

Projected Development

As discussed and illustrated in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County. Any changes in development can impact the County's risk to the wildfire hazard of concern. Therefore, the County should implement wildfire management strategies in existing building code to protect structures against the residual impacts from wildfire such as heat, debris, and char. Furthermore, development should be built with access to transit routes that will enable easier evacuation during a wildfire event.

A spatial analysis was conducted to determine the intersection of potential new development identified by municipalities and the wildfire hazard area. The exposure analysis shows that nine of these new development locations will be built in wildfire hazard areas; refer to Figure 4.3.13-4.

Projected Changes in Population

According to the 2018 5-year population estimates from the American Community Survey, the population of Sussex County (i.e., 142,298 persons) has decreased by approximately 4.7-percent since 2010. Even though the population has decreased, any changes in the density of population can impact the number of persons exposed to the wildfire hazard. Fire suppression capabilities are high at the State and local levels. However, new development and changes in population with a mix of additional structures, ornamental vegetation, and wildland fuels will require continued assessment of the hazard and mitigation risk.

Climate Change

According to the USDA Forest Service, climate change will likely alter the atmospheric patterns that affect fire weather. Changes in fire patterns will, in turn, impact carbon cycling, forest structure, and species composition (EPA 2020). Climate change associated with warmer temperatures, changes in rainfall, and increased periods of drought may create an atmospheric and fuel environment that is more conductive to large, severe fires (USDA 2013). Under a changing climate, wildfires exceeding 50,000 acres has increased over the past 30 years (USDA 2013). However, a study from the National Interagency Fire Center of the USGS shows that the number of acres burned by wildfires in New Jersey has decreased by 0.25 acres per square mile from events that took place in 2000 to 2014 compared to events that took place in 1984 and 1999 (EPA 2020).

Understanding the climate/fire/vegetation interactions is essential for addressing issues associated with climate change that include:

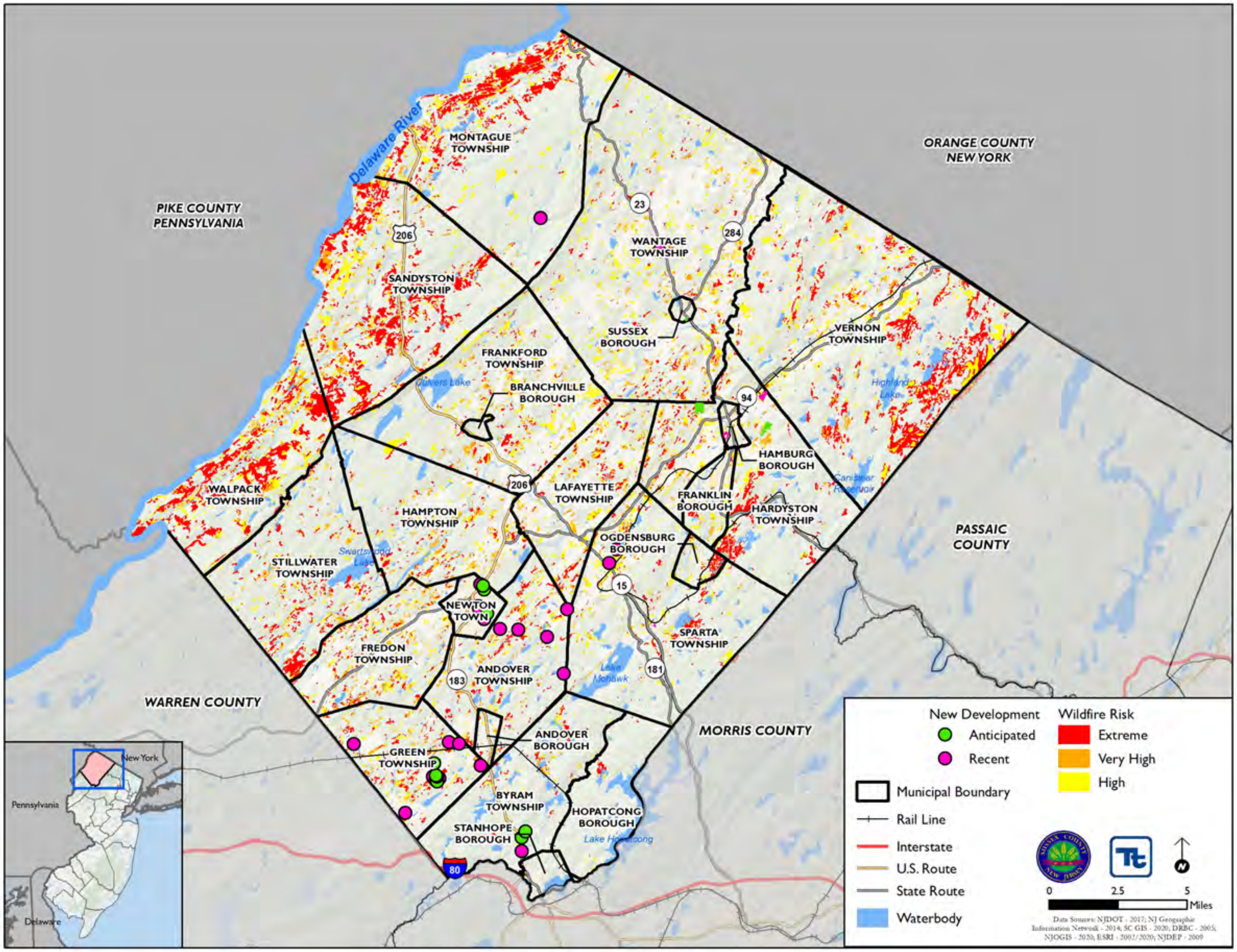
- Effects on regional circulation and other atmospheric patterns that affect fire weather
- Effects of changing fire regimes on the carbon cycle, forest structure, and species composition, and
- Complications from land use change, invasive species and an increasing WUI.

As discussed earlier, average temperatures are anticipated to increase in New Jersey, therefore, suitability of habitats for specific types of trees potentially changes, altering the fire regime and resulting in more frequent fire events and changes in intensity. Prolonged and more frequent heat waves have the potential to increase the likelihood of a wildfire. The increased potential combined with stronger winds may make it harder to contain fires and thus increase the County's vulnerability to this hazard.

Vulnerability Change Since the 2016 HMP

The 2021 HMP has been updated to reflect 2014-2018 American Community Survey 5-year estimates for population changes. The building stock inventory was updated using data from Sussex County. Further, the building stock inventory replacement cost values were updated using RS Means 2020 values providing an overall update to the assets assessed in this risk assessment. The NJDEP Wildfire Fuel Hazard spatial layer has not been updated since the last HMP; therefore, changes and any increases in overall wildfire hazard exposure are attributed to changes in population density and new development.

Figure 4.3.13-4. Wildfire Risk and New Development for Sussex County



4.4 HAZARD RANKING

2021 HMP Changes

- ➢ The hazard ranking section has been relocated to Section 4.4.
- ➢ The 2021 update hazard ranking methodology was expanded to include adaptive capacity and climate change.
- ➢ The probability of occurrence category was adjusted to include the benchmark value 'rare', and modifications to the remaining categories so that 'frequent' aligned with an event that has an annual probability.
- ➢ The following hazards of concern's countywide ranking changed from 2016 to 2021: the earthquake hazard reduced in rank from medium to low and the geological hazard reduced in rank from high to medium.

A comprehensive range of hazards that pose a significant risk to Sussex County were selected and considered during the development of this plan; see Section 4.1 (Identification of Hazards of Concern). However, each community has differing levels of exposure and vulnerability to each of these hazards. It is important for each community participating in this plan to recognize those hazards that pose the greatest risk to their community and direct their attention and resources accordingly to most effectively and efficiently manage risk and reduce losses. The hazard ranking for the County and each participating jurisdiction can be found in their jurisdictional annexes in Volume II, Section 9 of this plan.

To this end, a hazard risk ranking process was conducted for Sussex County and its municipalities using the method described below. This method includes four risk assessment categories—probability of occurrence, impact (population, property and economy), adaptive capacity, and changing future conditions (i.e., climate change). Each was assigned a weighting factor to calculate an overall ranking value for each hazard of concern. Depending on the calculation, each hazard was assigned a high, medium, or low ranking. Details regarding each of these categories is described below.

4.4.1 Hazard Ranking Methodology

Estimates of hazard risk for the County were developed using methodologies promoted by FEMA's hazard mitigation planning guidance, generated by FEMA's Hazus risk assessment tool, and input from Sussex County and participating jurisdictions.

As described in Section 4.2 (Methodology and Tools), three different levels of analysis were used to estimate potential impacts: 1) historic loss/qualitative analysis; 2) exposure analysis; and 3) loss estimation. All three levels of analysis are suitable for planning purposes; however, with any risk analysis, there is underlying uncertainty resulting from assumptions used to describe and assess vulnerability and the methodologies available to model impacts. Impacts from any hazard event within the County will vary from the analysis presented here based on the factors described for each hazard of concern; namely location, extent, warning time, and mitigation measures in place at the time of an event.

The hazard ranking methodology for some hazards of concern is based on a scenario event, while others are based on their potential risk to the County as a whole. In order to account for these differences, the quantitative hazard ranking methodology was adjusted using professional judgement and subject-matter input; assumptions are included, as appropriate, in the following subsections. The limitations of this analysis are recognized given the all scenarios do not have the same likelihood of occurrence; nonetheless, there is value in summarizing and comparing the hazards using a standardized approach to evaluate relative risk. The following categories were considered when evaluating the relative risk of the hazards of concern.

- **Probability of Occurrence -** The probability of occurrence of the scenario evaluated was estimated by examining the historic record and/or calculating the likelihood of annual occurrence. When no scenario was assessed, an examination of the historic record and judgement was used to estimate the probability of occurrence of an event that will impact the County.
- **Impact**—The following three hazard impact subcategories were considered: impact to people; impact to buildings; and impact to the economy. The results of the updated risk assessment and/or professional judgement were used to assign the numeric values for these three impact subcategories. A factor was applied to each subcategory, giving impact on population the greatest weight.
    - Population—Numeric value x 3
    - Buildings—Numeric value x 2
    - Economy—Numeric value x 1

  Adaptive Capacity - Adaptive capacity describes a jurisdiction's current ability to protect from or withstand a hazard event. This includes capabilities and capacity in the following areas: administrative, technical, planning/regulatory and financial. Mitigation measures already in place increases a jurisdiction's capacity to withstand and rebound from events (e.g. codes/ordinances with higher standards to withstand hazards due to design or location; deployable resources; or plans and procedures in place to respond to an event). In other words, assigning 'weak' for adaptive capacity means the jurisdiction does not have the capability to effectively respond, which increases vulnerability; whereas 'strong' adaptive capacity means the jurisdiction does have the capability to effectively respond, which decreases vulnerability. These ratings were assigned using the results of the core capability assessment with subject-matter input from each jurisdiction.
- **Climate Change (Changing Future Conditions) -** Current climate change projections were considered as part of the hazard ranking to ensure the potential for an increase in severity/frequency of the hazard was included. This was important to Sussex County to include because the hazard ranking helps guide and prioritize the mitigation strategy development, which should have a long-term future vision to mitigate the hazards of concern. The potential impacts climate change may have on each hazard of concern is discussed in Sections 4.3.1 through 4.3.13. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

Hazard Ranking Equation

[Probability of Occurrence x 0.40] + [(Impact on Population x 3) + (Impact on Property x 2) + (Impact on Economy x 1) x 0.40] + [Adaptive Capacity x 0.15] + [Climate Change x 0.05]

Table 4.4-1 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard. Using the weighting applied, the highest possible risk factor value is 9.0. The higher the number, the greater the relative risk. Based on the total for each hazard, a priority ranking is assigned to each hazard of concern (high, medium, or low). The rankings were categorized as follows: Low = Values less than or equal to 3.8; Medium = Values between 3.9 and 4.9; High = Values greater than or equal to 5.0.

Table 4.4-1. Summary of Hazard Ranking Approach

Category		Level / Category	Degree of Risk / Benchmark Value	Numeric Value	Weighted Value
Probability of Occurrence		Unlikely	A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability.	0	40%
		Rare	Between 1 and 10% annual probability of a hazard event occurring.	1	
		Occasional	Between 10 and 100% annual probability of a hazard event occurring.	2	
		Frequent	100% annual probability; a hazard event may occur multiple times per year.	3	
Impact (Sum of all 3)	Population (Numeric Value x 3)	Low	14% or less of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	1	40%
		Medium	15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	2	
		High	30% or more of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.	3	
	Property (Numeric Value x 2)	Low	Property exposure is 14% or less of the total number of structures for your community.	1	
		Medium	Property exposure is 15% to 29% of the total number of structures for your community.	2	
		High	Property exposure is 30% or more of the total number of structures for your community.	3	
	Economy (Numeric Value x 1)	Low	Loss estimate is 9% or less of the total replacement cost for your community.	1	
		Medium	Loss estimate is 10% to 19% of the total replacement cost for your community.	2	
		High	Loss estimate is 20% or more of the total replacement cost for your community.	3	
Adaptive Capacity		Weak	Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery.	3	15%
		Moderate	Plans, policies, codes/ordinances in place and meet minimum requirements; mitigation strategies identified but not implemented on a widespread scale; county/jurisdiction can recover but needs outside resources; moderate county/Jurisdiction capabilities.	2	
		Strong	Plans, policies, codes/ordinances in place and exceed minimum requirements; mitigation/protective measures in place; county/jurisdiction has ability to recover quickly because resources are readily available, and capabilities are high.	1	
Climate Change		Low	No local data is available; modeling projections are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).	1	5%
		Medium	Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).	2	
		High	Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).	3	

Note: A numerical value of zero is assigned if there is no impact.

**For the purposes of this exercise, "impacted" means exposed for population and property and estimated loss for economy. For non-natural hazards, although they may occur anywhere in the County, an event will not likely cause countywide impacts; therefore, impact to population was scored using an event-specific scenario.*

In an attempt to summarize the confidence level regarding the input utilized to populate the hazard ranking, a gradient of certainty was developed. A certainty factor of high, medium or low was selected and assigned to each hazard to provide a level of transparency and increased understanding of the data utilized to support the resulting ranking. The following scale was used to assign a certainty factor to each hazard:

- High—Defined scenario/event to evaluate; probability calculated; evidenced-based/quantitative assessment to estimate potential impacts through hazard modeling.
- Moderate—Defined scenario/event or only a hazard area to evaluate; estimated probability; combination of quantitative (exposure analysis, no hazard modeling) and qualitative data to estimate potential impacts.
- Low—Scenario or hazard area is undefined; there is a degree of uncertainty regarding event probability; majority of potential impacts are qualitative.

Table 4.4-2 summarizes the hazard scenario or hazard area evaluated; highlights key impacts to population, buildings/critical assets and the economy; and lists the associated certainty factor assigned for each hazard to convey the level of confidence in the data used. This table is not intended to be a complete and comprehensive list of all hazard impacts determined in the risk assessment and considered for the hazard ranking exercise. Refer to Sections 4.3.1 to 4.3.13 for a complete summary of all estimated impacts for each hazard.

Table 4.4-2. Overview of the Hazard Scenario and Associated Estimated Impacts Considered in the Hazard Ranking

Hazard of Concern	Hazard/ Scenario Area Evaluated	Population		Buildings		Economy[a]		Certainty Factor
Dam Failure	Partial or complete failure of a dam. There are 239 dams in the County; 40 are high hazard according to NJDEP.	Population impacted is dependent on the location and capacity of the dam, the extent of the dam failure inundation area and the severity of the failure.		The number of buildings impacted is dependent on the capacity of the dam, the extent of the dam failure inundation area and the severity of the failure.		Economic impacts include dam/building/infrastructure repairs; debris removal/disposal; utility impacts.		Low
Disease Outbreak	Disease outbreaks include: West Nile Virus, Eastern Equine Encephalitis virus, Lyme disease, Influenza, Ebola virus, and Coronavirus.	Population impacted is dependent on the disease and severity of the outbreak; in some cases, immuno-compromised persons are more vulnerable.		Structural impacts due to disease outbreak would be limited.		Economic losses can include County financial impacts to monitor/address outbreaks; lost wages or commercial interruptions; depends on the severity and type of disease outbreak.		Low
Drought	Prolonged drought event - The County is serviced by private wells or water suppliers who primarily get water from surface water, reservoirs and unconfined groundwater sources.	Entire population exposed. Population on surface water supplies may be impacted first; water restrictions/contamination; increased wildfire risk.		Droughts are not expected to cause direct damage to buildings.		Losses include aesthetic, landscape/nursery/agricultural industry impacts		Low
Earthquake*	100 and 500-Year MRP events NEHRP Soils D&E (soft soils that amplify ground shaking are present in the County)	NEHRP D&E:	18,048	NEHRP D&E:	9,684	500-year MRP building damages/loss:	$22,144,106	High
Flood*	100- and 500-Year MRP events	1% annual chance (100-year)	2,182	1% annual chance (100-year)	1,267	1% annual chance (100-year)	$137,650,964	High
		0.2% annual chance (500-year)	2,433	0.2% annual chance (500-year)	1,400			
Geological	Steep slope areas and areas developed over carbonate rock and abandoned mines with increased vulnerability to subsidence.	Steep Slope:	18,920	Steep Slope:	9,101	Steep Slope	$4,436,485,965	Moderate
		Carbonate Bedrock:	40,124	Carbonate Bedrock:	20,410	Carbonate Bedrock:	$21,031,014,086	

Hazard of Concern	Hazard/ Scenario Area Evaluated	Population		Buildings		Economy[a]		Certainty Factor
Hazardous Substance[b]	Release of a hazardous substance from a fixed site or in-transit.	Population impacted will depend on the type of material, time of day, and scale of the incident. May include population within small radii of site.		The degree of damages to a building depends on the location and scale of the incident.		The degree of damages depends on the location and scale of the incident.		Low
Hurricane	100-Year and 500-MRP events	Entire population exposed; the degree of impact to the population depends on the scale of the incident and warning time.		Entire building stock is exposed; the degree of impact depends on the scale of the incident.		100-Year MRP Estimated Damages	$9,953,005	High
						500-Year MRP Estimated Damages	$67,409,158	
Infestation and Invasive Species	Infestation and Invasive Species including insects and harmful algal bloom	Population impacted will depend on the type and severity of infestation and may cause an increased risk for disease outbreak.		Physical impacts will be limited to indirect impacts from invasive species which affect crops, vegetation and trees. Compromised/falling trees may put buildings, infrastructure and public safety at risk.		Economic impact will depend on the type and severity of infestation and harmful algal bloom (i.e., recreation).		Low
Nor'Easter	100-Year and 500-Year Mean Return Period Events	Entire population exposed; the degree of impact to the population depends on the scale of the incident.		Entire building stock is exposed; The degree of impact depends on the scale of the incident.		100-Year MRP Estimated Damages	$9,953,005	High
						500-Year MRP Estimated Damages	$67,409,158	
Severe Weather*	Severe Weather Event	Entire population exposed; the degree of impact to the population depends on the scale of the incident.		Entire building stock is exposed; The degree of impact depends on the scale of the incident.		Economic impacts depend upon the degree of impact.		Low
Severe Winter Weather	Severe Winter Weather Event	All residents/commuters/visitors are exposed; socially-vulnerable populations may be at increased risk.		All buildings are exposed; the degree of impact depends on the scale of the incident and condition of structures.		The cost of snow and ice removal and repair of roads/infrastructure can impact operating budgets.		Low
Wildfire	Wildfire Fuel Hazard areas (High, Very High, Extreme)	Population residing in the hazard area:	2,933	Number of buildings the hazard area:	1,557	Replacement cost value of buildings located in the hazard area:	$2,228,991,567	Moderate

Notes:
a Estimated loss in replacement cost values as available from HAZUS-MH.
b The impacts and vulnerability from a hazardous materials event are greatly dependent on the material and its physical and chemical properties, the quantity released, weather conditions, micro-meteorological effects of buildings and terrain, maintenance/mechanical failures, and distance and related response time for emergency response teams.
** Hazus estimated potential losses based on probabilistic models for the wind hazard; refer to Hurricane.*
Exposed = This refers to the number of assets located in the hazard area; all of which may not incur losses as a result of the event.
MRP = Mean Return Period
SFHA = Special flood hazard area (1-percent annual chance flood event)
RCV = Replacement cost value based on 2019 RSMeans

Table 4.4-3 summarizes the projected changes in hazard event occurrences in terms of location, extent or intensity and frequency and/or duration. In addition, it lists the associated value assigned to each hazard in the risk factor calculation (i.e., confidence in changing future conditions). Refer to Sections 4.3.1 to 4.3.13 for a more detailed discussion of all factors of change discussed for each hazard of concern.

Table 4.4-3. Overview of Projected Future Changes for each Hazard of Concern

Hazard	Projected Change			Confidence in Changing Future Conditions [a]
	Location	Extent/ Intensity	Frequency/ Duration	
Dam Failure	↑	↑	↑	Likely
Disease Outbreak	↑	—	↑	Likely
Drought	—	↑	↑	Likely
Earthquake	—	—	—	Uncertain
Flood	↑	↑	↑	Highly Likely
Geological Hazards	—	—	—	Uncertain
Hazardous Materials	—	—	—	Uncertain
Hurricane	↑	↑	↑	Highly Likely
Infestation and Invasive Species	↑	↑	↑	Likely
Nor'Easter	↑	↑	↑	Likely
Severe Weather	↑	↑	↑	Highly Likely
Severe Winter Weather	—	↓	↓	Likely
Wildfire	↑	↑	↑	Likely

Notes:
Arrow direction indicates a projected increase or decrease based on literature review as described in Sections 4.3.1 through 4.3.13
— *Straight line indicates uncertain and/or no change known at this time.*
a Similar to confidence levels outlined in the National Climate Assessment 2018

Highly Likely = Studies and modeling projections indicate exacerbated conditions/increased future risk due to climate change; very high confidence level (strong evidence, well documented and acceptable methods).
Likely = Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).
Uncertain = No local data is available; modeling projects are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).
No Change = Studies and modeling projections indicate there is no evidence at this time to indicate conditions may change in the future.

4.4.2 Hazard Ranking Results

Using the process described above, the ranking for the identified hazards of concern was determined for Sussex County (refer to Table 4.4-4). The hazard ranking is detailed in the subsequent tables that present the stepwise process for the ranking. The countywide ranking includes the entire planning area and may not reflect the highest risk indicated for any of the participating jurisdictions. The resulting ranks of each municipality indicate the differing degrees of risk exposure and vulnerability. The results support the appropriate selection and prioritization of initiatives to reduce the highest levels of risk for each municipality. Both the County and the participating jurisdictions have applied the same methodology to develop the countywide risk and local rankings to ensure consistency in the overall ranking of risk; jurisdictions had the ability to alter rankings based on local knowledge and experience in handling each hazard.

This hazard ranking exercise serves four purposes: 1) to describe the probability of occurrence for each hazard; 2) to describe the impact each would have on the people, property, and economy; 3) to evaluate the capabilities a community has with regards to the hazards of concern; and 4) to consider changing future conditions (i.e., climate change) in Sussex County.

Table 4.4-4. Ranking for Hazards of Concern for Sussex County

Hazard of Concern	Probability		Impact										Adaptive Capacity	Climate Change
			Population			Property			Economy			Total Impact Value)		
	Category	Numeric Value	Impact	Numeric Value	Weighted Value (x3)	Impact	Numeric Value	Weighted Value (x2)	Impact	Numeric Value	Weighted Value (x1)			
Dam Failure	Rare	1	M	2	6	L	1	2	L	1	1 x 1 = 1	9	2	2
Disease Outbreak	Frequent	3	L	1	3	L	1	2	L	1	1 x 1 = 1	6	2	2
Drought	Frequent	3	L	1	3	L	1	2	L	1	1 x 1 = 1	6	2	2
Earthquake	Rare	1	L	1	3	L	1	2	L	1	1 x 1 = 1	6	2	1
Flood	Frequent	3	L	1	3	L	1	2	L	1	1 x 1 = 1	6	2	3
Geological Hazards	Occasional	2	M	2	6	L	1	2	L	1	1 x 1 = 1	9	2	1
Hazardous Materials	Frequent	3	L	1	3	M	2	4	M	2	1 x 1 = 1	9	2	2
Hurricane	Frequent	3	M	2	6	L	1	2	M	2	1 x 1 = 1	10	2	2
Infestation and Invasive Species	Frequent	3	L	1	3	M	2	4	M	2	1 x 1 = 1	9	2	2
Nor'Easter	Frequent	3	M	2	6	M	2	4	M	2	1 x 1 = 1	12	2	2
Severe Weather	Frequent	3	L	1	3	M	2	4	M	2	1 x 1 = 1	9	1	2
Severe Winter Weather	Frequent	3	M	2	6	L	1	2	M	2	1 x 1 = 1	10	1	2
Wildfire	Occasional	2	L	1	3	L	1	2	M	2	1 x 1 = 1	7	2	2

H = High; L = Low; M = Medium

Table 4.4-5 presents the total calculations for each hazard ranking value for the hazards of concern.

Table 4.4-5. Total Hazard Ranking Values for the Hazards of Concern for Sussex County

Hazard of Concern	Probability x 40%	Total Impact x 40%	Adaptive Capacity x 15%	Changing Future Conditions x 5%	Total Hazard Ranking Value
Dam Failure	0.4	3.6	0.3	0.1	**4.4**
Disease Outbreak	1.2	2.0	0.3	0.1	**4.0**
Drought	1.2	2.4	0.3	0.1	**4.0**
Earthquake	0.4	2.4	0.3	0.05	**3.15**
Flood	1.2	2.4	0.3	0.15	**4.1**
Geological Hazards	0.8	3.6	0.3	0.05	**4.8**
Hazardous Materials	1.2	3.6	0.3	0.1	**5.2**
Hurricane	1.2	4.0	0.3	0.1	**5.6**
Infestation and Invasive Species	1.2	3.6	0.3	0.1	**5.2**
Nor'Easter	1.2	4.8	0.3	0.1	**6.4**
Severe Weather	1.2	3.6	0.15	0.1	**5.1**
Severe Winter Weather	1.2	4.0	0.15	0.1	**5.5**
Wildfire	0.8	2.8	0.3	0.1	**4.0**

Low = Values less than or equal to 3.8; Medium = Values between 3.9 and 4.9; High = Values greater than or equal 5.0.

These rankings have been used as one of the bases for identifying the jurisdictional hazard mitigation strategies included in Section 9 (Jurisdictional Annexes) of this plan. The summary rankings for the County reflect the results of the vulnerability analysis for each hazard of concern and vary from the specific results of each jurisdiction. For example, the severe storm hazard may be ranked low in one jurisdiction, but due to the exposure and impact countywide, it is ranked as a high hazard and is addressed in the County's mitigation strategy accordingly. Jurisdictional ranking results are presented in each local annex in Section 9 (Jurisdictional Annexes) of this plan.

SECTION 5. CAPABILITY ASSESSMENT

2021 HMP Changes

- In the 2016 HMP, the capability assessment section was presented in Section 6 as part of the mitigation strategy. For the 2021 HMP update, the capability assessment was expanded and presented in Section 5 as a stand-alone section with capabilities expanded in each jurisdictional annex as well (Section 9 [Jurisdictional Annexes]).

According to FEMA's *Mitigation Planning How-To Guide #3*, a capability assessment is an inventory of a community's missions, programs, and policies and an analysis of its capacity to carry them out. Each jurisdiction has a unique set of capabilities available to accomplish mitigation and reduce long-term vulnerable to future hazard events. Capabilities include authorities, policies, programs, staff, and funding. Reviewing existing capabilities helps identify capabilities that currently implement mitigation and leads to loss reductions or that have the potential to be implemented in the future.

This assessment is an integral part of the planning process. The assessment process enables identification, review, and analysis of current federal, state, and local programs, policies, regulations, funding, and practices that could either facilitate or hinder mitigation.

During the original planning process, Sussex County and participating jurisdictions identified and assessed their capabilities in the areas of existing programs, policies, and technical documents. By completing this assessment, each jurisdiction learned how or whether they would be able to implement certain mitigation actions by determining the following:

- Limitations that could exist on undertaking actions.
- The range of local and state administrative, programmatic, regulatory, financial, and technical resources available to assist in implementing their mitigation actions.
- Actions deemed infeasible, as they are currently outside the scope of capabilities.
- Types of mitigation actions that could be technically, legally (regulatory), administratively, politically, or fiscally challenging or infeasible.
- Opportunities to enhance local capabilities to support long term mitigation and risk reduction.

During the plan update process, all participating jurisdictions were tasked with developing or updating their capability assessment, paying particular attention to evaluating the effectiveness of these capabilities in supporting hazard mitigation and identifying opportunities to enhance local capabilities to integrate hazard mitigation into their plans, programs, and day-to-day operations.

County and municipal capabilities in the Planning and Regulatory, Administrative and Technical, and Fiscal subjects can be found in the Capability Assessment section of each jurisdictional annex in Section 9 (Jurisdictional Annexes).

5.1 UPDATE PROCESS SUMMARY

The purpose of the capability assessment is to understand the planning, regulatory, administrative, technical, and financial capabilities present in Sussex County. This assessment helps the County and its jurisdictions identify strengths and opportunities that can be used to reduce losses from hazard events and reduce risks throughout Sussex County.

To complete the capability assessment, the contracted consultant met with Sussex County and each municipality virtually to review the capability assessment from the 2016 HMP and update accordingly. In addition to in-person meetings, the consultant reviewed plans and codes/ordinances to enhance the information provided by the jurisdictions.

A summary of the various federal and state capabilities available to promote and support mitigation and reduce risk in Sussex County are presented below. Information provided by the County and municipalities are presented in Volume II, Section 9 (Jurisdictional Annexes) of this plan update.

5.2 PLANNING AND REGULATORY CAPABILITY

Planning and regulatory capabilities are based on the implementation of ordinances, policies, local laws and state statutes, and plans and programs that relate to guiding and management growth and development. Planning and regulatory capabilities refer not only to the current plans and regulations, but also to the jurisdiction's ability to change and improve those plans and regulations as needed. The following provides the planning and regulatory capabilities for Sussex County.

5.2.1 PLANNING AND REGULATORY CAPABILITIES – FEDERAL AND STATE

Table 5-1. Planning and Regulatory Capabilities – Federal and State

Capability	Details	
Disaster Mitigation Act (DMA)	**Description:**	The DMA is the current federal legislation addressing hazard mitigation planning. It emphasizes planning for disasters before they occur. It specifically addresses planning at the local level, requiring plans to be in place before Hazard Mitigation Assistance grant funds are available to communities. This plan is designed to meet the requirements of DMA, improving eligibility for future hazard mitigation funds.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	HMPs designed to meet the requirements of DMA will remain eligible for future FEMA Hazard Mitigation Assistance funds
	Hazard:	All-natural hazards
National Flood Insurance Program (NFIP)	**Description:**	The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages. The Flood Hazard Profile in Section 4.3.5 (Flood) provides information on recent legislation related to reforms to the NFIP. All municipalities in Sussex County participate in the NFIP.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Full compliance and good standing under the NFIP are application prerequisites for all FEMA grant programs for which participating jurisdictions are eligible under this plan.
	Hazard:	Flood
NFIP Community Rating System (CRS)	**Description:**	As an additional component of the NFIP, CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS: (1) reduce flood losses, (2) facilitate accurate insurance rating, and (3) promote the awareness of flood insurance. Municipalities, and the county as a whole, could expect significant cost savings on premiums if enrolled in the CRS program. At this time, no communities in Sussex County participate in the CRS program.
	Responsible Agency:	FEMA

Capability	Details	
	Provides Funding for Mitigation:	CRS premium discounts on flood insurance range from 5 percent for Class 9 communities up to 45 percent for Class 1 communities.
	Hazard:	Flood
Municipal Land Use Law	**Description:**	The State of New Jersey Municipal Land Use Law (L.1975, c. 291, s. 1, effective August 1, 1976) is the legislative foundation for the land use process in the State of New Jersey, including decisions by Planning Boards and Zoning Boards of Adjustment. It defines the powers and responsibilities of boards and is essential to their functions and decisions. It also provides the required components of a municipal master plan. Every municipal agency must adopt and can amend reasonable rules and regulations, consistent with this act or with any applicable ordinance, for the administration of its functions, powers, and duties. These plans help jurisdictions review their land use plans and policies with public participation. The Municipal Land Use Law requires that each municipality prepare a comprehensive plan and update that plan every 10 years.
	Responsible Agency:	State of New Jersey
	Provides Funding for Mitigation:	No
	Hazard:	All
State of New Jersey Hazard Mitigation Plan (2019 Update)	**Description:**	The State of New Jersey HMP includes an evaluation of the state's overall pre- and post-hazard mitigation policies, programs, and capabilities; the policies related to development in hazard-prone areas; and the state's funding capabilities. The State of New Jersey HMP thoroughly describes the federal and state programs available to Sussex County to promote mitigation. The State of New Jersey HMP was used as a resource in developing Sussex County's HMP update.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	No
	Hazard:	All
Critical Area Protection Policy	**Description:**	The following NJDEP programs both protect critical natural resources, and provide funding for the State, municipalities, and counties to purchase land for open-space preservation and recreation, which may directly or indirectly support hazard mitigation efforts: • Green Acres Program • Blue Acres Program • Historical Preservation Program • Farmland Preservation • Wetlands Act of 1970 (N.J.S.A. 13:9A) • Soil and Erosion and Sediment Control Act (N.J.S.A. 4:24) The Wetlands Act of 1970 (N.J.S.A. 13:9A) provide rules and regulations governing development in wetland areas of New Jersey. New Jersey has 15 soil conservation districts, following county boundaries that implement the New Jersey Soil Erosion and Sediment Control Act (N.J.S.A. 4:24), which governs certain aspects of new development. According to the Sussex County Comprehensive Farmland Preservation Plan of 2008, the State Development and Redevelopment Plan designates most of Sussex County as Rural and Environmentally-sensitive lands, and encourages the clustering of development within defined centers in order to preserve the county's rural environment. In line with the 2003 Comprehensive Farmland Preservation Plan, the county's mission continues to include farmland preservation. The county has undertaken initiatives to promote the economic well-being of local farmers and has identified additional initiatives to promote the local agricultural industry.

Capability	Details	
	Responsible Agency:	NJDEP, Sussex County Agriculture Development Board, Morris Land Conservancy
	Provides Funding for Mitigation:	Yes – the various programs (Green Acres, Blue Acres) provide funding to jurisdictions to acquire land and properties and turn into open space. The Sussex County Preservation Trust can be used to acquire floodprone residential properties.
	Hazard:	Flood, Severe Weather
Uniform Construction Code (UCC)	**Description:**	Building codes mandate best practices and technology, much of which is designed to reduce or prevent damage from occurring when structures are under stress. The UCC adopts up-to-date building codes as its Building Subcode and One- and Two-Family Subcode. These Subcodes contain requirements that address construction in both A and V flood zones. Also, all new construction is required to comply with the UCC for flood zone construction. New Jersey has enacted legislation directing the Department of Community Affairs (NJ DCA) to adopt a radon hazard code or revise the state building code to establish "adequate and appropriate standards to ensure that schools and residential buildings within tier one areas [as defined by the state] ... are constructed in a manner that minimizes radon gas and radon progeny entry and facilitates any subsequent remediation that might prove necessary." See N.J. Stat. Ann. 52:27D-123a. The Department then adopted a radon hazard sub-code which does not reference existing model standards or guidance, but which sets forth the basic requirements for a passive sub-slab or sub-membrane depressurization system. See N.J. Admin. Code 5:23-10.4. The radon control standards and procedures apply to new residential construction (and school construction) in "tier one" areas, as defined by the state, and Appendix 10-A of the sub-code lists the specific municipalities that are designated as tier one areas.
	Responsible Agency:	NJ DCA
	Provides Funding for Mitigation:	No
	Hazard:	All
Floodplain Management Policy	**Description:**	New Jersey State Law Flood Hazard Area Control Act (NJSA 58:16A-52): The Act and regulations attempts to minimize damage to life and property from flooding caused by development within fluvial and tidal flood hazard areas, to preserve the quality of surface waters, and to protect the wildlife and vegetation that exist within and depend upon such areas for sustenance and habitat. While it does not require local adoption, as it is enforced by the NJDEP, the floodplain ordinances of each municipality need to be reviewed to be in compliance with this new regulation.
	Responsible Agency:	New Jersey Department of Environmental Protection (NJDEP)
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Growth Management Policy	**Description:**	Land preservation and recreation comprise one of the cornerstones of New Jersey's smart growth policy. The New Jersey Statewide Comprehensive Outdoor Recreation Plan provides Statewide policy direction to the State, local governments, and conservation organizations in the preservation of open space and the provision of public recreation opportunities. The State Plan was prepared and adopted by the State Planning Commission according to the requirements of the State Planning Act of 1985 as amended (NJSA 52:18A-196 et seq.) to serve as an instrument of State policy to guide State agencies and local government in the exercise of governmental powers regarding planning, infrastructure investment and

Capability	Details	
		other public actions and initiatives that affect and support economic growth and development in the State. Green Acres Program, Open Space Tax Program, and Development and Redevelopment Plan. The State Planning Act has enhanced the traditionally limited role of county land-use planning and control. Also provides tools for municipalities when preparing their master land use plans and better opportunity for a comprehensive approach to planning so not to harm or be in conflict with neighboring Municipalities' plans.
	Responsible Agency:	
	Provides Funding for Mitigation:	No
	Hazard:	All

5.2.2 PLANNING AND REGULATORY CAPABILITIES – COUNTY AND LOCAL

Detailed information regarding these capabilities can be found in each jurisdictional annex found in Volume II, Section 9 (Jurisdictional Annexes).

5.3 ADMINISTRATIVE AND TECHNICAL CAPABILITY

Administrative and technical capabilities refer to the jurisdiction's staff and their skills and tools that can be used for mitigation planning and implementation. It also refers to the ability to access and coordinate the resources effectively. The following provides the administrative and technical capabilities for Sussex County.

5.3.1 ADMINISTRATIVE AND TECHNICAL CAPABILITY – FEDERAL AND STATE

Table 5-2. Administrative and Technical Capability – Federal and State

Capability		
Recovery Bureau	**Description:**	The Chief of the Recovery Bureau supervises the Mitigation, Public Assistance, and Finance Units. The Mitigation Unit undertakes hazard mitigation planning and the review of mitigation projects in advance of potential disasters and is also activated during and immediately after disasters to evaluate existing and proposed mitigation measures in the affected areas.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	No
	Hazard:	All
Mitigation Unit	**Description:**	The Mitigation Unit, within the Emergency Management Section, has the mission of enhancing state, county, and municipal risk reduction through the development and implementation of mitigation strategies. Hazard mitigation, by definition, is any sustained action that prevents or reduces the loss of property or human life from recurring hazards. The Mitigation Unit accomplishes this task by implementing and administering several grant-based programs in conjunction with FEMA.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Preparedness Bureau	**Description:**	The Preparedness Unit in the Preparedness Bureau is responsible for disseminating preparedness information in advance of a disaster or potential disaster. The Preparedness Unit maintains an extensive library of natural disaster preparedness and recovery information on its Plan and Prepare website (http://ready.nj.gov/plan-prepare/index.shtml). The disaster preparedness and recovery information featured prominently on the New Jersey State Police and NJOEM website home pages

Capability		
		(http://njsp.org/ and http://ready.nj.gov/index.shtml)is a critical part of New Jersey's efforts to protect public health and safety and to minimize loss of life and property in the event of a disaster.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	No
	Hazard:	All
Hazard Mitigation Grant Program Administrative Plan	**Description:**	In the event that an active disaster declaration has necessitated a FEMA-approved Hazard Mitigation Grant Program (HMGP) Administrative Plan, the plan is reviewed to ensure compliance with the prevailing guidance and to set forth the administrative procedures, organization, and requirements for administering the HMGP in New Jersey. The HMGP Administrative Plan is developed by the state and details the process for prioritizing post-disaster mitigation funding of local mitigation projects.
	Responsible Agency:	NJOEM
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Bureau of Dam Safety & Flood Control	**Description:**	The Bureau of Dam Safety & Flood Control leads the state's efforts filling the State NFIP Coordinator position and providing Community Rating System (CRS) support. In addition, the section's responsibilities include the funding of construction and operation of federal, state, and local flood control mitigation projects throughout the state. The section has also taken a lead role on the development and adoption of NJ Flood Hazard Area mapping, as well as an active partnership with FEMA on their Map Modernization Program efforts. The bureau assists communities participating in the NFIP and interested in joining CRS through the NJDEP Community Assistance Program Unit.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather
Dam Safety Section	**Description:**	The NJDEP Dam Safety Section under the Bureau of Dam Safety & Flood Control has responsibility for overseeing dam safety in the state. The primary goal of the program is to ensure the safety and integrity of dams in New Jersey, and thereby protect people and property from the consequences of dam failures. The section also coordinates with the Division of State Police, local and county emergency management officials in the preparations and approval of emergency action plans. The Dam Safety Section reviews plans and specifications for the construction of new dams or for the alteration, repair, or removal of existing dams. The section must grant approval before the owner can proceed with construction. Engineers from the Dam Safety Section evaluate each project, investigate site conditions, and check recommended construction materials. During construction, engineers identify conditions that may require design changes, check for compliance with approved plans and specifications, and approve foundations before material is placed. Existing dams are periodically inspected to assure that they are adequately maintained, and owners are directed to correct any deficiencies found. The regulations require the owner to obtain a professional engineer to inspect their dams on a regular basis. These investigations include a comprehensive review of all pertinent material contained in the Section's files, a visual inspection, technical studies when necessary, and preparation of a comprehensive report.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes

Capability		
	Hazard:	Flood, Severe Weather
Division of Water Supply and Geoscience	**Description:**	This Division works to ensure adequate, reliable, and safe water supply is available for the future. This goal is accomplished through the regulation of ground and surface water diversions, permitting of wells, permitting of drinking water infrastructure, monitoring of drinking water quality, and technical support for water systems to achieve compliance with all federal and state standards. Water Supply staff provides technical assistance to assist water systems during water supply emergencies, as needed to re-establish safe and adequate public water supplies, and to address routine non-compliance from significant deficiencies or poor water quality test results. The Drinking Water State Revolving Fund (DWSRF) program assists water systems in financing the cost of infrastructure through the use of federal and New Jersey Environmental Infrastructure Trust (NJEIT) funds. Additionally, Water Supply provides operator licensing and training support as well as financial assistance through the DWSRF program.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	All
New Jersey Geological and Water Survey	**Description:**	The New Jersey Geological and Water Survey evaluates geologic, hydrogeologic and water quality data to manage and protect water resources, to identify natural hazards and contaminants, and to provide mineral resources including offshore sands for beach nourishment. Information provided by the survey includes GIS data and maps of geology, topography, groundwater, and aquifer recharge. In addition, the data tracks wellhead protection areas, aquifer thicknesses, properties and depths, groundwater quality, drought, geologic resources, and hazards such as earthquakes, abandoned mines, karst-influenced sinkholes, and landslides.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	No
	Hazard:	Drought, Earthquake, Geological
Office of Planning Advocacy	**Description:**	The New Jersey Office of Planning Advocacy (OPA) supports and coordinates planning throughout the state to protect the environment, mitigate development hazards and guide future growth into compact, mixed use development and redevelopment while fostering a robust long-term economy. The OPA implements the goals of the State Development and Redevelopment Plan to achieve comprehensive, long-term planning; and integrates that planning with programmatic and regulatory land use decisions at all levels of government and the private sector.
	Responsible Agency:	New Jersey Department of the State
	Provides Funding for Mitigation:	No
	Hazard:	Natural Hazards
Office of the State Climatologist	**Description:**	The Office of the New Jersey's State Climatologist (ONJSC) generates and archives climate data. Generated data are from the New Jersey Weather and Climate Network (NJWxNet), which is an assemblage of 55 automated weather stations situated throughout the state. A decade or more of hourly observations are available from some of the stations, while others have shorter records. Since fall 2012 observations are available on a five-minute basis. Along with these records, ONJSC archives or has ready access to National Weather Service Cooperative Weather Station data. These are daily observations from several dozen stations at any given time over the past century. Individual stations have as many as 120 years of data while other stations have started or ceased operating since the late 1800s. Another

Capability		
		source of generated data is the Community Collaborative Rain, Hail and Snow Network (CoCoRaHS), which includes daily observations of rain and snow from as many as several hundred volunteers throughout the state.
	Responsible Agency:	Rutgers University
	Provides Funding for Mitigation:	No
	Hazard:	Natural Hazards
New Jersey Climate Adaptation Alliance (NJADAPT)	**Description:**	NJADAPT focuses on climate change preparedness for New Jersey in key impact sectors (public health; watersheds, rivers and coastal communities; built infrastructure; agriculture; and natural resources). NJADAPT is a collaborative effort of scientists and data managers in academia, government, the private sector and non-governmental organization community who have developed a strategic plan for a New Jersey platform to host and apply climate science impacts and data. The NJADAPT website (http://www.njadapt.org/) includes a flood exposure profile for community discussions about hazard impacts; NJ Flood Mapper (which is a tool for flooding hazards and sea level rise); and Getting to Resilience (a tool used to help communities reduce vulnerability and increase preparedness).
	Responsible Agency:	Rutgers University
	Provides Funding for Mitigation:	No
	Hazard:	Natural Hazards
New Jersey Highlands Council	**Description:**	The Highlands Water Protection and Planning Council (Highlands Council) is a regional planning agency that works in partnership with municipalities and counties in the Highlands Region to encourage a comprehensive regional approach to implementing the 2004 Highlands Water Protection and Planning Act (the Highlands Act). The Highlands Act established the Highlands Council and charged it with the creation and adoption of a regional master plan to protect and enhance the natural resources within the New Jersey Highlands. The Highlands Regional Master Plan (RMP) was adopted by the Highlands Council on July 17, 2008 and became effective on September 8, 2008. Conformance with the Highlands RMP is a two-phase process: petition and implementation. During the petition process, municipalities and counties work in collaboration with Highlands Council staff to prepare draft documents that will integrate the land use and resource management requirements of the Highlands Act into local regulatory and planning documents. Once a petition is approved by the Highlands Council, work begins on implementation, which involves finalizing those documents for local adoption and ongoing management of resources. Southeastern areas of Sussex County are located in the Highlands Region. The Highlands Council may provide grant funding to municipalities and counties to support local hazard mitigation planning. Such plans would identify local level risks associated with extreme storm events and develop local actions that would potentially prevent or mitigate hazardous situations. For example, grants fund stormwater management plans which support green infrastructure for stormwater management, as well as stormwater mitigation plans. These plans should be in place prior to disaster events. Highlands Council grants may be used for planning, design, and/or engineering activities, but do not fund capital expenses. The Highlands Council is participating in the Governor's Climate Resiliency initiative and is preparing to develop a Highlands Climate Change chapter of the Regional Master Plan.

Capability		
		The Highlands Council has initiated a stormwater management program for counties and municipalities to assist in advance planning. The Council also requires extensive green stormwater infrastructure for all projects reviewed. The Highlands was a member of the Advisory Committee when Sussex County developed their Green Stormwater Infrastructure Element.
	Responsible Agency:	New Jersey Highlands Council
	Provides Funding for Mitigation:	Yes
	Hazard:	All
North Jersey Transportation Planning Authority (NJTPA)	**Description:**	The NJTPA is the federally authorized Metropolitan Planning Organization for the 13-county northern New Jersey region. Each year, they oversee over $2 billion in transportation improvement projects and provide a forum for interagency cooperation and public input. The Passaic River Basin Climate Resilience Planning Study was completed in 2019. The study focuses on the potential impacts that climate change will have on transportation infrastructure located within the Passaic River Basin, of which extreme southeastern Sussex County is a part of. The results of their analysis are included in the Sussex County HMP's risk assessment and their recommendations were shared with the Planning Partnership to reduce transportation asset vulnerability to climate change and increase resilience to existing and future heat or flooding events.
	Responsible Agency:	NJTPA
	Provides Funding for Mitigation:	Yes - planning
	Hazard:	All
U.S. Army Corps of Engineers (USACE)	**Description:**	The USACE works with NJDEP to mitigate flooding in Sussex County as needs arise.
	Responsible Agency:	USACE
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood

5.3.2 ADMINISTRATIVE AND TECHNICAL CAPABILITY – COUNTY AND LOCAL

Table 5-3 summarizes the administrative and technical capabilities in Sussex County. Detailed information regarding administrative and technical capabilities in the County and the municipalities can be found in each jurisdictional annex found in Volume II, Section 9 (Jurisdictional Annexes).

Table 5-3. Administrative and Technical Capability – County and Local

Capability		
Sussex County Sheriff's Office, Division of Emergency Management (DEM)	**Description:**	The Sussex County Sheriff's Office has the responsibility for a wide range of law enforcement services: Bureau of Corrections; Bureau of Law Enforcement; and Security of the County Court Complex. The Sussex County DEM is a division of the Sheriff's Office. The Sussex County DEM is a county-level emergency service required by statute that coordinates resources to serve the needs of Sussex County during times of emergency events and disasters. In carrying out its responsibilities, the DEM oversees the emergency management activities of all county agencies and Sussex County's 24 municipalities. Each municipality has an emergency management coordinator with whom this division interacts and the coordinators, in turn, interact at the local level with police, fire, EMS, public works, public health, schools, etc. In addition to the foregoing, the DEM presents training and educational programs including personal emergency preparedness, access and functional needs and incident command for responders. The division also oversees two community alert programs, Swift911™ and Register Ready, that are of tremendous service to the public. The Sussex County DEM is leading the HMP update and hosting information about the HMP on their website (https://www.sussex.nj.us/cn/webpage.cfm?TID=7&TPID=11091) including a link to the citizen survey. As mitigation grant funding becomes available, the Sussex County DEM distributes information to the municipal coordinators at quarterly meetings.
	Responsible Agency:	Sussex County Sheriff's Office, Division of Emergency Management (DEM)
	Provides Funding for Mitigation:	No
	Hazard:	All
Sussex County Division of Planning and Economic Development	**Description:**	The Sussex County Division of Planning and Economic Development is responsible for providing staff and technical assistance to the County Planning Board, Agricultural Development Board, Solid Waste Advisory Committee, 208 Water Quality Policy Advisory Committee, Strategic Growth Advisory Committee and Board of Chosen Commissioners on all matters related to land use, development and conservation. The Division manages the following programs: • Census data for the county • Housing Market • Cross Acceptance • Development Review • Economic Development • Farmland Preservation • Open Space Preservation • Regional Planning • Solid Waste Planning • Transportation Planning • Water Quality Management Planning • Conferences and Presentations

Capability		
	Responsible Agency:	Sussex County Division of Planning
	Provides Funding for Mitigation:	No
	Hazard:	All
Sussex County Planning Board	**Description:**	The Sussex County Planning Board is responsible for approving site plan and subdivision applications within their jurisdiction in accordance with the New Jersey County Planning Enabling Act. A Development Review Committee reviews all applications and acts on behalf of the full Board. Applications for waiver from County development standards are heard by the full Board with input from county engineering and planning staff.
	Responsible Agency:	Board of Chosen Commissioners
	Provides Funding for Mitigation:	No
	Hazard:	All
Sussex County Division of Engineering	**Description:**	The Sussex County Division of Engineering is charged with overseeing the numerous facets associated with maintaining, improving, and monitoring the county's transportation network. The Division works closely with the Division of Facilities Management providing project support and civil/survey design services for a variety of facility related capital improvement projects. Additionally, the Division of Engineering provides technical support to the Division of Planning. Included within the department's responsibilities are tasks such as in-house design of road and bridge improvement projects, management of multimillion dollar design projects, monitoring the condition of bridges; signals; signs; traffic markings and other similar infrastructure items, developing long term capital budgets, construction stakeout, ROW surveys, management of county road and bridge construction projects, track traffic trends, and monitor work within the county right of way through road opening and driveway permits. The Division supported the update of the 2021 Sussex County HMP, is a member of the Steering Committee, and reviewed and contributed to the plan and County annex.
	Responsible Agency:	Sussex County Department of Engineering
	Provides Funding for Mitigation:	No
	Hazard:	All
Sussex County Open Space Committee	**Description:**	The Sussex County Open Space Committee consists of seven voting members who are appointed by the Board of Chosen Commissioners. The members are drawn from the agricultural, nonagricultural and business communities. The Committee oversees the use of Open Space Trust Fund dollars to acquire lands and wetlands for the protection of environmentally sensitive areas; for the preservation of scenic, cultural or historically valuable areas; and for public outdoor recreation areas.
	Responsible Agency:	Board of Chosen Commissioners

Capability		
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood
Sussex County Division of Public Works	**Description:**	The Sussex County Division of Public Works is responsible for the proper maintenance, surfacing, resurfacing, drainage and repair of all County roads, bridges, and drains. The Office of Roads maintains all County roads, bridges, and drains and keeps them in a clear and safe condition. The Division is also in charge of removing all snow, ice, leaves, debris, or other matter that may impede or restrict travel within the County. The Division investigates complaints involving County roads and bridges and then takes proper action to see that the needed repairs are made with a minimum of delay. The Division supported the update of the 2021 Sussex County HMP, is a member of the Steering Committee, and reviewed and contributed to the plan and County annex.
	Responsible Agency:	Division of Public Works
	Provides Funding for Mitigation:	No
	Hazard:	Hurricane, Nor'Easter, Flood, Severe Weather, Severe Winter Weather
Sussex County Department of Health and Environmental Services	**Description:**	The Sussex County Department of Health and Environmental Services' mission is to protect, promote, maintain and improve the health and quality of life for Sussex County citizens and visitors through a responsive, well managed and organized community effort. The Department has information on who to contact in times of emergency on their website (local radio stations, state and federal resources). The following are under the Department; some of which are described more fully below: • Environmental Health • Public Health Nursing • Emergency Preparedness • HAZ-MAT • Special Child Health Services • Weights and Measures • Mosquito Control • Health Education Topics • Sussex-Warren Chronic Disease Coalition
	Responsible Agency:	Department of Health and Environmental Services
	Provides Funding for Mitigation:	No
	Hazard:	All

Capability		
Sussex County GIS Management	**Description:**	Geographic Information Systems (GIS) provides mapping and GIS services to meet the business needs of county divisions, constitutional offices, local government and not-for-profit organizations within Sussex County. This includes providing support and maintenance in the areas of data conversion, cartography, computer graphics and visualization, Global Positioning Systems (GPS), database design and software development. GIS Management supported the update of the 2021 Sussex County HMP, is a member of the Steering Committee, and reviewed and contributed to the plan and County annex.
	Responsible Agency:	Sussex County GIS Management
	Provides Funding for Mitigation:	No
	Hazard:	All Hazards
Sustainable Jersey	**Description:**	Sustainable Jersey is a nonprofit organization that provides tools, training and financial incentives to support communities as they pursue sustainability programs. By supporting community efforts to reduce waste, cut greenhouse gas emissions, and improve environmental equity, Sustainable Jersey aims to empower communities to build a better world for future generations. The organization also offers a certification program. Sustainable Jersey certification is a designation for municipal governments in New Jersey. All actions taken by municipalities to score points toward certification must be accompanied by documentary evidence and is reviewed. The certification is free and completely voluntary.
	Responsible Agency:	-
	Provides Funding for Mitigation:	No
	Hazard:	All
Sussex County HAZ-MAT Team	**Description:**	The Sussex County HAZ-MAT team, consists of 20+/- full time county employees trained to the technician level, available to respond to environmental and public health emergencies 24 hours a day, seven days a week. A collaborative effort between the Sussex County Sheriff's Office, the Sussex County Office of the Prosecutor, the Sussex County Division of Public Works, and the Sussex County Sussex County Department of Environmental and Public Health Services, the team was recognized by the State of New Jersey, Department of Environmental Protection as a Model Program for Hazardous Material Response. With the assistance of the County Office of Emergency Management and the Sussex County Public Safety Training Academy, the program has matured into a valuable asset and tool for the municipalities of Sussex County. State of the art haz-mat equipment including response vehicles, air monitoring instruments, personal protective equipment, and decon units were all paid for through Homeland Security Grants received from the State and Federal Government with very little impact from county tax dollars.
	Responsible Agency:	Sussex County Sheriff's Office, the Sussex County Office of the Prosecutor, the Sussex County Division of Public Works, and the Sussex County Sussex County Department of Environmental and Public Health Services
	Provides Funding for Mitigation:	No
	Hazard:	Hazardous Materials

Capability		
Sussex County Economic Development Partnership (SCEDP)	**Description:**	The Sussex County Economic Development Partnership, Inc. (SCEDP) is dedicated to the creation of sustainable economic opportunity and prosperity to improve the quality of life in Sussex County, NJ. The SCEDP will proactively facilitate the recruitment, retention and expansion of business that will complement, and be consistent with, the character and environment of Sussex County.
	Responsible Agency:	Sussex County Economic Development Partnership
	Provides Funding for Mitigation:	No
	Hazard:	-
Rutgers Cooperative Extension of Sussex County	**Description:**	Rutgers Cooperative Extension is part of the Federal Land Grant University system serving as the educational outreach arm of the United States Department of Agriculture. Rutgers Cooperative Extension of Sussex County was established in 1912 and was the first Cooperative Extension program in New Jersey. The office provides research-based information to help Sussex County residents acquire knowledge to make informed decisions to maintain or improve their quality of life. Educational programs are provided without regard to race, color, national origin, gender, religion, age, disability, political beliefs, sexual orientation, or marital or family status. Program delivery methods include: classes and conferences, telephone and in-person consultations, replies to emailed questions, newspaper columns, radio and television programs, bus trips, fairs and clubs, field meetings and demonstrations, computerized diet and financial analyses, videos, newsletters, fact sheets, speaking engagements for organizations and work sites, exhibits and displays, and web sites.
	Responsible Agency:	Rutgers Cooperative Extension of Sussex County
	Provides Funding for Mitigation:	No
	Hazard:	All hazards

5.4 FISCAL CAPABILITIES

Fiscal capabilities are the resources that a jurisdiction has access to or is eligible to use to fund mitigation actions. The table below provides a list of programs, descriptions, and links for those jurisdictions seeking funding sources. This table is not intended to be a comprehensive list, but rather a tool to help begin identifying potential sources of funding.

Table 5-4. Fiscal Capabilities

Capability		
Federal		
Hazard Mitigation Grant Program	**Description:**	The HMGP is a post-disaster mitigation program. FEMA makes these grants available to states by after each federal disaster declaration. The HMGP can provide up to 75 percent funding for hazard mitigation measures and can be used to fund cost-effective projects that will protect public or private property or that will reduce the likely damage from future disasters in an area covered by a federal disaster declaration. Examples of projects include acquisition and demolition of structures in hazard prone areas, flood-proofing or elevation to reduce future damage, minor structural improvements, and development of state or local standards. Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved HMP (this plan). Additional information regarding the HMGP is available on the FEMA website: https://www.fema.gov/grants/mitigation Sussex County has received HMGP funding, including funding to purchase generators to provide continuity of operations during utility failures.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Flood Mitigation Assistance Program	**Description:**	The FMA program combines the previous Repetitive Flood Claims and Severe Repetitive Loss Grants into one grant program. The FMA provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. The FMA is funded annually; no federal disaster declaration is required. Only NFIP insured homes and businesses are eligible for mitigation in this program. Funding for FMA is very limited and, as with the HMGP, individuals cannot apply directly for the program. Applications must come from local governments or other eligible organizations. The federal cost share for an FMA project is at least 75 percent. For the nom-federal share, at most 25 percent of the total eligible costs must be provided by a non-federal source; of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At minimum, a FEMA-approved local flood mitigation plan is required before a project can be approved. The FMA funds are distributed from FEMA to the state. NJOEM serves as the grantee and program administrator for the FMA program. The FMA program is detailed on the FEMA website: https://www.fema.gov/grants/mitigation/floods
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather
Building Resilient Infrastructure	**Description:**	Building Resilient Infrastructure and Communities (BRIC) will support states, local communities, tribes and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. BRIC is a new FEMA

Capability		
and Communities (BRIC) Program		pre-disaster hazard mitigation program that replaces the existing Pre-Disaster Mitigation (PDM) program. The BRIC program guiding principles are supporting communities through capability- and capacity-building; encouraging and enabling innovation; promoting partnerships; enabling large projects; maintaining flexibility; and providing consistency. For additional information regarding the BRIC program, please refer to: https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Individual Assistance	**Description:**	Individual Assistance (IA) provides help for homeowners, renters, businesses, and some non-profit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration. For homeowners and renters, those who suffered uninsured or underinsured losses could be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals are allowed to borrow up to $200,000 to repair or replace real estate, $40,000 to cover losses to personal property, and an additional 20 percent for mitigation. For businesses, loans could be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory, and supplies. Businesses of any size are eligible. Non-profit organizations, such as charities, churches, and private universities are eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster but are restricted by law to small businesses only. IA is detailed on the FEMA website: https://www.fema.gov/individual-disaster-assistance.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Public Assistance	**Description:**	Public Assistance (PA) provides cost reimbursement aid to local governments (state, county, local, municipal authorities, and school districts) and certain non-profit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services. This program is largely funded by FEMA with both local and state matching contributions required. PA is detailed on the FEMA website: https://www.fema.gov/public-assistance-local-state-tribal-and-non-profit.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Department of Homeland Security Grant Program	**Description:**	The Homeland Security Grant Program (HSGP) plays an important role in the implementation of the National Preparedness System by supporting the building, sustainment, and delivery of core capabilities essential to achieving the National Preparedness Goal of a secure and resilient nation. In FY 2020, the total amount of funds available under HSGP was $1.12 billion. HSGP is comprised of three interconnected grant programs including the State Homeland Security Program, Urban Areas Security Initiative (UASI), and the

Capability		
		Operation Stonegarden. Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration. Additional information regarding HSGP is available on the website: https://www.fema.gov/grants/preparedness/homeland-security.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Fire Management Assistance Grant Program	**Description:**	Assistance for the mitigation, management, and control of fires on publicly or privately-owned forests or grasslands that threaten such destruction as would constitute a major disaster. Provides a 75% federal cost share and the state pays the remaining 25% for actual cost. Information on this program is available on the website: https://www.fema.gov/assistance/public/fire-management-assistance.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire
Assistance to Firefighters Grant Program	**Description:**	The primary goal of the Assistance to Firefighters Grants is to enhance the safety of the public and firefighters with respect to fire-related hazards by providing direct financial assistance to eligible fire departments, nonaffiliated Emergency Medical Services organizations, and State Fire Training Academies. This funding is for critically needed resources to equip and train emergency personnel to recognized standards, enhance operations efficiencies, foster interoperability, and support community resilience. Information regarding this grant program is available on the website: https://www.fema.gov/grants/preparedness/firefighters.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Wildfire, Hazardous Materials
High Hazard Potential Dams Grant Program	**Description:**	The Rehabilitation of High Hazard Potential Dams Grant Program provides technical, planning, design, and construction assistance in the form of grants to non-Federal governmental organizations or nonprofit organizations for rehabilitation of eligible high hazard potential dams. Information regarding this program is available on the website: https://www.fema.gov/emergency-managers-management/dam-safety/grants/high-hazard-potential-dam-awards#:~:text=The%20High%20Hazard%20Potential%20Dam%20(HHPD)%20Grant%20Awards,equivalent%20state%20agency%20is%20eligible%20for%20the%20grant.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Dam Failure
	Description:	The Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations.

Capability		
Small Business Administration Loan		SBA disaster loans can be used to repair or replace the following items damaged or destroyed in a declared disaster: real estate, personal property, machinery and equipment, and inventory and business assets. Homeowners could apply for up to $200,000 to replace or repair their primary residence. Renters and homeowners could borrow up to $40,000 to replace or repair personal property-such as clothing, furniture, cars, and appliances that were damaged or destroyed in a disaster. Physical disaster loans of up to $2 million are available to qualified businesses or most private nonprofit organizations. Additional information regarding SBA loans is available on the SBA website: https://www.sba.gov/managing-business/running-business/emergency-preparedness/disaster-assistance.
	Responsible Agency:	SBA
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Community Development Block Grant Program	**Description:**	CDBG are federal funds intended to provide low and moderate-income households with viable communities, including decent housing, a suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, and planning and administration. Public improvements could include flood and drainage improvements. In limited instances and during the times of "urgent need" (e.g., post disaster) as defined by the CDBG National Objectives, CDBG funding could be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event. Additional information regarding CDBG is available on the website: https://www.hudexchange.info/programs/cdbg-entitlement/. In Sussex County, the following municipalities are eligible for CDBG funding: • Borough of Andover • Township of Andover • Borough of Branchville • Township of Byram • Township of Frankford • Borough of Franklin • Township of Fredon • Township of Green • Borough of Hamburg • Township of Hampton • Township of Hardyston • Borough of Hopatcong • Township of Lafayette • Township of Montague • Town of Newton • Borough of Ogdensburg • Township of Sparta • Township of Sandyston • Borough of Stanhope

Capability		
		• Township of Stillwater • Borough of Sussex • Township of Vernon • Township of Walpack • Township of Wantage
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Federal Highway Administration-Emergency Relief for Federally Owned Roads	**Description:**	The Federal Highway Administration (FHWA) Emergency Relief is a grant program through the U.S. Department of Transportation (DOT) that can be used for repair or reconstruction of federal-aid highways and roads on federal lands that have suffered serious damage as a result of a disaster. New Jersey Department of Transportation serves as the liaison between local municipalities and FHWA. Additional information regarding the FHWA Emergency Relief Program is available on the website: https://highways.dot.gov/federal-lands/programs/erfo
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Federal Transit Administration - Emergency Relief	**Description:**	The Federal Transit Authority (FTA) Emergency Relief is a grant program that funds capital projects to protect, repair, reconstruct, or replace equipment and facilities of public transportation systems. Administered by the Federal Transit Authority at the U.S. DOT and directly allocated to Metropolitan Transit Authority (MTA) and Port Authority, this transportation-specific fund was created as an alternative to FEMA PA. Additional information regarding the FTA Emergency Relief Program is available on the website: https://www.transit.dot.gov/funding/grant-programs/emergency-relief-program/emergency-relief-program.
	Responsible Agency:	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Disaster Housing Program	**Description:**	Emergency assistance for housing, including minor repair of home to establish livable conditions, mortgage and rental assistance available through the U.S. Department of Housing and Urban Development (HUD). Information on this program is available on the website: https://www.hud.gov/program_offices/public_indian_housing/publications/dhap.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
HOME Investment Partnerships Program	**Description:**	Grants to local and state government and consortia for permanent and transitional housing, (including financial support for property acquisition and rehabilitation for low income persons). Information on this program is available on the website: https://www.hud.gov/hudprograms/home-program.

Capability		
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	-
HUD Disaster Recovery Assistance	**Description:**	Grants to fund gaps in available recovery assistance after disasters (including mitigation). Information on this program is available on the website: https://www.hud.gov/info/disasterresources.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Section 108 Loan Guarantee	**Description:**	Enables states and local governments participating in the CDBG program to obtain federally guaranteed loans for disaster-distressed areas. Information on this program is available on the website: https://www.hudexchange.info/programs/section-108/.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Smart Growth Implementation Assistance program	**Description:**	The Smart Growth Implementation Assistance (SGIA) program through the U.S. Environmental Protection Agency (EPA) focuses on complex or cutting-edge issues, such as stormwater management, code revision, transit-oriented development, affordable housing, infill development, corridor planning, green building, and climate change. Applicants can submit proposals under 4 categories: community resilience to disasters, job creation, the role of manufactured homes in sustainable neighborhood design, or medical and social service facilities siting. Information on this program is available on the website: https://www.epa.gov/smartgrowth.
	Responsible Agency:	EPA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Partners for Fish and Wildlife	**Description:**	Financial and technical assistance to private landowners interested in pursuing restoration projects affecting wetlands and riparian habitats. Information on this program is available on the website: https://www.fws.gov/partners/.
	Responsible Agency:	U.S. Fish and Wildlife Service
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Transportation Investment Generating Economic	**Description:**	Investing in critical road, rail, transit and port projects across the nation. Information on this program is available on the website: https://www.transportation.gov/tags/tiger-grants.

Capability		
Recovery (TIGER)	**Responsible Agency:**	U.S. DOT
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Community Facilities Direct Loan & Grant Program	**Description:**	This program provides affordable funding to develop essential community facilities in rural areas. An essential community facility is defined as a facility that provides an essential service to the local community for the orderly development of the community in a primarily rural area, and does not include private, commercial or business undertakings. Information on this program is available on the website: https://www.rd.usda.gov/programs-services/community-facilities-direct-loan-grant-program.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Emergency Loan Program	**Description:**	USDA's Farm Service Agency provides emergency loans to help producers recover from production and physical losses due to drought, flooding, other natural disasters or quarantine. Information on this program is available on the website: https://www.fsa.usda.gov/programs-and-services/farm-loan-programs/emergency-farm-loans/index.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All natural hazards
Emergency Watershed Protection program	**Description:**	The Emergency Watershed Protection (EWP) program provides assistance to relieve imminent hazards to life and property caused by floods, fires, drought, windstorms, and other natural occurrences through the Natural Resources Conservation Service. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/.
	Responsible Agency:	USDA
	Provides Funding for Mitigation:	Yes
	Hazard:	All-natural hazards
Financial Assistance	**Description:**	Financial assistance to help plan and implement conservation practices that address natural resource concerns or opportunities to help save energy, improve soil, water, plant, air, animal and related resources on agricultural lands and non-industrial private forest land. Information on this program is available on the website: https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/financial/.
	Responsible Agency:	NRCS
	Provides Funding for Mitigation:	Yes
	Hazard:	-

Capability		
Emergency Management Performance Grants (EMPG) Program	**Description:**	Assist local, tribal, territorial, and state governments in enhancing and sustaining all-hazards emergency management capabilities. Information on this program is available on the website: https://www.fema.gov/grants/preparedness/emergency-management-performance.
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Reimbursement for Firefighting on Federal Property	**Description:**	Provides reimbursement only for direct costs and losses over and above normal operating costs. Information on this program is available on the website: https://www.usfa.fema.gov/grants/firefighting_federal_property.html.
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	Fire
Land & Water Conservation Fund	**Description:**	Matching grants to states and local governments for the acquisition and development of public outdoor recreation areas and facilities (as well as funding for shared federal land acquisition and conservation strategies). Information on this program is available on the website: https://www.nps.gov/subjects/lwcf/index.htm.
	Responsible Agency:	National Park Service
	Provides Funding for Mitigation:	Yes
	Hazard:	-
State		
New Jersey Clean Energy Program	**Description:**	New Jersey's Clean Energy Program (NJCEP) promotes increased energy efficiency and the use of clean, renewable sources of energy including solar, wind, geothermal, and sustainable biomass. The results for New Jersey are a stronger economy, less pollution, lower costs, and reduced demand for electricity. NJCEP offers financial incentives, programs, and services for residential, commercial, and municipal customers. Refer to https://www.njcleanenergy.com/main/about-njcep/about-njcep for additional details on NJCEP. The program also offers a Community Energy Plan Grant for government entities (e.g. municipality, county, Green Team or environmental commission, or other Sustainable Jersey organization within a community or county). The grant will provide funding for an entity to create a Community Energy Master Plan to align local communities with the State Energy Master Plan
	Responsible Agency:	New Jersey Board of Public Utilities
	Provides Funding for Mitigation:	Yes
	Hazard:	Hazards impacted by climate change
Grant and Loan Programs	**Description:**	NJDEP offers a wide variety of funding opportunities for local governments and other types of organizations to fund numerous environmentally based projects. This includes funding for: air quality, energy, and sustainability; compliance and enforcement; engineering and construction; land use management; local government assistance; natural and historic resources; site remediation and waste management programs; and water resource management.

Capability		
		Information on each of the programs can be found on the NJDEP website: https://www.nj.gov/dep/grantandloanprograms/.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Green Acres Program	**Description:**	Green Acres was created to meet New Jersey's growing recreation and conservation needs. This program has helped preserve over 1.2 million acres of land in New Jersey.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Blue Acres Program	**Description:**	Blue Acres provides funding for acquisition of land in floodways of the Delaware River, Sussex River, and Raritan River and their respective tributaries, for recreation and conservation purposes. Properties (including structures) that have been damaged by, or may be prone to incurring damage caused by, storms or storm-related flooding, or that may buffer or protect other lands from such damage, are eligible for acquisition.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather
New Jersey Water Bank	**Description:**	The New Jersey Water Bank (NJWB) is a partnership between the NJDEP and the NJEIT to provide low cost financing for the design, construction, and implementation of projects that help protect and improve water quality and help ensure safe and adequate drinking water. The NJWB finances projects by utilizing two funding sources. The Trust issues revenue bonds which are used in combination with zero percent interest funds to provide very low interest loans for water infrastructure improvements. The NJDEP administers a combination of Federal State Revolving Fund capitalization grants, as well as the State's matching funds, loan repayments, State appropriations and interest earned on such funds.
	Responsible Agency:	NJDEP and New Jersey Environmental Infrastructure Trust
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather
New Jersey Redevelopment Authority	**Description:**	The New Jersey Redevelopment Authority (NJRA) is an independent state financing authority committed exclusively to the redevelopment of New Jersey's urban areas. NJRA offers several financing resources including site acquisition funding, predevelopment assistance, several development assistance resources, and technical assistance.
	Responsible Agency:	-
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Department of	**Description:**	The New Jersey Department of Community Affairs (NJDCA) is a state agency created to provide administrative guidance, financial support, and technical assistance to local governments, community development organizations, businesses, and individuals to

Capability		
Community Affairs		improve the quality of life in New Jersey. NJDCA offers a wide range of programs, funding, and services that respond to issues of public concern including fire and building safety, housing production, community planning and development, and local government management and finance. Among other funding sources, NJDCA administers CDBG funding and is typically the CDBG-Disaster Relief funding recipient for the State of New Jersey.
	Responsible Agency:	-
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Board of Public Utilities	**Description:**	The New Jersey Board of Public Utilities (BPU) works with private utility companies to provide analysis of natural hazard information affecting the provision of electric power, telecommunications, public water, sewage collection and treatment, and other regulated public utilities. The data are used during response and recovery efforts in the event of emergency or disaster and is also used to analyze impact of mitigation plans and projects. BPU also provides technical assistance for the Energy Resiliency Program
	Responsible Agency:	BPU
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Environmental Infrastructure Financing Program	**Description:**	Qualified borrowers receive loans in two equal parts: Approximately one half to three quarters comes from a 0-interest State Revolving Fund maintained by the NJDEP. The other portion comes from proceeds of highly rated tax-exempt revenue bonds sold by the Trust. Combining these two funds results in a loan that is 50 to 75% lower than traditional loan rates.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Small Cities Communities Development Block Grants	**Description:**	The New Jersey Small Cities Communities Development Block Grants provide funds for economic development, housing rehabilitation, community revitalization, and public facilities designated to benefit people with low and moderate incomes, or to address recent local needs for which no other source of funding is available to non-entitlement counties and municipalities. Information on the program is available on the website: https://www.nj.gov/dca/divisions/dhcr/offices/neighborhood.html.
	Responsible Agency:	NJDCA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Conservation Foundation	**Description:**	The New Jersey Conservation Foundation (NJCF) is a private, not-for-profit organization. Through acquisition and stewardship, NJCF protects strategic lands, promotes strong land use policies, and forges partnerships to achieve conservation goals. Grants to help fund preservation activities. Information on the program is available on the website: https://www.njconservation.org/what-we-do/.
	Responsible Agency:	NJCF

Capability		
	Provides Funding for Mitigation:	Yes
	Hazard:	-
The New Jersey Infrastructure Bank	**Description:**	Two programs provide and administer low interest rate loans to qualified municipalities, counties, regional authorities, and water purveyors in New Jersey. Approximately $350 million is awarded annually. 1. NJEIT for the purpose of financing water quality infrastructure projects that enhance ground and surface water resources, ensure the safety of drinking water supplies, protect the public health and make possible responsible and sustainable economic development. 2. The New Jersey Transportation Infrastructure Bank (NJTIB) is an independent State Financing Authority responsible for providing and administering low interest rate loans to qualified municipalities, counties, and regional authorities in New Jersey for the purpose of financing transportation quality infrastructure projects. Information on the program is available on the website: https://www.njib.gov/.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
Drinking Water State Revolving Fund	**Description:**	The DWSRF program assists water systems in financing the cost of infrastructure through the use of federal and New Jersey Infrastructure Trust funds. Additionally, the Water Supply program provides operator licensing and training support as well as financial assistance through the DWSRF program. Information on the program is available on the website: https://www.state.nj.us/dep/watersupply/dws_loans.html.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	-
New Jersey Department of Transportation (NJDOT)	**Description:**	Funding of the Program is typically federal through the Federal Highway Administration or State through the Transportation Trust Fund. Information on the program is available on the website: https://www.state.nj.us/transportation/business/localaid/funding.shtm.
	Responsible Agency:	NJDOT
	Provides Funding for Mitigation:	Yes
	Hazard:	-
NJ Highlands Council – Open Space Partnership	**Description:**	The Highlands Open Space Partnership Funding program is a matching grant program designed to support the acquisition of property for the protection of resources within the Highlands Region, and to further the goals of landowner equity as specified in the Highlands Water Protection and Planning Act of 2004 and the Highlands Regional Master Plan. The Highlands Council shall provide a maximum grant award of 50% of the total purchase price of the property. Applications will be considered for acquisition of property in fee simple or through conservation easements for any passive recreation or conservation purposes. See program details below for complete information.
	Responsible Agency:	NJ Highlands Council. State agencies, Highlands county or municipal governments, and charitable conservancies are eligible to apply.

Capability		
	Provides Funding for Mitigation:	Yes – open space
	Hazard:	-
NJ Highlands Council – Plan Conformance Grants	**Description:**	Plan Conformance Grants provide funding to support costs associated with Plan Conformance activities (i.e. engagement of professionals and staff in the development of required Plan Conformance components).
	Responsible Agency:	Municipalities in the Highlands Region, as defined by the Highlands Act (Planning or Preservation Area), that have submitted a duly-adopted Notice of Intent to petition Highlands Council in accordance with the Council's Plan Conformance Guidelines.
	Provides Funding for Mitigation:	Yes
	Hazard:	Harmful Algal Bloom
NJ Highlands – Transfer of Development Rights	**Description:**	Transfer of Development Rights (TDR) is a land-use tool that encourages transfer of development potential from areas a community wants to preserve (Sending Zones) to areas where growth is desired (Receiving Zones). The Highlands Act mandated the creation of a TDR program as an effective means of addressing landowner equity while advancing planning goals of the Act.
	Responsible Agency:	Any municipality in New Jersey can apply for funding.
	Provides Funding for Mitigation:	Yes
	Hazard:	-
County and Local		
Sussex County Farmland Preservation, Recreation, and Open Space Trust Fund	**Description:**	The Farmland Preservation, Recreation, and Open Space Trust Fund is divided into two separate categories, each having its own distinct goals and objectives. The Farmland Preservation Program uses Trust Fund dollars to purchase development easements on farm land, forever protecting the agriculture use. The Open Space program uses Trust Fund dollars to acquire land and/or water areas for the protection of ecologically sensitive areas; preservation of areas of scenic, cultural or historic value; public outdoor recreational facilities (active or passive); preservation of lands of exceptional flora or fauna; and for the protection of critical water supplies. The Trust Fund cannot be used for construction and development of mitigation projects and is strictly used to acquire open space. Projects are selected through an open and competitive process, governed by state and local statutes. Funds can only be used to purchase land in Sussex County from willing sellers on a voluntary basis. The county does not condemn property if the owner is unwilling to sell. The Trust Fund is funded through a property tax assessment determined annually by the Board of Chosen Commissioners.
	Responsible Agency:	Board of Chosen Commissioners, Open Space Advisory Committee
	Provides Funding for Mitigation:	Yes
	Hazard:	All

5.5 PLAN INTEGRATION

Described earlier in this section and within each annex, participating jurisdictions identified integration of hazard risk management into their existing planning, regulatory, and operational/administrative framework ("integration capabilities") and intended integration promotion (integration actions). Volume II, Section 9

(Jurisdictional Annexes) provides details on how each jurisdiction integrates hazard mitigation into their existing capabilities.

5.5.1 INTEGRATION PROCESS

Hazard mitigation is a sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards. Integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns that do not increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Sussex County Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Section 9 (Jurisdictional Annexes) details how this is done for each participating municipality and the County. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes and have added new mitigation actions to support this effort.

The Planning Partnership representatives will continue to incorporate mitigation planning as an integral component of daily government operations. Planning Partnership representatives will continue to work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution presented in Appendix A (Plan Adoption) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

1. Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts.
2. The Hazard Mitigation Plan, Master Plans, Emergency Management Plans, and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of County residents.

Section 7 (Plan Maintenance) provides for additional information on the implementation of the mitigation plan through existing programs.

SECTION 6. MITIGATION STRATEGY

This section presents the process by which Sussex County will reduce or eliminate potential losses from the hazards identified in Section 4.1 (Identification of Hazards) of this HMP. The mitigation strategy focuses on existing and potential future mitigation actions to alleviate the effects of hazards on Sussex County's population, economy, environment and general building stock.

The Planning Partnership reviewed the results of the risk assessment and capability assessment to identify and develop mitigation actions. This section includes the following. Individual actions are listed within Section 9 (Jurisdictional Annexes).

1. Background and Past Mitigation Accomplishments
2. General Planning Approach
3. Review and Update of Mission Statement, Mitigation Goals and Objectives
4. Mitigation Strategy Development

Hazard mitigation reduces the potential impacts of, and costs associated with, emergency and disaster-related events. Mitigation actions address a range of impacts, including impacts on the population, property, the economy, and the environment.

Mitigation actions can include activities such as: revisions to land-use planning, training and education, and structural and nonstructural safety measures.

2021 HMP Changes

- The goals and objectives were updated to align with County and local priorities.
- The capability assessment was moved to Section 5.
- A Strengths, Weaknesses, Obstacles and Opportunities exercise was conducted for the high-ranked hazards to inform the updated mitigation strategy.
- A mitigation toolbox was compiled and distributed to assist with the mitigation strategy update.

6.1 BACKGROUND AND PAST MITIGATION ACCOMPLISHMENTS

In accordance with the requirements of the DMA 2000, a discussion regarding past mitigation activities and an overview of past efforts is provided as a foundation for understanding the mitigation goals, objectives, and activities outlined in this plan update. Sussex County, through previous and ongoing hazard mitigation activities, has demonstrated that it is proactive in protecting its physical assets and citizens against losses from natural hazards. Examples of previous and ongoing Sussex actions and projects include the following. Refer to Section 9.2 through 9.25 for mitigation accomplishments by each municipality.

- The County continues to incorporate hazard mitigation considerations and priorities into various plan updates and integrate the County Master Plan with the County HMP during the Master Plan Update.
- The County works to design and implement a mitigation awareness campaign through County Planning or Rutgers Extension to Farms/Tree Farms regarding the ingestion pathway response for the radiological hazard.
- The County coordinates with the Sussex County College FM Radio Station to disseminate preparedness information.
- County staff participate in the Emergency Preparedness Conference and workshops.

6.2 GENERAL MITIGATION PLANNING APPROACH

The overall approach used to update the County and local hazard mitigation strategies are based on FEMA and State of New Jersey regulations and guidance regarding local mitigation plan development, including the following:

- DMA 2000 regulations, specifically 44 CFR 201.6 (local mitigation planning).
- FEMA *Local Mitigation Planning Handbook*, March 2013.
- FEMA *Local Mitigation Plan Review Guide*, October 1, 2011.
- FEMA *Integrating Hazard Mitigation into Local Planning*, March 1, 2013.
- FEMA *Plan Integration: Linking Local Planning Efforts*, July 2015.
- FEMA *Mitigation Planning How-To Guide #3, Identifying Mitigation Actions and Implementing Strategies* (FEMA 386-3), February 2013.
- FEMA *Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards*, January 2013.

The mitigation strategy update approach includes the following steps that are further detailed in later subsections of this section:

- Section 6.3 – Strengths, Weaknesses, Obstacles and Opportunities (SWOO) exercise
- Section 6.4 – Stakeholder Surveys
- Section 6.5 – Review and update the mitigation goals and objectives
- Section 6.6 – Prepare an implementation strategy, including:
  - Identification of progress on previous County and local mitigation strategies
  - Development of updated County and local mitigation strategies, and
  - Prioritization projects and initiatives in the updated mitigation strategy

6.3 STRENGTHS, WEAKNESSES, OBSTACLES AND OPPORTUNITIES EXERCISE

The Steering Committee participated in a Strengths, Weaknesses, Obstacles and Opportunities (SWOO) exercise focusing on the high-ranked countywide hazards to update the strengths, weaknesses, obstacles and opportunities last conducted in 2016. The discussion of each hazard began with identifying County, local jurisdiction and stakeholder strengths to mitigate the risk and potential future impacts of these hazards. Next, the weaknesses, challenges and obstacles the planning area faces to reduce each hazard's risk were identified. To conclude the discussion of each high-ranked hazard, the Steering Committee members were asked to identify potential opportunities for enhanced mitigation.

SWOO results were recorded to assist with the problem statement development to update to the mitigation strategy. Refer to Appendix B (Participation Documentation) which provides the information captured for each hazard during the SWOO exercise.

6.4 STAKEHOLDER SURVEYS

As discussed in Section 2 (Planning Process), stakeholder surveys were developed and distributed to solicit input regarding vulnerabilities, capabilities and mitigation projects. The County distributed directly via email to identified points of contact in the following sectors. In addition, all Planning Partners were asked to distribute broadly within their jurisdictions.

- Academia
- Emergency services

- Transportation/Department of Public Works
- Utilities
- Hospital and health care
- Business/commerce
- Social services
- General - for planning agencies and other stakeholders that do not fit within one of the above categories

Information gathered from these surveys was shared with all plan participants and used to inform the updated mitigation strategy development and finalization of the annexes (Section 9). Refer to Appendix D (Public and Stakeholder Outreach) for a copy of the survey results.

6.5 REVIEW AND UPDATE OF MITIGATION GOALS AND OBJECTIVES

This section documents the County's efforts to develop hazard mitigation goals and objectives that are established to reduce or avoid long-term vulnerabilities to the identified hazards.

6.5.1 GOALS AND OBJECTIVES

According to CFR 201.6(c)(3)(i): "The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards." The mitigation goals were developed based on the risk assessment results, discussions, research, and input from the Steering and Planning Committees, existing authorities, polices, programs, resources, stakeholders, and the public.

The Steering Committee reviewed the 2016 HMP goals and objectives at the August 2020 Steering Committee kickoff meeting. The updated goals and objectives were then presented to the Planning Partnership at the September 2020 municipal kickoff meeting. The goals and objectives were updated in consideration of the hazard events and losses since the 2016 plan, the goals and objectives established in the updated State HMP, county and local risk management plans/priorities, as well as direct input from the Steering Committee (representing the County and participating jurisdictions) recognizing the need to move forward to best manage their hazard risk.

For the purposes of this plan, goals and objectives are defined as follows:

FEMA defines ***Goals*** as general guidelines that explain what should be achieved. Goals are usually broad, long-term, policy statements, and represent a global vision.

FEMA defines ***Objectives*** as strategies or implementation steps to attain mitigation goals. Unlike goals, objectives are specific and measurable, where feasible.

FEMA defines ***Mitigation Actions*** as specific actions that help to achieve the mitigation goals and objectives.

Goals are general guidelines that explain what is to be achieved. They are broad, long-term, policy-type statements that represent global visions. Goals help define the benefits that the plan is trying to achieve. The success of the plan, once implemented, should be measured by the degree to which its goals have been met (that is, by the actual benefits in terms of hazard mitigation).

Objectives are short-term aims, which when combined form a strategy or course of action to meet a goal. Unlike goals, objectives are specific and measurable.

The goals and objectives update provides clear guidelines for how the County and all jurisdictions can move forward to best manage their hazard risk. Amendments include additions and edits to goals and objectives to express the plan participants' interests in integrating this plan with other planning mechanisms/programs and to support mitigation through the protection and preservation of natural systems, incorporate resilience of lifelines, and integrate green infrastructure.

As a result of this review process, the goals and objectives for the 2021 update were amended as presented in Table 6-1. *Italicized* text indicates the updates made to the goals and objectives. A new goal was added and move to Goal #1, and the goals and objectives that follow were renumbered. Although an objective is listed with each goal, the objectives were developed to meet multiple goals as demonstrated in Table 6-2.

Table 6-1. Sussex County Mitigation Goals and Objectives

Goal	Objective Statement
Goal 1: Protect life	1.1: Identify the need for, and acquire, any special health and emergency services, training, and equipment to enhance response and recovery capabilities for specific hazards to vulnerable populations
	1.2: Maintain and enhance local regulatory standards including full and effective building code enforcement, floodplain management and other vulnerability-reducing regulations
	1.3: Develop, enhance and protect early warning and emergency communications systems
	1.4: Identify and train non-traditional first responders to increase response capabilities
Goal 2: Protect property	2.1: Pursue cost-effective mitigation actions to reduce the impacts of hazards on people, property and the economy
	2.2: Preserve, restore and enhance natural environmental resources including open space and agricultural resources that serve a natural hazard mitigation function
	2.3: Facilitate the development and timely submittal of project applications meeting state and federal guidelines for funding to reduce the number of repetitive and severe repetitive loss properties and hardening/retrofitting infrastructure, critical facilities *and lifelines* with identified needs
	2.4: *Encourage the use of green stormwater infrastructure to mitigate flooding and improve water quality*
Goal 3: Increase preparedness and awareness	3.1: Increase awareness of hazard risks and understanding of the advantages of mitigation to the general public, business and community members, and by local government officials
	3.2: Increase local government official awareness regarding funding opportunities for mitigation
	3.3: Provide government officials and local practitioners with educational opportunities and information regarding best practices for hazard mitigation planning, project identification, and implementation
	3.4: *Increase awareness of dam ownership and available mitigation funding for dams*
Goal 4: Develop and maintain an understanding of risks from hazards	4.1: Improve data collection and sharing; and increase data availability to the county and municipalities to reduce the impacts of hazards and for use in future planning efforts
	4.2: Acquire and maintain detailed data regarding critical facilities, *lifelines* and infrastructure such that these sites can be prioritized and risk-assessed for possible mitigation actions
	4.3: Continue support of hazard mitigation planning, project identification, and implementation at the municipal and county level
	4.4: *Strengthen understanding of, and adaptation to, a changing climate*
Goal 5: Enhance mitigation capabilities to reduce hazard vulnerabilities	5.1: Support increased participation in the National Flood Insurance Program Community Rating System
	5.2: Support increased integration of municipal/county hazard mitigation planning and floodplain management with effective municipal zoning regulation, and effective municipal/county subdivision regulation, and comprehensive planning
	5.3: Provide user-friendly hazard-data accessibility for mitigation planning, other planning efforts and for private citizens

Goal	Objective Statement
	5.4: Provide direct support, where possible, to municipal mitigation programs
Goal 6: Support continuity of operations pre-, during, and post-hazard events	6.1: Ensure continuity of operations of government, non-government, commerce, private sector, and infrastructure
	6.2: Support and encourage the implementation of back-up and alternative energy sources
	6.3: Develop, enhance and identify systems and procedures to help facilitate and prioritize an expedient response during disaster recovery efforts
Goal 7: *Address Long-Term Vulnerabilities from High Hazard Dams*	7.1: *Ensure dam infrastructure is maintained*
	7.2: *Ensure EAPs are maintained and updated*
	7.3: *Support the identification and access to funding to repair/replace dams*

6.6 MITIGATION STRATEGY DEVELOPMENT AND UPDATE

6.6.1 REVIEW OF 2016 HMP MITIGATION ACTION PLAN

To evaluate progress on local mitigation actions, the planning consultant met with each participant to discuss the status of the mitigation actions identified in the 2016 plan. For each action, jurisdictions were asked to provide the status of each action (*No Progress, In Progress, Ongoing Capability, Discontinue, or Completed*) and provide review comments on each. Jurisdictions were requested to quantify the extent of progress and provide reasons for the level of progress or why actions were being discontinued. Each jurisdictional annex in Section 9 (Jurisdictional Annexes) provides a table identifying the jurisdiction's prior mitigation strategy, the status of those actions and initiatives, and their disposition within their updated strategy.

Local mitigation actions identified as *Complete*, and those actions identified as *Discontinued*, were removed from the updated strategies. Local mitigation actions identified as an *Ongoing Capability* were incorporated into the capability assessment of each jurisdictional annex. Those actions identified as *No Progress* or *In Progress* that remain a priority for the jurisdiction, have been carried forward into the updated mitigation strategy.

At the September 2020 kickoff meeting and during subsequent local-level planning meetings (phone, email, in-person local support meetings), all participating jurisdictions were requested to identify mitigation activities completed, ongoing, and potential/proposed. As new potential mitigation actions, projects, or initiatives became evident during the plan update process, including as part of the risk assessment update and as identified through the public and stakeholder outreach process detailed in Section 2 (Planning Process), jurisdictions were made aware of these either through direct communication (local meetings, email, phone), at Steering and Planning Committee meetings, or via their draft jurisdictional annexes.

Throughout the planning process, jurisdictions worked with the planning consultant to assist with the development and update of their annex and include mitigation strategies, focusing on identifying well-defined, implementable projects with a careful consideration of benefits (risk reduction, losses avoided), costs, and possible funding sources (including mitigation grant programs).

6.6.2 IDENTIFICATION AND ANALYSIS OF MITIGATION TECHNIQUES

Concerted efforts were made to assure that the jurisdictions develop updated mitigation strategies that included activities and initiatives covering the range of mitigation action types described in recent FEMA planning guidance (FEMA *Local Mitigation Planning Handbook* March 2013), specifically:

- <u>Local Plans and Regulations</u>—These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.
- <u>Structure and Infrastructure Projects</u>—These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures, as well as critical facilities and infrastructure. This type of action involves projects to construct manmade structures to reduce the impact of hazards.
- <u>Natural Systems Protection</u>—These are actions that minimize damage and losses and preserve or restore the functions of natural systems.
- <u>Education and Awareness Programs</u>—These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions could include participation in national programs, such as the National Flood Insurance Program and Community Rating System, StormReady (NOAA), and Firewise (NFPA) Communities.

6.6.3 2021 HMP MITIGATION ACTION PLAN

To help support the selection of an appropriate, risk-based mitigation strategy, each annex was updated to provide a summary of hazard vulnerabilities identified during the plan update process, either directly by local representatives or through review of available County and local plans and reports, and through the hazard profiling and vulnerability assessment process.

A mitigation strategy workshop was co-led by NJOEM-Mitigation Unit and the contracted planning consultant on November 12, 2020, for all participating jurisdictions to support the development of the updated mitigation strategy. To assist with the identification of implementable and action-oriented mitigation actions, a three-step process was followed for the 2021 HMP update: 1) Assemble a 'mitigation toolbox'; 2) Identify problem statements through 'mitigation brainstorming' and 3) Update the mitigation action plan. This section describes the process followed by the County and the jurisdictions to develop the 2021 updated mitigation action plan.

The concept of a 'mitigation toolbox' was introduced to the Planning Partnership at the October 2020 risk assessment meeting. A mitigation toolbox contains numerous resources available to the County and participating jurisdictions to assist with the development of an updated mitigation action plan. This toolbox was referred to throughout the 2021 HMP mitigation strategy update. All materials were made available to all participants to access and will continue to serve as a resource over the plan performance period. The toolbox contains, but is not limited, to the following and will be continuously added to over time:

- 2021 HMP goals and objectives
- 2016 HMP Mitigation Strategy
- Risk assessment results
- Capability assessment results
- Outcomes of the SWOO
- Mitigation Catalog
- Subject-matter expertise
- Stakeholder and public input (e.g., citizen survey and stakeholder survey results)
- Existing plans/policies/programs
- FEMA resources (e.g., Mitigation Ideas).

As discussed in Section 2 (Planning Process) and earlier in this section, the October 2020 risk assessment meeting and individual jurisdiction meetings were focused on understanding risk and capabilities and identify gaps in capabilities, challenges and opportunities. This provided context for the next steps in the update of the mitigation strategy and inform the Planning Partnership of the available resources in their 'toolbox.'

At the November 2020 Mitigation Strategy Workshop, the Planning Partnership developed problem statements based on the impacts of hazards in the County. The results of the updated risk assessment, challenges and opportunities identified during the capability assessment update and SWOO sessions, and information gathered from the citizen survey were used to inform problem statement development. This workshop was held remotely due to the coronavirus pandemic. Jurisdictions then had follow-up phone calls with the planning consultant to brainstorm and develop mitigation actions. Information gathered from the citizen and stakeholder surveys were shared with the Planning Partnership to further inform the updated mitigation strategy development.

As a result, problem statements were developed to detail the problems/challenges/gaps/identified vulnerabilities the jurisdiction faces. Mitigation alternatives were then evaluated to best reduce future risk and address the identified problem. These problem statements were intended to provide a detailed description of the problem area, including impacts to the jurisdiction, past damages, and loss of service. These problem statements helped form a bridge between the hazard risk assessment, which quantifies impacts to each community, with the development of achievable mitigation strategies.

A strong effort has been made to better focus local mitigation strategies to clearly defined, readily implementable projects and initiatives that meet the definition or characteristics of mitigation. Broadly defined mitigation actions were eliminated from the updated strategy unless accompanied by discrete actions, projects, or initiatives.

Certain continuous or ongoing strategies that represent programs that are fully integrated into the normal operational and administrative framework of the community have been identified within the capabilities section of each annex and removed from the updated mitigation strategy.

Throughout the course of the plan update process, additional regional and county-level mitigation actions were identified by the following processes:

- Review of the results and findings of the updated risk assessment.
- Review of available regional and county plans reports and studies;
- Direct input from county departments and other county and regional agencies
- Input received through the public and stakeholder outreach process.

6.7 MITIGATION BEST PRACTICES

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in Sussex County, in compliance with 44 CFR Section 201.6(c)(3)(ii). One catalog was developed for each natural hazard of concern evaluated in this plan; referred to as the Mitigation Catalog (Appendix F). The catalogs present alternatives that are categorized in two ways:

- By whom would have responsibility for implementation:
    - Individuals – personal scale
    - Businesses – corporate scale
    - Government – government scale
- By what each of the alternatives would do:
    - Manipulate the hazard
    - Reduce exposure to the hazard
    - Reduce vulnerability to the hazard
    - Build local capacity to respond to or be prepared for the hazard

The alternatives presented include actions that will mitigate current risk from hazards and actions that will help reduce risk from changes in the impacts of these hazards resulting from climate change. Hazard mitigation actions recommended in this plan were selected from among the alternatives presented in the catalog, as well as other resources made available to all jurisdictions (i.e., FEMA's Mitigation Ideas). The catalog provides a baseline of mitigation alternatives that are backed by a planning process, are consistent with the established goals and objectives, and are within the capabilities of the planning partners to implement. Some of these actions may not be feasible based on the selection criteria identified for this plan. The purpose of the catalog was to provide a list of what could be considered to reduce risk from natural hazards within the planning area. Actions in the catalog that are not included for the partnership's action plan were not selected for one or more of the following reasons:

- The action is not feasible
- The action is already being implemented
- There is an apparently more cost-effective alternative
- The action does not have public or political support.

6.8 MITIGATION STRATEGY EVALUATION AND PRIORITIZATION

Section 201.c.3.iii of 44 CFR requires an action plan describing how mitigation actions identified will be prioritized. The County and participating jurisdictions utilized a modified STAPLEE (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) mitigation action evaluation methodology based on a set of evaluation criteria suited to the purposes of hazard mitigation strategy evaluation. This method provides a systematic approach that considers the opportunities and constraints of implementing a specific mitigation action.

The Steering Committee applied an action evaluation methodology, which includes an expanded set of 14 criteria to include the consideration of cost-effectiveness, availability of funding, anticipated timeline, and if the action addresses multiple hazards. The 14 evaluation criteria used in the 2021 update process is the same used in the 2016 plan:

1. Life Safety—How effective will the action be at protecting lives and preventing injuries?
2. Property Protection—How significant will the action be at eliminating or reducing damage to structures and infrastructure?
3. Cost-Effectiveness—Are the costs to implement the project or initiative commensurate with the benefits achieved?
4. Technical—Is the mitigation action technically feasible? Is it a long-term solution? Eliminate actions that, from a technical standpoint, will not meet the goals.
5. Political—Is there overall public support for the mitigation action? Is there the political will to support it?
6. Legal—Does the jurisdiction have the authority to implement the action?
7. Fiscal—Can the project be funded under existing program budgets (i.e., is this initiative currently budgeted for)? Would it require a new budget authorization or funding from another source such as grants?
8. Environmental–What are the potential environmental impacts of the action? Will it comply with environmental regulations?
9. Social—Will the proposed action adversely affect one segment of the population? Will the action disrupt established neighborhoods, break up voting districts, or cause the relocation of lower income people?
10. Administrative—Does the jurisdiction have the personnel and administrative capabilities to implement the action and maintain it? Will outside help be necessary?
11. Multi-hazard—Does the action reduce the risk to multiple hazards?
12. Timeline—Can the action be completed in less than 5 years (within our planning horizon)?
13. Local Champion—Is there a strong advocate for the action or project among the jurisdiction's staff, governing body, or committees that will support the action's implementation?

14. Other Local Objectives—Does the action advance other local objectives, such as capital improvements, economic development, environmental quality, or open space preservation? Does it support the policies of other plans and programs?

Specifically, for each mitigation action, the jurisdictions were asked to assign a numeric rank (-1, 0, or 1) for each of the 14 evaluation criteria, defined as follows:

- 1 = Highly effective or feasible
- 0 = Neutral
- -1 = Ineffective or not feasible

Further, jurisdictions were asked to provide a summary of the rationale behind the numeric rankings assigned, as applicable. The numerical results were totaled to assist each jurisdiction in selecting mitigation actions for the updated plan.

As step one in the prioritization process, actions that had a numerical value between 0 and 4 were initially prioritized as *low*; actions with numerical values between 5 and 9 were initially categorized as *medium*; and actions with numerical values between 10 and 14 were initially categorized as *high*. As step two, jurisdictions were then asked to consider the benefits and costs, as well as the desired timeline for implementation and project completion timeline when finalizing each action's priority as *high/medium/low*. These attributes are included in the mitigation strategy table and for FEMA-eligible projects in the mitigation worksheets (Section 9 – Jurisdictional Annexes).

In addition, municipalities were asked to identify the most important project(s) that they would like to begin implementation on as quickly as possible once resources are available. These actions are listed at the beginning of the list of proposed mitigation actions for each annex.

For the plan update there has been an effort to develop more clearly defined and action-oriented mitigation strategies. These local strategies include projects and initiatives that are seen by the community as the most effective approaches to advance their local mitigation goals and objectives within their capabilities. In addition, each jurisdiction was asked to develop problem statements. With this process, participating jurisdictions were able to develop action-oriented and achievable mitigation strategies.

6.9 BENEFIT/COST REVIEW

Section 201.6.c.3iii of 44 CFR requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a cost/benefit review of the proposed projects and their associated costs. Stated otherwise, cost-effectiveness is one of the criteria that must be applied during the evaluation and prioritization of all actions comprising the overall mitigation strategy.

The benefit/cost review applied in for the evaluation and prioritization of projects and initiatives in this plan update process was qualitative; that is, it does not include the level of detail required by FEMA for project grant eligibility under the Hazard Mitigation Assistance (HMA) grant programs. For all actions identified in the local strategies, jurisdictions have identified both the costs and benefits associated with project, action or initiative.

Costs are the total cost for the action or project, and could include administrative costs, construction costs (including engineering, design and permitting), and maintenance costs.

Benefits are the savings from losses avoided attributed to the implementation of the project, and could include life-safety, structure and infrastructure damages, loss of service or function, and economic and environmental damage and losses.

When possible, jurisdictions were asked to identify the actual or estimated dollar costs and associated benefits. Often numerical costs and/or benefits were not identified and may be impossible to quantify. In this case, jurisdictions were asked to evaluate project cost-effectiveness using *high*, *medium*, and *low* ratings. Where estimates of costs and benefits were available, the ratings were defined as the following:

Low <= $10,000 Medium = $10,000 to $100,000 High >=$100,000

Where quantitative estimates of costs and/or benefits were not available, qualitative ratings using the following definitions were used:

Table 6-2. Qualitative Cost and Benefit Ratings

Costs	
High	Existing funding levels are not adequate to cover the costs of the proposed project, and implementation would require an increase in revenue through an alternative source (e.g., bonds, grants, and fee increases).
Medium	The project could be implemented with existing funding but would require a re-apportionment of the budget or a budget amendment, or the cost of the project would have to be spread over multiple years.
Low	The project could be funded under the existing budget. The project is part of or can be part of an existing, ongoing program.
Benefits	
High	Project will have an immediate impact on the reduction of risk exposure to life and property.
Medium	Project will have a long-term impact on the reduction of risk exposure to life and property or will provide an immediate reduction in the risk exposure to property.
Low	Long-term benefits of the project are difficult to quantify in the short term.

Using this approach, projects with positive benefit versus cost ratios (such as high over high, high over medium, medium over low) are considered cost-effective. For some of the Sussex County initiatives identified, the planning partnership might seek financial assistance under FEMA's HMA programs. These programs require detailed benefit/cost analysis as part of the application process. These analyses will be performed when funding applications are prepared, using the FEMA benefit/cost analysis model process. The planning partnership is committed to implementing mitigation strategies with benefits that exceed costs. For projects not seeking financial assistance from grant programs that require this sort of analysis, the planning partnership reserves the right to define "benefits" according to parameters that meet its needs and the goals and objectives of this plan.

SECTION 7. PLAN MAINTENANCE PROCEDURES

This section details the formal process that will ensure that the HMP remains an active and relevant document and that the Planning Partnership maintains their eligibility for applicable funding sources. The plan maintenance process includes a schedule for monitoring and evaluating the plan annually and producing an updated plan every five years. In addition, this section describes how public participation will be integrated throughout the plan maintenance and implementation process. It explains how the mitigation strategies outlined in this plan update will be incorporated into existing planning mechanisms and programs, such as comprehensive land use planning processes, capital improvement planning, and building code enforcement and implementation. The plan's format allows sections to be reviewed and updated when new data become available, resulting in a plan that will remain current and relevant.

The plan maintenance matrix shown in Table 7-1 provides a synopsis of responsibilities for plan monitoring, evaluation, and update, which are discussed in further detail in the sections below.

Table 7-1. Plan Maintenance Matrix

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Monitoring	Preparation of status updates and action implementation tracking as part of submission for Annual Progress Report.	September or upon major update to Comprehensive Plan or major disaster	Jurisdictional points of contact identified in Section 8 (Planning Partnership) and Section 9 (Jurisdictional Annexes)	Jurisdictional implementation lead identified in Section 8 (Planning Partnership) and Section 9 (Jurisdictional Annexes)
Integration	In order for integration of mitigation principles to become an organic part of the ongoing county, municipal, and local authority activities, the county will incorporate the distribution of the Safe Growth Worksheet (see subsection 7.1.2 and Table 7-2 below) for annual review and update by all participating jurisdictions.	September each year with interim email reminders to address integration in county, municipal, and local authority activities.	Sussex County HMP Coordinator and jurisdictional points of contact identified in Section 8 (Planning Partnership) and Section 9 (Jurisdictional Annexes)	HMP Coordinator
Evaluation	Review the status of previous actions as submitted by the monitoring task lead and support to assess the effectiveness of the plan (BATool^{SM} or manual); compile and finalize the Annual Progress Report	Finalized progress report completed by September of each year	Sussex County Steering Committee	Jurisdictional points of contacts identified in Section 9 (Jurisdictional Annexes)
Linkage	Non-participating jurisdictions requesting to 'link' into the plan need to complete procedures outlined in Appendix H	Notify the County HMP Coordinator by April and complete linkage package by September the same year	HMP Coordinator and non-participating jurisdiction	Steering Committee
Update	Reconvene the planning partners, at a minimum, every	Every 5 years or upon major update to	Sussex County HMP Coordinator	Jurisdictional points of contacts identified

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
	5 years to guide a comprehensive update to review and revise the plan.	Comprehensive Plan or major disaster		in Section 9 (Jurisdictional Annexes)

7.1 MONITORING EVALUATING AND UPDATING THE PLAN

The procedures for monitoring, evaluating, and updating the plan are provided below.

The HMP Coordinator is assigned to manage the maintenance and update of the plan during its performance period. The HMP Coordinator will chair the Planning Partnership (Steering Committee and municipal points of contact) and be the primary point of contact for questions regarding the plan and its implementation as well as to coordinate incorporation of additional information into the plan.

The Planning Partnership shall fulfill the monitoring, evaluation and updating responsibilities identified in this section which is comprised of a representative from each participating jurisdiction. Each jurisdiction is expected to maintain a representative on the Planning Partnership throughout the plan performance period (five years from the date of plan adoption). As of the date of this plan, primary and secondary mitigation planning representatives (points-of-contact) are identified in each jurisdictional annex in Section 9 (Jurisdictional Annexes).

Regarding the composition of the committee, it is recognized that individual commitments change over time, and it shall be the responsibility of each jurisdiction and its representatives to inform the HMP Coordinator of any changes in representation. The HMP Coordinator will strive to keep the committee makeup as a uniform representation of planning partners and stakeholders within the planning area.

Currently, the Sussex County HMP Coordinator is designated as:

Robert Haffner, Director
Sussex County Division of Emergency Management
135 Morris Turnpike, Newton, NJ 07860
973-579-0380

7.1.1 MONITORING

The Planning Partnership shall be responsible for monitoring progress on, and evaluating the effectiveness of, the plan, and documenting annual progress. Each year, beginning one year after plan development, Sussex County and local Planning Partnership representatives will collect and process information from the departments, agencies and organizations involved in implementing mitigation projects or activities identified in their jurisdictional annexes (Section 9) of this plan, by contacting persons responsible for initiating and/or overseeing the mitigation projects.

In the first year of the performance period, this will be accomplished by utilizing an online performance progress reporting system, the BATool^{SM} which will enable local and county representatives direct access to mitigation initiatives to easily update the status of each project, document successes or obstacles to implementation, add or delete projects to maintain mitigation project implementation. It is anticipated that all participating partners will be prompted by the tool to update progress on a quarterly basis, providing an incentive for participants to refresh their mitigation strategies and to continue implementation of projects. It is expected that this reporting system will support the submittal of an increased number of project grant fund applications due to the functionality of the system which facilitates the sorting and prioritization of projects.

In addition to progress on the implementation of mitigation actions, including efforts to obtain outside funding; and obstacles or impediments to implementation of actions, the information that Planning Partnership representatives shall be expected to document, as needed and appropriate include:

- Any grant applications filed on behalf of any of the participating jurisdictions (which may be documented in the BATool^{SM}),
- Hazard events and losses occurring in their jurisdiction,
- Additional mitigation actions believed to be appropriate and feasible (which may be documented in the BATool^{SM}),
- Public and stakeholder input.
- Plan monitoring for years 2 through 4 of the plan performance periods will be similarly addressed via the BATool^{SM} or manually.

7.1.2 INTEGRATION PROCESS OF THE HMP INTO PLANNING MECHANISMS

Hazard mitigation is sustained action taken to reduce or eliminate the long-term risk to human life and property from natural hazards. Integrating hazard mitigation into a jurisdiction's existing plans, policies, codes, and programs leads to development patterns that do no increase risk from known hazards or leads to redevelopment that reduces risk from known hazards. The Sussex County Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Refer to the Capability Assessments in Section 9 (Jurisdictional Annexes) for how this is done for each participating jurisdiction. During this process, many jurisdictions recognized the importance and benefits of incorporating hazard mitigation into future local planning and regulatory processes.

The Planning Partnership representatives will incorporate mitigation planning as an integral component of daily government operations. Planning Partnership representatives will work with their government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the jurisdiction governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

- Hazard mitigation planning will be formally recognized as an integral part of overall planning and emergency management efforts;
- The Hazard Mitigation Plan, Comprehensive Plans, Emergency Management Plans and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of residents.

During the HMP annual review process, each participating jurisdiction will be asked to document how they are utilizing and incorporating the Sussex County HMP into their day-to-day operations and planning and regulatory processes. Additionally, each jurisdiction will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report. The following checklist was adapted from FEMA's Local Mitigation Handbook (2013), Appendix A, Worksheet 4.2. This checklist will help a jurisdiction analyze how hazard mitigation is integrated into plans, ordinances, regulations, ordinances, and policies. By completing the checklist, it will help jurisdictions identify areas that integrate hazard mitigation currently and where to make improvements and reduce vulnerability to future development. In this manner, the integration of mitigation into activities will evolve into an ongoing culture within the county and all jurisdictions.

Table 7-2. Safe Growth Checklist

Planning Mechanisms	Do you do this? Yes	No	How is it being done or how will this be utilized in the future?
Operating, Local and Capital Improvement Program Budgets			
• When constructing upcoming budgets, hazard mitigation actions will be funded as budget allows. Construction projects will be evaluated to see if they meet the hazard mitigation goals.			
• Annually, the jurisdiction will review mitigation actions when allocating funding.			
• Do budgets limit expenditures on projects that would encourage development in areas vulnerable to natural hazards?			
• Do infrastructure policies limit extension of existing facilities and services that would encourage development in areas vulnerable to natural hazards?			
• Do budgets provide funding for hazard mitigation projects identified in the County HMP?			
Human Resource Manual			
• Do any job descriptions specifically include identifying and/or implementing mitigation projects/actions or other efforts to reduce natural hazard risk?			
Building and Zoning Ordinances			
• Prior to, zoning changes, or development permitting, the jurisdiction will review the hazard mitigation plan and other hazard analyses to ensure consistent and compatible land use.			
• Does the zoning ordinance discourage development or redevelopment within natural areas including wetlands, floodways, and floodplains?			
• Does it contain natural overlay zones that set conditions?			
• Does the ordinance require developers to take additional actions to mitigate natural hazard risk?			
• Do rezoning procedures recognize natural hazard areas as limits on zoning changes that allow greater intensity or density of use?			
• Do the ordinances prohibit development within, of filling of, wetlands, floodways, and floodplains?			
Subdivision Regulations			

Planning Mechanisms	Do you do this? Yes	No	How is it being done or how will this be utilized in the future?
• Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
• Do the subdivision regulations restrict the subdivision of land within or adjacent to natural hazard areas?			
• Do the regulations provide for conservation subdivisions or cluster subdivisions in order to conserve environmental resources?			
• Do the regulations allow density transfers where hazard areas exist?			
Comprehensive Plan			
• Are the goals and policies of the plan related to those of the County HMP?			
• Does the future land use map clearly identify natural hazard areas?			
• Do the land use policies discourage development or redevelopment with natural hazard areas?			
• Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Land Use			
• Does the future land use map clearly identify natural hazard areas?			
• Do the land use policies discourage development or redevelopment with natural hazard areas?			
• Does the plan provide adequate space for expected future growth in areas located outside natural hazard areas?			
Transportation Plan			
• Does the transportation plan limit access to hazard areas?			
• Is transportation policy used to guide growth to safe locations?			
• Are transportation systems designed to function under disaster conditions (e.g. evacuation)?			
Environmental Management			
• Are environmental systems that protect development from hazards identified and mapped?			
• Do environmental policies maintain and restore protective ecosystems?			
• Do environmental policies provide incentives to development that is located outside protective ecosystems?			
Grant Applications			

Planning Mechanisms	Do you do this? Yes	No	How is it being done or how will this be utilized in the future?
• Data and maps will be used as supporting documentation in grant applications.			
Ordinances			
• When updating ordinances, hazard mitigation will be a priority			
Economic Development			
• Local economic development group will take into account information regarding identified hazard areas when assisting new businesses in finding a location.			
Public Education and Outreach			
• Does the jurisdiction have any public outreach mechanisms / programs in place to inform citizens on natural hazards, risk, and ways to protect themselves during such events?			

7.1.3 EVALUATING

The evaluation of the mitigation plan is an assessment of whether the planning process and actions have been effective, if the HMP goals are being achieved, and whether changes are needed. The HMP will be evaluated on an annual basis to determine the effectiveness of the programs, and to reflect changes that could affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at an annual plan review meeting of the Planning Partnership, to be held either in person or via teleconference approximately one year from the date of local adoption of this update, and successively thereafter. At least two weeks before the annual plan review meeting, the Sussex County HMP Coordinator will advise Planning Partnership members of the meeting date, agenda and expectations of the members.

The Sussex County HMP Coordinator will be responsible for calling and coordinating the annual plan review meeting and soliciting input regarding progress toward meeting plan goals and objectives. These evaluations will assess whether:

- Goals and objectives address current and expected conditions.
- The nature or magnitude of the risks has changed.
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available.
- Actions were cost effective.
- Schedules and budgets are feasible.
- Implementation problems, such as technical, political, legal or coordination issues with other agencies are presents.
- Outcomes have occurred as expected.
- Changes in county or community resources impacted plan implementation (e.g., funding, personnel, and equipment)

- New agencies/departments/staff should be included, including other local governments as defined under 44 CFR 201.6. New agencies/departments/staff should be included, including other local governments as defined under 44 CFR 201.6.

Specifically, the Planning Partnership will review the mitigation goals, objectives, and activities using performance-based indicators, including:

- New agencies/departments
- Project completion
- Under/over spending
- Achievement of the goals and objectives
- Resource allocation
- Timeframes
- Budgets
- Lead/support agency commitment
- Resources
- Feasibility

Finally, the Planning Partnership will evaluate how other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions ("Implementation of Mitigation Plan through Existing Programs" subsection later in this section discusses this process). Other programs and policies can include those that address:

- Economic development
- Environmental preservation
- Historic preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use/zoning
- Public education and outreach
- Transportation

The Planning Partnership should refer to the evaluation forms, Worksheets #2 and #4 in the FEMA 386-4 guidance document, to assist in the evaluation process (see Appendix G – Plan Review Tools). Further, the Planning Partnership should refer to any process and plan review deliverables developed by the county or participating jurisdictions as a part of the plan review processes established for prior or existing local HMPs within the county.

The Sussex County HMP Coordinator shall be responsible for preparing an Annual HMP Progress Report for each year of the performance period, based on the information provided by the local Planning Partnership members, information presented at the annual Planning Partnership meeting, and other information as appropriate and relevant. These annual reports will provide data for the five-year update of this HMP and will assist in pinpointing any implementation challenges. By monitoring the implementation of the HMP on an annual basis, the Planning Partnership will be able to assess which projects are completed, which are no longer feasible, and what projects should require additional funding.

The Annual HMP Progress Report shall be posted on the Sussex County HMP website to keep the public apprised of the plan's implementation. Additionally, the website provides details on the HMP update planning process. For communities who might choose to join the NFIP CRS program, this report will also be provided to each CRS participating community in order to meet annual CRS recertification requirements. To meet this recertification timeline, the Planning Partnership will strive to complete the review process and prepare an Annual HMP Progress Report by September 30 of each year. (https://www.sussex.nj.us/cn/webpage.cfm?TPID=11091)

The HMP will also be evaluated and revised following any major disasters, to determine if the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in the Section 4.3 (Hazard Profiles) of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase the jurisdictions disaster resistance and build a better and stronger community.

7.1.4 UPDATING

44 CFR 201.6.d.3 requires that local hazard mitigation plans be reviewed, revised as appropriate, and resubmitted for approval in order to remain eligible for benefits awarded under DMA 2000. It is the intent of the Sussex County HMP Planning Partnership to update this plan on a five-year cycle from the date of initial plan adoption.

To facilitate the update process, the Sussex County HMP Coordinator, with support of the Planning Partnership, shall use the second annual Planning Partnership meeting to develop and commence the implementation of a detailed plan update program. The Sussex County HMP Coordinator shall invite representatives from NYS DHSES to this meeting to provide guidance on plan update procedures. This program shall, at a minimum, establish who shall be responsible for managing and completing the plan update effort, what needs to be included in the updated plan, and a detailed timeline with milestones to assure that the update is completed according to regulatory requirements.

At this meeting, the Planning Partnership shall determine what resources will be needed to complete the update. The Sussex County HMP Coordinator shall be responsible for assuring that needed resources are secured.

Following each five-year update of the mitigation plan, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all planning group members and the New York State Hazard Mitigation Officer.

7.1.5 GRANT MONITORING AND COORDINATION

Sussex County recognizes the importance of having an annual coordination period that helps each planning partner become aware of upcoming mitigation grant opportunities identifies multi-jurisdiction projects to pursue. Grant monitoring will be the responsibility of each planning partner as part of their annual progress reporting. The Sussex County HMP Coordinator will keep the planning partners apprised of Hazard Mitigation Assistance grant openings and assist in developing letters of intent for grant opportunities when practicable.

Sussex County intends to be a resource in the support of project grant writing and development. The degree of this support will depend on the level of assistance requested by the partnership during open windows for grant applications. As part of grant monitoring and coordination, Sussex County intends to provide the following:

- Notification to planning partners about impending grant opportunities.
- A current list of eligible, jurisdiction-specific projects for funding pursuit consideration.

- Notification about mitigation priorities for the fiscal year to assist the planning partners in the selection of appropriate projects.

Grant monitoring and coordination will be integrated into the annual progress report or as needed based on the availability of non-HMA or post-disaster funding opportunities.

7.2 IMPLEMENTATION OF MITIGATION PLAN THROUGH EXISTING PROGRAMS

Effective mitigation is achieved when hazard awareness and risk management approaches and strategies become an integral part of public activities and decision-making. Within the county there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate and coordinate with, and complement, those existing plans and programs.

The “Capability Assessment” section of Section 6 (Mitigation Strategy) provides a summary and description of the existing plans, programs and regulatory mechanisms at all levels of government (federal, state, county and local) that support hazard mitigation within the county. Within each jurisdictional annex in Section 9 (Jurisdictional Annexes), the County and each participating jurisdiction identified how they have integrated hazard risk management into their existing planning, regulatory and operational/administrative framework (“existing integration”), and how they intend to promote this integration (“opportunities for future integration”).

It is the intention of Planning Partnership representatives to incorporate mitigation planning as an integral component of daily government operations. Planning Partnership representatives will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (Appendix A) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Partnership anticipates that:

1. Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts;
2. The Hazard Mitigation Plan, Comprehensive Plans, Emergency Management Plans and other relevant planning mechanisms will become mutually supportive documents that work in concert to meet the goals and needs of county residents.

Other planning processes and programs to be coordinated with the recommendations of the hazard mitigation plan include the following:

- Emergency response plans
- Training and exercise of emergency response plans
- Debris management plans
- Recovery plans
- Capital improvement programs
- Municipal codes
- Community design guidelines
- Water-efficient landscape design guidelines
- Stormwater management programs
- Water system vulnerability assessments
- Community Wildfire Protection Plans
- Comprehensive Flood Hazard Management Plans

- Resiliency plans
- Community Development Block Grant-Disaster Recovery action plans
- Public information/education plans

Some action items do not need to be implemented through regulation. Instead, these items can be implemented through the creation of new educational programs, continued interagency coordination, or improved public participation.

During the annual plan evaluation process, the Planning Partnership representatives will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and include these findings and recommendations in the Annual HMP Progress Report.

7.3 CONTINUED PUBLIC INVOLVEMENT

Sussex County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. This HMP update will continue to be posted on-line (https://www.sussex.nj.us/cn/webpage.cfm?TPID=11091). In addition, public outreach and dissemination of the HMP will include:

- Links to the plan on jurisdiction websites of each jurisdiction with capability.
- Continued utilization of existing social media outlets (Facebook, Twitter) to inform the public of natural hazard events, such as floods and severe storms. Educate the public via the jurisdictional websites on how these applications can be used in an emergency situation.
- Development of annual articles or workshops on flood hazards to educate the public and keep them aware of the dangers of flooding.
- A new interactive website that features the plan, a complete hazard profile, stakeholder surveys, citizen surveys, public commentary and mitigation project submission

Planning Partnership representatives and the Sussex County HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the plan via the hazard mitigation website at any time. The HMP Coordinator will maintain this website, posting new information and maintaining an active link to collect public comments. The HMP Coordinator also intends to post the annual plan review report on the website and StoryMap.

The public can also provide input at the annual review meeting for the HMP and during the next five-year plan update. The Sussex County HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the five-year plan update as appropriate. Additional meetings might also be held as deemed necessary by the planning group. The purpose of these meeting would be to provide the public an opportunity to express concerns, opinions, and ideas about the mitigation plan.

The Planning Partnership representatives shall be responsible to assure that:

- Public comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- Copies of the latest approved plan (or draft in the case that the five-year update effort is underway) are available for review, along with instructions to facilitate public input and comment on the plan.
- Appropriate links to the Sussex County HMP website are included on jurisdiction websites.

- Public notices are made as appropriate to inform the public of the availability of the plan, particularly during plan update cycles.
- The Sussex County HMP Coordinator shall be responsible to assure that:
- Public and stakeholder comment and input on the plan, and hazard mitigation in general, are recorded and addressed, as appropriate.
- The Sussex County HMP website and StoryMap is maintained and updated as appropriate, including the posting of the annual plan review reports.
- Copies of the latest approved plan are available for review at appropriate county facilities along with instructions to facilitate public input and comment on the plan.

Public notices, including media releases, are made as appropriate to inform the public of the availability of the plan, particularly during plan update cycles.

ACRONYMS AND ABBREVIATIONS

%	Percent
ACOE	Army Corps of Engineers
ACS	American Community Survey
ADA	Americans with Disabilities Act
AICP	American Institute of Certified Planners
ANSS	Advanced National Seismic System
APA	Approval Pending Adoption
ARC	American Red Cross
ASCE	American Society of Civil Engineers
B	Borough
BCA	Benefit Cost Analysis
BCEGS	Building Code Effectiveness Grading Schedule
BFE	Base Flood Elevation
BOCA	Building Officials Code Administration
CAV	Community Assistance Visit
CDBG	Community Development Block Grant
CDBG-DR	Community Development Block Grant Disaster Recovery
CDC	Centers for Disease Control and Prevention
CDMS	Comprehensive Data Management System
CFR	Code of Federal Regulations
CIP	Capital Improvement Plan

COOP/COG	Continuity of Operations/Continuity of Government
CPC	Climate Prediction Center
CRS	Community Rating System
DEM	Division of Emergency Management
DFIRM	Digital Flood Insurance Rate Map
DHS	Department of Homeland Security
DMA 2000	Disaster Mitigation Act of 2000
DOT	Department of Transportation
DPW	Department of Public Works
DR	Major Disaster Declaration (FEMA)
EF	Enhanced Fujita Scale
EM	Emergency Declaration (FEMA)
EM	Emergency Management
EMS	Emergency Medical Services
EOC	Emergency Operation Center
EOP	Emergency Operation Plan
EPA	Environmental Protection Agency
ESF	Emergency Support Function
ESRI	Environmental Systems Research Institute
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FIRM	Flood Insurance Rate Map
FIA	Flood Insurance Administration

FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance
FPA	Floodplain Administrator
FY	Fiscal Year
GIS	Geographic Information System
HAZMAT	Hazardous Materials
HAZUS	Hazards U.S.
HAZUS-MH	Hazards U.S. Multi-Hazard
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HUC	Hydrologic Unit
HUD	U.S. Department of Housing and Urban Development
HVAC	Heating, Ventilation, and Air Conditioning
I	Interstate
IA	Individual Assistance
ICS	National Incident Command System
ISO	Insurance Service Organization
IT	Information Technology
LEPC	Local Emergency Planning Committee
LOMR	Letter of Map Revision
LOIP	Letter of Intent to Participate
MGD	Million Gallons per Day

Mi	Mile
MMI	Modified Mercalli Intensity Scale
Mph	Miles per Hour
MRP	Mean Return Period
N/A	Not Applicable
NA	Not Available
NASA	National Aeronautics and Space Administration
NCDC	National Climate Data Center
NCEI	National Centers for Environmental Information
NDMC	National Drought Mitigation Center
NEHRP	National Earthquake Hazard Reductions Program
NESIS	Northeast Snowfall Impact Scale
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NGVD	National Geodetic Vertical Datum
NHC	National Hurricane Center
NID	National Inventory of Dams
NIMS	National Incident Management System
NJ	New Jersey
NJDEP	New Jersey Department of Environmental Protection
NJGS	New Jersey Geological Survey
NJOEM	New Jersey Office of Emergency Management
NJTPA	North Jersey Transportation Planning Authority

NOAA	National Oceanic and Atmospheric Administration
NPDP	National Performance of Dams Program
NRCC	Northeast Regional Climate Center
NRCS	Natural Resources Conservation Service
NSIDC	National Snow and Ice Data Center
NSSL	National Severe Storms Library
NWIS	National Water Information System
NWS	National Weather Service
OEM	Office of Emergency Management
ONJSC	Office of the New Jersey State Climatologist
PA	Public Assistance
PCII	Protected Critical Infrastructure Information
PDM	Pre-Disaster Mitigation Program
PDSI	Palmer Drought Severity Index
PE	Professional Engineer
PGA	Peak Ground Acceleration
POC	Point of Contact
RCV	Replacement Cost Value
RL	Repetitive Loss
RSI	Regional Snowfall Index
RTE	Route
SBA	Small Business Administration
SC	Steering Committee

SF	Square Feet
SFHA	Special Flood Hazard Area
SPC	Storm Prediction Center
Sq. Mi.	Square mile
SRL	Severe Repetitive Loss
STAPLEE	Social, Technical, Administrative, Political, Legal, Economic, Environmental
SWMP	Storm Water Management Plan
SWOO	Strengths, Weaknesses, Obstacles and Opportunities
T	Township or Town
TBD	To Be Determined
TS	Tropical Storm
UASI	Urban Areas Security Initiative
USACE	U.S. Army Corps of Engineers
USD	U.S. Dollar
USDA	U.S. Department of Agriculture
USDM	U.S. Drought Monitor
USDOT	U.S. Department of Transportation
USEDA	U.S. Economic Development Administration
USEPA	U.S. Environmental Protection Agency
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geologic Survey
VA	Vulnerability Assessment

WMA	Watershed Management Area
WUI	Wildland Urban Interface

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