Volume I

County of Essex
All Hazard Mitigation Plan
2020 Update

Prepared for:

Essex County Sheriff's Office
Essex County Office of Emergency Management
Sheriff Armando B. Fontoura, Sheriff

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Essex County
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FEBRUARY 2020

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SECTION 1. INTRODUCTION

1.1 BACKGROUND

In response to the requirements of the Disaster Mitigation Act of 2000 (DMA 2000), Essex County and the jurisdictions located therein have developed this Hazard Mitigation Plan (HMP), which represents a regulatory update to the *2015 Essex County All 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), also supports plan development for jurisdictions in New Jersey.

> ***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.*

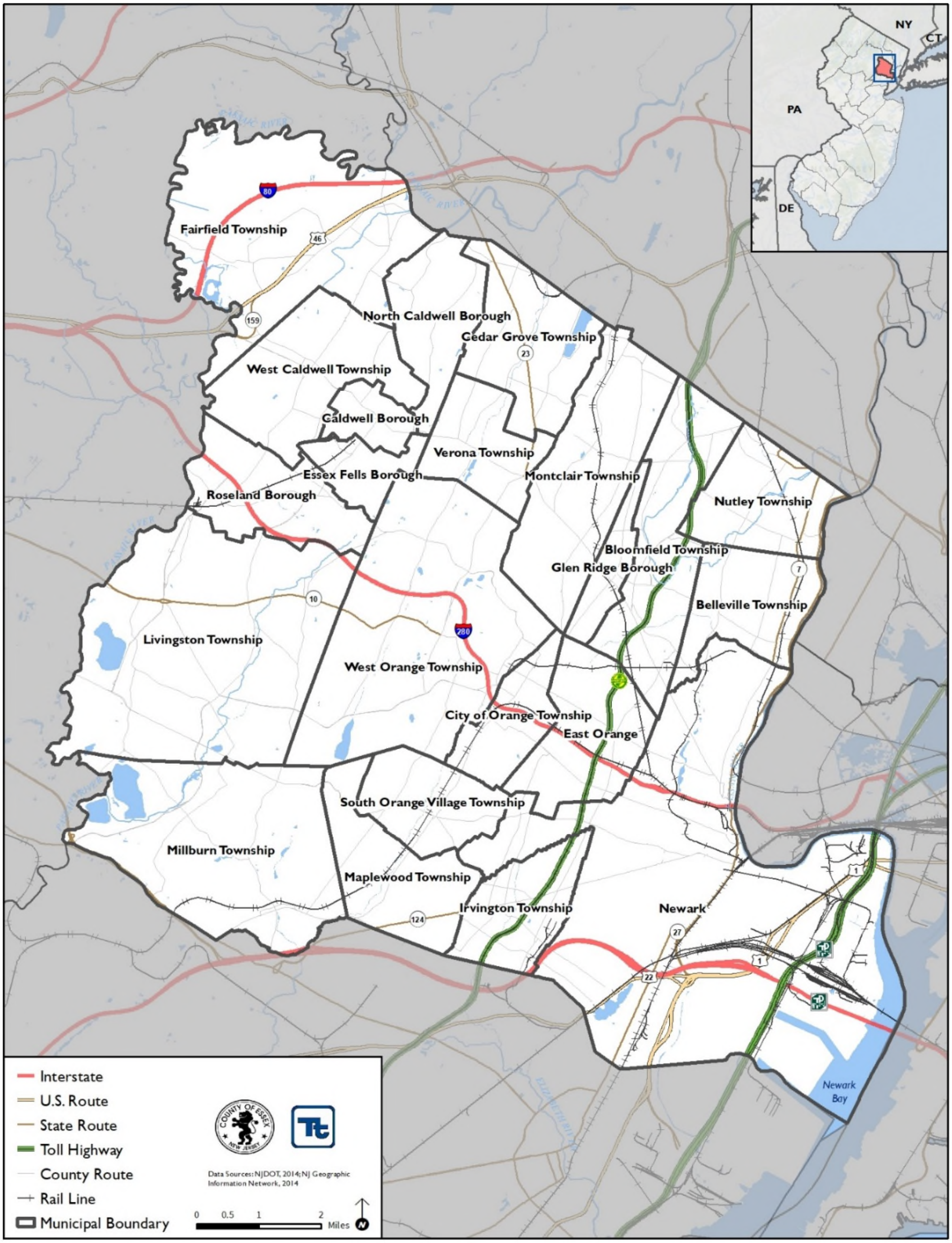
Specifically, the DMA 2000 requires that states, with support from local governmental agencies, develop and update HMPs on a five-year basis to prepare for and reduce the potential impacts of natural hazards. The DMA 2000 is intended to facilitate cooperation between state and local authorities, prompting 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.

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

Table 1-1. Participating Essex County Jurisdictions

Townships	
Belleville	Millburn
Bloomfield	Montclair
Cedar Grove	Nutley
Fairfield	South Orange
Irvington	Verona
Livingston	West Caldwell
Maplewood	West Orange
Boroughs	**Cities**
Caldwell	East Orange
Essex Fells	Orange
Glen Ridge	Newark
North Caldwell	**County**
Roseland	Essex County

Figure 1-1. Essex County New Jersey Planning Area



1.1.1 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.

1.1.2 Benefits of Mitigation Planning

Mitigation planning forms the foundation for Essex County's long-term strategy to reduce disaster losses and break the cycle of disaster damage, reconstruction, and repeated damage. Mitigation planning also allows Essex County, as a whole and with 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 Essex 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.

1.1.3 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 regulations and guidance:

- 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. Essex County Hazard Mitigation Planning Process

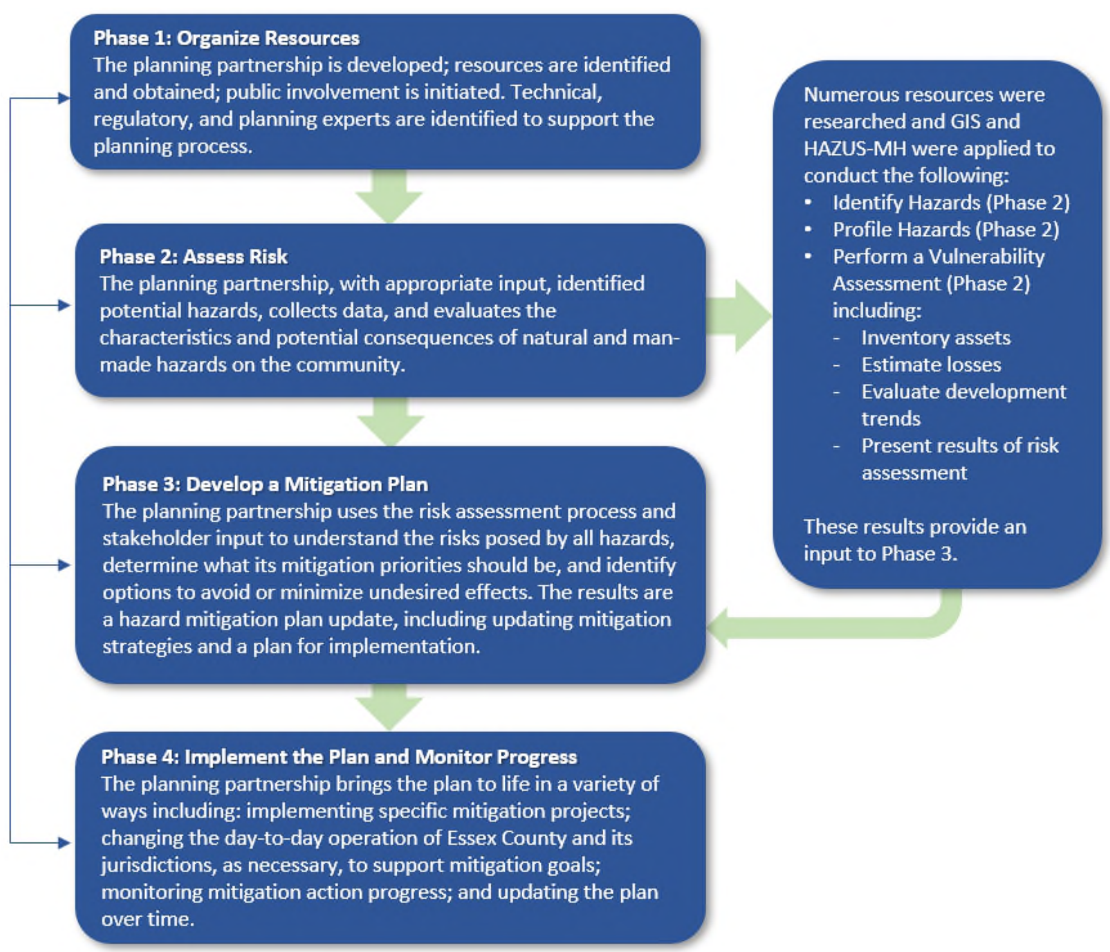


Table 1-2. FEMA Local Mitigation Plan Review Crosswalk

HMP Criteria	Primary Location in the HMP
Prerequisites	
Adoption by the Local Governing Body: §201.6(c)(5)	Section 1.0; Appendix A
Planning Process	
Documentation of the Planning Process: §201.6(b) and §201.6(c)(1)	Section 2.0; Section 8.0
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 3.0, 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 3.0; Section 4.3; Section 9
Mitigation Strategy	
Local Hazard Mitigation Goals: §201.6(c)(3)(i)	Section 6.0; Section 9
Identification and Analysis of Mitigation Actions: §201.6(c)(3)(ii)	Section 6.0; Section 9
Implementation of Mitigation Actions: §201.6(c)(3)(iii)	Section 6.0; Section 9
Multi-Jurisdictional Mitigation Actions: §201.6(c)(3)(iv)	Section 6.0; Section 9
Plan Maintenance Process	
Monitoring, Evaluating, and Updating the Plan: §201.6(c)(4)(i)	Section 7.0
Incorporation into Existing Planning Mechanisms: §201.6(c)(4)(ii)	Section 6.0, 7.0; Section 9
Continued Public Involvement: §201.6(c)(4)(iii)	Section 7.0

1.2 Planning Process Overview

Essex County and the participating jurisdictions 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).

1.2.1 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 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***

The Essex County Sheriff's Office 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 Floodplain Administrator and requested their involvement. Further, each jurisdiction was encouraged to form a 'mitigation team' comprised of representatives across municipal departments to ensure broad participation, share the work of the update process and ensure accurate information was captured in their chapter, or annex. The mitigation team worked directly with the primary and alternate POCs 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 Essex County HMP update. A list of Steering Committee and municipal POCs is provided in Section 2 (Planning Process), while Appendix B (Participation Documentation) provides 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 involvement (as discussed in Section 2).

1.2.2 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 New Jersey HMP, as well as other relevant county and local planning documents, as discussed in Section 6 (Mitigation Strategy).

1.2.3 Hazards of Concern

Essex County and participating jurisdictions reviewed the hazards that caused measurable impacts based on events, losses, and information available since the development of the 2015 Essex County HMP and the 2019 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 2020 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.

1.2.4 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 (FEMA 2015).

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 Essex County, there are numerous existing plans and programs that support hazard risk management and reduction, and thus, it is critical that the 2020 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).

1.2.5 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 2015 Essex 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.

1.2.6 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, Essex County and the participating jurisdictions have accomplished the following:

- Developed a Steering Committee and countywide planning partnership with jurisdictions and stakeholders.
- Reviewed the 2015 Essex County All Hazard Mitigation Plan.
- Identified and reviewed those hazards that are of greatest concern to Essex 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 mission statement, goals and objectives.
- Reviewed mitigation strategies identified in the 2015 Essex 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, Essex County and its participating jurisdictions have informed the public and provided opportunities for public comment and input. Numerous agencies and stakeholders have participated as core or support members by providing input and expertise throughout the planning process. Refer to Appendix D (Public and Stakeholder Outreach Documentation) for copies of public service announcements, social media posts and other forms of public and stakeholder outreach conducted.

1.2.7 Adoption

Upon FEMA Approval Pending Adoption (APA) status of the 2020 HMP update, Essex County and each municipality will adopt the plan by resolution of local governing body. An example resolution to be submitted authorizing adoption of the 2020 Essex County All Hazard Mitigation Plan. The Essex County and municipal adoption resolutions will be included in Appendix A upon receipt of the FEMA APA status. Please refer to Section 8 (Planning Partnership) for additional information on plan adoption procedures.

1.3 Organization of the Hazard Mitigation Plan

The Essex 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 Essex 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 Essex County, including: (1) physical setting, (2) land use, (3) land use trends, (4) population and demographics, (5) general building stock and (6) critical facilities.

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); description of the status of local data; and planned steps to improve local data to support mitigation planning.

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 mission statement, goals and objectives in response to priority hazards of concern and the process by which Essex 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 Essex County and each participating jurisdiction containing their hazards of concern, hazard ranking, capability assessment, mitigation actions, action prioritization specific only to Essex 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), annex sign-off sheets discussed in Section 6 (Mitigation Strategy) and additional worksheets submitted during workshops conducted throughout the planning process.

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

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

Appendix E: Risk Assessment Supplementary Data: Critical facility list, hazard ranking worksheets and vulnerability assessments conducted for the hazards of concern from Section 4 (Risk Assessment).

Appendix F: Mitigation Strategy Supplementary Data: Documentation of the broad range of actions identified during the mitigation process.

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

Appendix H: Linkage Procedures: Outlines the procedures to include non-participating local governments in the plan in the future.

1.4 The Updated Plan – What is Different?

Both the planning process and the 2020 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. Further, the sections in the 2020 HMP have been realigned to increase the readability of the plan. The following summarizes process and plan changes that differ from the 2015 process and HMP:

- Section 2 (Planning Process) was formerly Section 3 in the 2015 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 5 (Capability Assessment) and Section 9 (Jurisdictional Annexes) are subject to several changes of 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 2015 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.
- 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.
    - Inclusion of a table of jurisdiction-specific risk assessment results per hazard.
    - 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 2015 previous mitigation strategy status table to more clearly identify if the action is to be included in the 2020 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.
    - Mitigation action worksheets have only been developed for FEMA-eligible projects, per NJOEM guidance.
- Newly available data provided for a more detailed and accurate risk assessment.
    - The updated plan is based on new inventory data and hazard data.
    - The topic of FEMA lifelines is included. All jurisdictions identified critical facilities considered lifelines in accordance with FEMA's definition.
    - The flood hazard was expanded to include urban flooding or flooding outside of the floodplain. The Planning Partnership identified locations of urban flooding which was developed into a spatial layer to inform the mitigation strategy.
    - A repetitive loss area analysis was conducted to assist with the identification of areas of repetitive flooding.
- Focused stakeholder engagement sessions that involved utility, transportation and green infrastructure/climate change stakeholders to inform the risk assessment, capability assessment and mitigation strategy.
- To increase public engagement, the following efforts were made:
    - Multi-lingual public outreach strategy (English, Spanish and Portuguese) to reach a broader audience in the County (informational materials, social media posts and translator at a public engagement event).
    - 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.
    - Additional public engagement was provided in the form of an outreach booth at the Essex County Senior Wellness event where representatives distributed mitigation information and offered interactive activities to collect resident feedback (e.g., short surveys and a 'vote' for preferred mitigation action types to be implemented in the County).
- A grant-funding webinar was conducted to summarize the upcoming fiscal year 2019 FEMA Hazard Mitigation Assistance grant funding opportunity and how jurisdictions can leverage the HMP update and

develop competitive applications and benefit-cost analyses. In addition, the planning consultant and NJOEM met with individual municipalities that expressed interest in applying to assist with identifying projects and providing guidance on the information needed to complete the grant application and BCA process.

- 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.
    - 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 indicates the major changes between the two plans as they relate to 44 CFR planning requirements.

Table 1-3. HMP Changes Crosswalk

44 CFR Requirement	2015 HMP	2020 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 2015 plan followed an outreach strategy utilizing multiple media developed and approved by the Steering Committee. This strategy involved the following: • Public participation on an oversight Steering Committee. • Establishment of a plan informational website. • Press releases. • 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 2015 plan, the 2020 planning effort deployed an enhanced public engagement methodology: • Multi-lingual informational materials and news release • Use of social media. • Web-deployed survey • All meetings open to the public • Attending a well-trafficked County event to engage residents • Stakeholder focus group sessions were held As with the 2015 plan, the 2020 planning process identified key stakeholders and coordinated with them throughout the process. 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 2015 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.	The same methodology, using new, updated data, was deployed for the 2020 plan update. A new hazard, economic collapse was included, and the flood hazard was expanded to include urban flooding (or flooding outside of the floodplain). 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).

44 CFR Requirement	2015 HMP	2020 Updated HMP
§201.6(c)(2)(i): [The risk assessment] shall include a] description of the … location and extent of all-natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.	The 2015 plan presented a risk assessment of each hazard of concern. Each section included the following: • 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.	The same format, using new and updated data, was used for the 2020 plan update. Each section of the risk assessment includes the following: • 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 2015 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 coastal storm, 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.	The same methodology was deployed for the 2020 plan update, using new and updated data. Additional hazards of concern include the following: • Economic Collapse • Expansion of the flood hazard to include urban flooding
§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.	The same methodology was deployed for the 2020 plan update using new and updated data. In addition, to assist with the identification of repetitive flooding areas, a repetitive loss area analysis was conducted.
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.	The same methodology was deployed for the 2020 plan update using new and updated data. In addition, all jurisdictions identified which critical facilities are considered lifelines in accordance with FEMA's definition.
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 coastal storm, 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	The same methodology was deployed for the 2020 plan update using new and updated data.

44 CFR Requirement	2015 HMP	2020 Updated HMP
	was the same for all hazards and was generated in HAZUS-MH.	
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.	The same methodology was deployed for the 2020 plan update using new and updated data. If available, mitigation measures being considered for new development identified in hazard areas is noted in Section 9 (Jurisdictional Annexes).
§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 2015 plan contained a mission statement, 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 same methodology to review the mission statement, goals and objectives, and actions was applied to the 2020 plan update. The Steering Committee reviewed and reconfirmed the mission statement, 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 capabilities were moved to the capability and integration sections. The balance of the actions was carried over to the 2020 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 a mission statement, goals, and objectives targeted specifically for this hazard mitigation plan. These planning components supported the actions identified in the plan.	The same methodology to review the mission statement, goals and objectives, and actions was applied to the 2020 plan update. The Steering Committee reviewed and reconfirmed the mission statement, goals, and objectives and they were approved by the Planning Committee.
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 2015 plan included mitigation action worksheets that evaluated alternative actions considered for the final mitigation strategy.	For the 2020 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 was used in jurisdictional annexes to the plan.
Requirement: §201.6(c)(3)(ii): [The mitigation strategy] must also address the jurisdiction's participation in the National Flood Insurance Program, and continued compliance with the program's requirements, as appropriate.	All municipal planning partners that participate in the National Flood Insurance Program indicated their commitment to maintain compliance and good standing under the program.	The same methodology was deployed for the 2020 plan update, using new and updated data. 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	Each recommended action was prioritized using a revised methodology based on the STAPLEE criteria was used to prioritize projects.	A revised methodology based on the STAPLEE criteria and using new and updated data was used for the 2020 plan update.

44 CFR Requirement	2015 HMP	2020 Updated HMP
review of the proposed projects and their associated costs.		
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 2015 plan outlined a detailed maintenance strategy.	The 2020 plan details a plan maintenance strategy similar to that of the initial plan. It has been enhanced to provide a roadmap for the annual monitoring of the plan. 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 2015 plan details recommendations for incorporating the plan into other planning mechanisms.	The 2020 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 2015 plan details a strategy for continuing public involvement.	The 2015 plan maintenance strategy was enhanced for the 2020 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 plan (e.g., City Council, County Commissioner, Tribal Council).	Essex County and all municipalities participated in the 2015 HMP.	The 2020 plan achieves DMA compliance for Essex County and all municipalities. Resolutions for each partner adopting the plan can be found in Appendix A of this volume.

SECTION 2. PLANNING PROCESS

2020 HMP Changes

- The sections in the 2020 HMP were realigned to increase the readability of the plan. Section 2 (formerly Section 3 in the 2015 HMP) now comprises the Planning Process section of the plan.
- All aspects of the planning process were updated for the 2020 HMP.
- Public outreach was enhanced to reach a broader audience by using additional medial outlines (Facebook, Twitter), attending already-scheduled County events, and having multi-lingual materials (brochure, social media posts) and a translator at a public meeting.
- Stakeholder outreach was enhanced by holding sector-specific focus group sessions to obtain a comprehensive understanding of capabilities, vulnerabilities, and potential mitigation projects.
- Workshop-style meetings were held with the Planning Partnership to engage participants, using small break-out groups and large-scale poster maps to convey hazard vulnerability and assist with hazard ranking updates.

2.1 INTRODUCTION

This section includes a description of the planning process used to update the 2015 Essex County All Hazard Mitigation Plan (HMP), including how it was prepared, who was involved in the process, and how stakeholders and the public were 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. Essex County invited all municipalities in the County to join with them in the preparation of the Essex County All Hazard Mitigation Plan. Essex County and all its municipalities are participating in the HMP.

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

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

The Essex 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 municipal 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, described in subsection 2.2 below, 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) Integration of Existing Data, Plans, and Technical Information; (4) Integration with Existing Planning Mechanisms and Programs; and (5) Continued Public Involvement.

2.2 ORGANIZATION OF THE PLANNING PROCESS

Many parties supported the preparation of this HMP update: County officials, municipal officials, stakeholders, and consultants. This planning process does not represent the start of hazard risk management in Essex 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 a historical perspective of the county and local activities implemented to reduce vulnerablity to hazards in the planning area.

This section of the HMP identifies 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 Essex County Sherriff's Office led the update to the 2015 Essex County Hazards Mitigation Plan. Essex County was notified by NJOEM that their application for a planning grant to update their 2015 Hazard Mitigation Plan under FEMA's Hazard Mitigation Grant Program (PDMC-PL-02-NJ-2016-002) was approved. 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 May 2019. Specifically, Tetra Tech, the "contract consultant", was tasked with the following:

- 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 June 2019, Essex County's Office of Emergency Management notified the 22 municipalities of Essex 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 22 municipalities returned their Letter of Intent to Participate. Appendix B also provides copies of their LOIPs.

> ***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***

To facilitate HMP development, Essex County developed a Steering Committee to provide guidance and direction to the HMP update 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 the following:

- Providing guidance and overseeing the planning process on behalf of the general planning partnership.
- Attending and participating in Steering Committee meetings.
- Assisting with the development and completion of certain planning elements, including the following:
  - Identification of "Hazards of Concern."
  - Public and Stakeholder Outreach.
  - Mitigation Planning Goals and Objectives.
  - Identification and screening of appropriate mitigation strategies and activities.
  - Reviewing and commenting on plan documents prior to submission to NJOEM and FEMA.

The organizational structure was successfully implemented for the 2020 HMP updated consistent with the development of the initial 2015 planning process; new Steering Committee members included representatives from the Townships of Belleville and Millburn (see Table 2-1). 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.

Table 2-1. Essex County Hazard Mitigation Steering Committee Members

Name	Title
Joseph DiVincenzo	County Executive
Armando Fontoura	Sheriff/County OEM Coordinator
Theodore Stephens, Esq	County Prosecutor
Mitchell McGuire	Chief of Detectives
Amir Jones	Undersheriff/Deputy OEM Coordinator
Michael Capodanno	Director of Homeland Security
Robert Jackson, AB, MBA	County Administrator
Julias Coltre, QPA	Deputy County Administrator
Darryl Johnson	Haz Mat/Bomb Technician
Edward Esposito, CEM	Essex County Sheriff's Office/Communications
Ryan Peter	EMS and Preparedness
Stephanie Knox, CEM	Essex County OEM/Planning/CERT
David Antonio	County DPW-Planner
Darren Marshall	IT/GIS Coordinator
Luis E. Rodriguez, PE	Supervising Engineer, DPW
Sanjeev Varghese, PE	County Floodplain Administrator

Name	Title
Jerry Grande	Director of County Roads and Bridges
Robert Echavarria, CEM	Millburn Municipal OEM/Fire Chief
Juba Dowdell, CPM	Newark Municipal OEM/Deputy Coordinator
William Smith	Fairfield Municipal OEM/Fire Marshal
Tim Walker	County Risk Manager
Anthony Puglisi	Public Information Officer
Kevin Lynch	Public Information Officer
Carrie Nawrocki, PHO	Essex Regional Health
Daniel Salvante	Director of Parks Department
Captain Nick Breiner	Township of Belleville Police Captain/Deputy Municipal OEM

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. Table 2-2 lists the current municipal members of the Planning Partnership (Steering Committee and Planning Committee), at the time of this HMP's publication. Please note that while Steering Committee members are also part of the overall project Planning Partnership fulfilling these responsibilities on behalf of Essex County. The Planning Partnership was charged with the following:

- Represent their jurisdiction throughout the planning process.
- Assure participation of all department and functions within their jurisdiction that have a stake in mitigation (e.g., planning, engineering, code enforcement, police and emergency services, public works).
- Assist in gathering information for inclusion in the HMP update, including the use of previously developed reports and data.
- Support and promote the public involvement process.
- Report on progress of mitigation actions identified in prior or existing HMPs, as applicable.
- Identify, develop, and prioritize appropriate mitigation initiatives.
- Report on progress of integration of prior or existing HMPs into other planning processes and municipal operations.
- Support and develop a jurisdictional annex for their jurisdiction.
- Review, amend, and approve all sections of the plan update.
- Adopt, implement, and maintain the plan update.

The Planning Committee was charged with the following:

- Represent their jurisdiction throughout the planning process;
- Establish plan development goals;
- Establish a timeline for completion of the plan;
- Ensure that the plan meets the requirements of DMA 2000 and FEMA and NJOEM guidance;
- Solicit and encourage the participation of regional agencies, a range of stakeholders, and citizens in the plan development process;
- Assist in gathering information for inclusion in the plan, including the use of previously developed reports and data;
- Organize and oversee the public involvement process;
- Involve your local NFIP Floodplain Administrator in the planning process.
- Report on progress of 2015 HMP mitigation actions;
- Identify, develop and prioritize appropriate mitigation initiatives;
- Report on progress of 2015 HMP integration into other planning processes and municipal operations;
- Review, amend and approve all sections of the plan;
- Develop and author the jurisdictional annex for their jurisdiction;
- Develop, revise, adopt, and maintain the plan.

Table 2-2. Essex County Hazard Mitigation Planning Partnership Members

Jurisdiction	Name	Title	Steering Committee Member
Essex County	Edward Esposito	Captain	X (also Primary POC for County)
	Sanjeev Varghese	Public Works Director and County Engineer	X (also Secondary POC for County)
	Joseph DiVincenzo	County Executive	X
	Armando Fontoura	Sheriff/County OEM Coordinator	X
	Theodore Stephens, Esq	County Prosecutor	X
	Mitchell McGuire	Chief of Detectives	X
	Amir Jones	Undersheriff/Deputy OEM Coordinator	X
	Michael Capodanno	Director of Homeland Security	X
	Robert Jackson, AB, MBA	County Administrator	X
	Julias Coltre, QPA	Deputy County Administrator	X
	Darryl Johnson	Haz Mat/Bomb Technician	X
	Ryan Peter	EMS and Preparedness	X
	Stephanie Knox, CEM	Essex County OEM/Planning/CERT	X
	David Antonio	County DPW-Planner	X
	Darren Marshall	IT/GIS Coordinator	X
	Luis E. Rodriguez, PE	Supervising Engineer, DPW	X
	Jerry Grande	Director of County Roads and Bridges	X
	Tim Walker	County Risk Manager	X
	Anthony Puglisi	Public Information Officer	X
	Kevin Lynch	Public Information Officer	X

Jurisdiction	Name	Title	Steering Committee Member
	Carrie Nawrocki, PHO	Essex Regional Health	X
	Daniel Salvante	Director of Parks Department	X

Jurisdiction	Municipal Primary Point of Contact	Title	Municipal Alternate Point of Contact	Title
Township of Belleville	Martin Lutz	Deputy Fire Chief/OEM Coordinator	Nick Breiner	Deputy Coordinator/Police Department
Township of Bloomfield	Fred Menzel	OEM Coordinator	Thomas Pelaia	Deputy OEM Coordinator
Borough of Caldwell	Mark Guiliano	Emergency Management Coordinator	Brian Maclay	Deputy Emergency Management Coordinator
Township of Cedar Grove	Jeffrey McElroy	OEM Coordinator	John D-Ascensio	Deputy OEM Coordinator
City of East Orange	Salomon Steplight	OEM Coordinator	David Williams	OEM Deputy Coordinator
Borough of Essex Fells	James Egan	E.M. Coordinator	Sgt. John R Schmunk	Deputy EM Coordinator
Township of Fairfield	William Smith	OEM Coordinator	Steve Bury	Engineer
Borough of Glen Ridge	Michael Rohal	Borough Administration / Engineer / Clerk/ OEM Coordinator	Michael Zichelli	Deputy Administrator / Director of Planning
Township of Irvington	John F Brown	OEM Coordinator	Antonio Gary	Fire Chief/Deputy Coordinator
Township of Livingston	Christopher C. Mullin	Fire Chief, Fire Official, OEM Coordinator	Rossana Mattia	Administrative Assistant to the Fire Chief
Township of Maplewood	Sonia Viveiros	Business Administrator	Jim DeVaul	Chief Police
Township of Millburn	Captain Chris Beady	OEM Coordinator, Milburn Fire	Alex McDonald	Deputy Coordinator, Business Administrator
Township of Montclair	Rob Bianco	Emergency Management Coordinator, Department of Community Services	John Herrmann	Fire Chief/DEMC
City of Newark	Dorian Herrell	OEM Coordinator	Juba Dowdell	OEM Deputy Coordinator
Borough of North Caldwell	Kevin O'Sullivan	Borough Administrator	John D'Ascensio	OEM Coordinator
Township of Nutley	Salvatore Ferraro	Engineering / DPW	William Cassidy	OEM Coordinator
City of Orange Township	Raymond Wingfield	Assistant Director DPW/OEM Coordinator	Elvin Padilla Jr.	Fire Captain/OEM Deputy Coordinator
Borough of Roseland	Tom Jacobsen	Construction Official	Gary Schall	Superintendent DPW
Township of South Orange Village	Adam D. Loehner	Village Administrator	Salvatore Renda	Village Engineer
Township of Verona	Joel Martin	OEM Coordinator, Police Department	Chris Kiernan	Police Chief
Township of West Caldwell	Larry Peter	Emergency Management Coordinator	John Medina	Deputy Emergency Management Coordinator
Township of West Orange	Dominic Allegrino	OEM Coordinator	Leonard Lepore	Director, Municipal Engineer

DPW = Department of Public Works
POC = Point of Contact as identified in the Letters of Intent to Participate and Jurisdictional Annexes (Section 9)
OEM = Office of Emergency Management

The jurisdictional Letter of Intent to Participate identifies the above “Planning Partner Expectations” as serving to identify those activities comprising overall participation by jurisdictions throughout the planning process. The jurisdictions in Essex 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 HMP. Essex County's intent was to encourage participation by all-inclusive municipalities, 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 municipalities 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). All known 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.

Exhibit 2-1. September 19, 2019 Risk Assessment Meeting

A summary of committee meetings (Steering Committee and Planning Partnership) meetings 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 (County and municipal) 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 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 Planning Outreach

Date	Activity/DMA 2000 Requirement	Key Outcomes/Purpose*	Participants*
June 11, 2019	2	Project Management Kickoff Meeting	Essex County Sheriff's Office/OEM; Tetra Tech
June 20, 2019	1b, 2	Municipal OEM Coordinators Meeting *[Announced commencement of HMP update and distributed the LOIPs]*	Essex County Sheriff's Office/OEM; Municipal OEM Coordinators
July 18, 2019	1b, 2, 3a, 4a	Planning Partnership (Steering Committee and Planning Committee) Kickoff Meeting – open to the public *[Review of 2015 HMP; Data Collection; Review of Mission Statement, Goals, and Objectives; Hazards of Concern Identification; Public Outreach Strategy; Participation Requirements]*	Essex County: Sheriff's Office, OEM, Public Information Officer – County Executive's Office, Public Information Director, Office of the Mental Health Administrator NJOEM – Mitigation Unit JCP&L Municipalities: Belleville (T); Bloomfield (T); Caldwell (B); Cedar Grove (T); East Orange (C); Essex Fells; Fairfield (T); Glen Ridge (B); Irvington (T); Livingston (T); Maplewood (T); Millburn (T); Montclair (T); North Caldwell (B); Newark (C); Nutley (T); Orange (C); Roseland (B); South Orange (T); Verona (T); West Caldwell (T); West Orange (T) Tetra Tech
July and August 2019	2, 3b, 3c, 3e, 4a, 4b, 4c	Local Support Meetings	Belleville (T); Bloomfield (T); Caldwell (B); Cedar Grove (T); Essex Fells; Fairfield (T); Glen Ridge (B); Irvington (T); Livingston (T); Maplewood (T); Millburn (T); Montclair (T); North Caldwell (B); Nutley (T);; Roseland (B); South Orange (T); Verona (T); West Caldwell (T); West Orange (T); Tetra Tech
August 27, 2019	1b, 2, 4a, 4b	Steering Committee Meeting *[Review Steering Committee guidelines, Review goals, County annex update, Public and stakeholder outreach; Schedule upcoming meetings]*	Essex County Sheriff's Office; Essex County Department of Public Works; Essex Regional Health Commission; Belleville (T); Fairfield (T); Millburn (T); Tetra Tech
September 11, 2019	2, 3d	Steering Committee Outreach *[Updated hazard ranking methodology and draft Essex County hazard ranking and draft risk assessment results*	Essex County: County Executive; County Administrator; Sheriff's Office (Law Enforcement Services, Homeland Security, OEM, IT/GIS; Haz Mat); Prosecutor's Office; Department of Public Works (Engineering, Planning, Roads and Bridges); Risk Manager; Public Information; Department of Parks, Recreation and Cultural Affairs; Essex Regional Health Commission; Belleville (T); Fairfield (T); Millburn; Newark (C) Tetra Tech

Table 2-3. Summary of Planning Outreach

Date	Activity/DMA 2000 Requirement	Key Outcomes/Purpose*	Participants*
		distributed via email for review and comment]	
September 12, 2019	1b, 2	Municipal OEM Coordinators Meeting *[Public outreach; Upcoming meetings and importance of participation]*	Essex County Sheriff's Office/OEM; Municipal OEM Coordinators
September 19, 2019	2, 3b, 3c, 3e, 4a, 4b, 4c	Local Support Meetings	East Orange (C); Orange (C); Newark (C); Tetra Tech
September 19, 2019	1b, 2, 3a, 3b, 3c, 3d, 3e	Planning Partnership #2- Risk Assessment and SWOO 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]*	Essex County: Sheriff's Office, OEM, Public Information Officer – County Executive's Office, Essex County Regional Health Municipalities: Belleville (T); Bloomfield (T); Caldwell (B); Cedar Grove (T); East Orange (C); Essex Fells; Fairfield (T); Glen Ridge (B); Irvington (T); Livingston (T); Maplewood (T); Millburn (T); Montclair (T); North Caldwell (B); Newark (C); Nutley (T); Orange (C); Roseland (B); South Orange (T); Verona (T); West Caldwell (T); West Orange (T) Tetra Tech
September 23, 2019	2, 3a, 3b, 3d	FEMA Coastal Restudy Meeting for Essex and Hudson Counties *[Status update on the coastal study for New York and New Jersey to update flood risk information]*	Essex County Division of Housing and Community Development Municipalities: Belleville (T); North Caldwell (B); Newark (C); Nutley (T); West Caldwell (T); New Jersey Department of Environmental Protection; Hudson County and municipalities; FEMA; Tetra Tech.
September 24, 2019	1b, 2	Public Event – Senior Wellness Day *[Engagement opportunity to share update process with residents; survey conducted on preferred mitigation projects in the County; distribution of materials]*	Essex County Sheriff's Office; Tetra Tech; Diversity For members of the public see sign-in sheet (Appendix C)

Table 2-3. Summary of Planning Outreach

Date	Activity/DMA 2000 Requirement	Key Outcomes/Purpose*	Participants*
September 26, 2010	2, 4b	FEMA Pre-Disaster Mitigation and Flood Mitigation Assistance Grant Funding Webinar	Webinar offered to all plan participants
October 24, 2019	1b, 2, 3a, 3b, 3c, 3d, 3e	Steering Committee Meeting *[Update and finalization of the mission statement, goals and objectives; plan maintenance; stakeholder focus group sessions]*	Essex County Sheriff's Office; Belleville (T); Maplewood (T); Millburn (T); Tetra Tech
October 24, 2019	1b, 2, 4a, 4b, 4c	Mitigation Strategy Workshop – open to the public *[Annex checklists distributed; Problem statement development; Mitigation resources distributed including mitigation catalog and critical facility/lifeline risk assessment results; Review of Mitigation Action Worksheets and NJOEM requirements; Small group break-outs to update municipal mitigation strategy]*	Essex County: Sheriff's Office, OEM Municipalities: Belleville (T); Caldwell (B); Cedar Grove (T); Fairfield (T); Glen Ridge (B); Irvington (T); Livingston (T); Maplewood (T); Millburn (T); Montclair (T); North Caldwell (B); Newark (C); Nutley (T); Roseland (B); South Orange (T); West Caldwell (T); West Orange (T) Tetra Tech
November 14, 2019	1b, 3a, 3c, 3d, 3e, 4b,	Stakeholder Focus Group Sessions *[Capabilities, Vulnerable areas and assets identified; Current and potential future mitigation actions identified for three sectors]*	Utilities Session: Essex County OEM; Essex County Fire Coordinator; PSE&G; Cedar Grove (T); Fairfield (T); Livingston (T); Newark (C); Tetra Tech Transportation Session: Essex County Sheriff Office; Essex County OEM; Essex County Transportation Advisory Board; New Jersey Transit; TRANSCOM; Fairfield (T); Millburn (T); Newark (C); Tetra Tech Green Infrastructure/Climate Change Session: Essex County OEM; Essex County Environmental Commission; Rutgers Cooperative Extension; Montclair Business Improvement District; Association of New Jersey Environmental Commission (ANJEC); Tetra Tech
December 10 – 19, 2019	1b, 2, 3, 4, 5	Planning Partnership	All project points of contact for Essex County and all municipalities were provided the opportunity to review the draft plan.

Table 2-3. Summary of Planning Outreach

Date	Activity/DMA 2000 Requirement	Key Outcomes/Purpose*	Participants*
		Review of Draft Plan	
December 20, 2019	1b	Draft HMP posted on Essex County Sheriff's website for public review and comment	
February 4, 2020	1b, 2, 3, 4, 5	Draft Plan Review Meeting – open to the public *[draft plan review; discussed comments received from stakeholders and the public were reviewed; linkage procedures and upcoming plan adoption steps were discussed]*	Essex County Sheriff's Office; Belleville (T); Fairfield (T); Millburn (T); Tetra Tech
February 5, 2020	1b, 2, 3, 4, 5	Final Plan Review	Submitted to NJOEM

Note:

**Refer to Appendix B for sign-in sheets, agendas and meeting notes*

TBD = To be determined

Each number in column 2 identifies specific DMA 2000 requirements, as follows:

1a – Prerequisite – Adoption by the Local Governing Body

1b – Stakeholder and 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

> ***Stakeholder Engagement Sessions:***
> *Utility, Transportation, Green Infrastructure/Climate Change*
>
> - Online survey distributed in advance to inform session
> - Session Format:
>   - Group discussion
>   - Map Exercises
> - Topics Covered
>   - Vulnerabilities
>   - Capabilities
>   - Mitigation Strategy

Stakeholders are the individuals, agencies, and jurisdictions that have a vested interest in the recommendations of the hazard mitigation plan, 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 Steering and Planning Committees. 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.

2.3.1 Federal Agencies

FEMA Region II: Provided updated planning guidance through meeting(s) with the New Jersey Office of Emergency Management Mitigation Unit and communicated to Essex County; held the FEMA Risk MAP coastal restudy meeting; conducted plan review.

National Weather Service (NWS): Provided data and information, provided subject matter expert review of atmospheric/weather-related hazard profile.

Information regarding hazard identification and the risk assessment for this HMP update was 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)
- U.S. Fish and Wildlife Service

2.3.2 State Agencies

New Jersey Office of Emergency Management (NJOEM): Administered planning grant; provided updated planning guidance; attended the Kickoff meeting in July 2019; consulted with individual municipalities interested in applying for 2019 FEMA Hazard Mitigation Assistance grants; provided review of the draft HMP update.

New Jersey Transit: Attended the November 2019 stakeholder focus group session for the transportation sector.

The following State agencies were invited to attend the November 2019 stakeholder focus group session for their appropriate sector:

- New Jersey Department of Transportation
- New Jersey Board of Utilities
- Port Authority of New York and New Jersey

2.3.3 County and Regional Agencies and Commissions

Several County departments were represented on the Steering Committee and involved in the HMP update planning process; refer to Table 2-2 for a complete list of County entities that participated in the planning process with departments and divisions listed below. As previously noted, Steering Committee members were invited to all meetings, were provided updates via email communication and invited to review the draft HMP.

- Essex County Executive
- Essex County Administrator
- Essex County Sheriff's Office
    - Sheriff
    - Undersheriff
    - Office of Emergency Management
    - Law Enforcement Services
    - Homeland Security
- Department of Public Works
    - Division of Planning
    - Division of Engineering
    - Division of Roads and Bridges
- Department of Parks, Recreation and Cultural Affairs
- Prosecutor's Office

The following highlights three County entities that led HMP update and contributed to the County annex.

Exhibit 2-2. County Executive Social Media Posts about the HMP update

Essex County Sheriff's Office: The Sheriff's Office, Office of Emergency Management (OEM), provided leadership of the planning process, acting as chair of the Steering Committee, providing data, and facilitating communication with plan participants as well as public outreach. Captain Edward Esposito was identified as the ongoing Essex County HMP Coordinator in Section 7 (Plan Maintenance) and served in this role throughout the planning process. In addition, the Sheriff's Office including OEM provided critical data, assisted with the update of the hazards of concern and ranking, updated the previous mitigation strategy, facilitated outreach to jurisdictions and stakeholders, contributed to the County's capability assessment and updated mitigation strategy, and reviewed draft sections of the HMP.

Essex County Department of Public Works, Division of Planning: The Division of Planning functions include responsibility for long-range planning relating to development and conservation of land and resources in the County. This includes studies pertaining to the census, safety, land use, traffic, storm water, and transportation facilities. The Division of Planning includes the operations of the Essex County Planning Board, Essex County Construction Board of Appeals, and the Essex County Transportation Advisory Board. The Division of Planning, led by David Antonio, served on the Steering Committee and attended meetings throughout the planning process. Mr. Antonio and his team provided updated information on legal/regulatory and planning capabilities in the County, updated the previous mitigation strategy, facilitated outreach to jurisdictions and stakeholders, contributed to the County's updated mitigation strategy and annex, and reviewed draft sections of the HMP.

Essex County Department of Public Works, Division of Engineering: The Division of Engineering provides professional engineering services which include design, construction, construction inspection, construction management, bridge inventory, and maintenance throughout Essex County. The Division of Engineering, led by Sanjeev Varghese, served on the Steering Committee and attended meetings throughout the planning process. Mr. Varghese and his team provided updated information on legal/regulatory and planning capabilities in the County, updated the previous mitigation strategy, facilitated outreach to jurisdictions and stakeholders, contributed to the County's updated mitigation strategy and annex, and reviewed draft sections of the HMP.

Regional and Local Stakeholders

Essex Regional Health: Member of the Steering Committee; attended meetings; assisted with public outreach including posting meetings and the citizen survey on social media (Exhibit 2-2).

Essex County Environmental Commission: Attended the November 2019 stakeholder focus group session for the climate change/green infrastructure sector.

Essex County Transportation Advisory Board: Attended the November 2019 Stakeholder Focus Group Session for the transportation sector.

Rutgers Cooperative Extension Water Resources Program: Attended the November 2019 stakeholder focus group session for the climate change/green infrastructure sector.

The following regional and local stakeholders were invited to attend the November 2019 stakeholder focus group session for the appropriate sector; participate in a stakeholder survey to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP.

- New Jersey Future
- NY/NJ Baykeeper
- Montclair Sustainability Officer
- Newark Sustainability Officer
- Sustainable Essex Alliance
- Sustainable Jersey
- Master Gardeners of Essex County
- Essex County Environmental Center
- Rahway River Watershed Association
- Association of NJ Environmental Commissions (ANJEC)

Emergency Services

The Steering and Planning Committee is comprised of several members of the emergency services sector. All emergency management Municipal Coordinators have been briefed on the plan update at their quarterly meetings and many are their municipality's HMP primary or secondary point of contact and attended meetings. In addition, the Essex County Sheriff's Office notified the following when the draft plan was available for public review/comment and encouraged their continued participation:

- Emergency Management Municipal Coordinators
- Local Emergency Management Committee (LEPC) members*
- Police Chiefs
- Fire Chiefs
- Community Emergency Response Team (CERT) members

*The LEPC has representatives from academia, major businesses, representatives from Emergency Planning and Community Right-to-Know Act (EPCRA) facilities and non-profit organizations.

Academia

When the draft plan became available for public review, the Essex County Sheriff's Office requested all municipalities distribute the draft plan announcement to local public and private schools. The Count Executive distributed the draft plan email announcement to the Superintendents in the County. The following are members of the LEPC and were also provided the draft plan announcement: Essex County College; New Jersey Institute of Technology; Rutgers Cooperative Extension; Montclair University; Bloomfield College; Caldwell University; Seton Hall University. The New Jersey Institute of Technology (City of Newark) was invited to the November 2019 stakeholder focus group transportation session.

Utilities

Utility providers in the County and regional stakeholders were invited to attend the November 2019 Stakeholder Focus Group session for the utility sector; participate in a utility sector stakeholder survey to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP. In addition, when the draft plan became available for public review, utility providers were also emailed the announcement and encouraged to review and comment. Areas of involvement in the planning process are noted below.

PSE&G: Attended the November 2019 Stakeholder Focus Group Session; Participated in the utility sector stakeholder survey

JCP&L: Attended the July 2019 HMP Kickoff meeting

In addition to PSE&G and JCP&L listed above, the following utility stakeholders were invited to attend the November 2019 stakeholder focus group session, participate in the utility survey and provide input on the draft HMP:

- Verizon
- New Jersey American Water
- Passaic Valley Sewerage Commission
- Passaic Valley Water Commission
- East Orange Water Commission
- Newark Water Utility
- Essex Fells Water Company
- Essex County Utilities Authority
- Board of Public Utilities

Business/Commerce

When the draft plan became available for public review, the Essex County Sheriff's Office requested the Economic Development and Improvement Authority distribute the email announcement to businesses in the County. In addition, major businesses are members of the LEPC.

Transportation

Exhibit 2-3. Transportation Focus Group Session, November 14, 2019

Transportation providers in the County and regional stakeholders were invited to attend the November 2019 Stakeholder Focus Group session for the transportation sector; participate in a transportation sector stakeholder survey to provide input on vulnerable assets, capabilities, and current/potential future mitigation projects; and invited to provide input on the draft HMP. Areas of involvement in the planning process are noted below.

North Jersey Transportation Planning Authority (NJTPA): Collaborated with the planning consultant and discussed the recently published Passaic River Basin Climate Resilience Planning Study; Shared the spatial data used to inform the Climate Resilience Plan

NJ Transit Police: Attended the November 2019 Stakeholder Focus Group Session

NJ Transit: Attended the November 2019 Stakeholder Focus Group Session

TRANSCOM: Attended the November 2019 Stakeholder Focus Group Session

Essex County Transportation Advisory Board: Attended the November 2019 Stakeholder Focus Group Session

In addition to stakeholders listed above, the following transportation stakeholders were invited to attend the November 2019 stakeholder focus group session, participate in the transportation survey and provide input on the draft HMP:

- Port Authority of New York and New Jersey
- Together North Jersey
- Essex County Special Transportation System
- Rutgers University Police Department
- New Jersey Institute of Technology Police

2.3.4 Neighboring Counties

Essex County has tried to keep surrounding and nearby counties and municipalities apprised of the project and allowed the opportunity to provide input to this planning process. In September 2019, the FEMA coastal map restudy meeting was a joint meeting with FEMA, NJDEP, Hudson County, Essex County and affected municipalities where the hazard mitigation plan update was discussed.

The following counties were invited to the Stakeholder Focus Group sessions in November 2019 and were contacted on January 2, 2020 via formal letter and email from the Essex County Sheriff to inform them about the draft plan documents and to invite them to provide input.

- Bergen County, New Jersey – invitation to the stakeholder workshop and letter regarding the draft plan public review

- Hudson County, New Jersey – invitation to the stakeholder workshop and letter regarding the draft plan public review
- Morris County, New Jersey - invitation to the stakeholder workshop and letter regarding the draft plan public review
- Passaic County, New Jersey - invitation to the stakeholder workshop and letter regarding the draft plan public review
- Union County, New Jersey - invitation to the stakeholder workshop and letter regarding the draft plan public review
- Somerset County, New Jersey - invitation to the stakeholder workshop

2.3.5 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 and draft documents will be made available to the public via the Essex County Sheriff's Office website dedicated to the HMP update. 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 Sheriff's Office posted a news release on their website to announce the commencement of the HMP update; refer to Appendix D (Public and Stakeholder Outreach Documentation) for the news release.
- A public project website was developed and is being maintained to facilitate communication between the Steering Committee, Planning Committee, public and stakeholders. The public website provides a project overview, access to the citizen's survey, multi-lingual brochures (English, Spanish and Portuguese) and various stakeholder surveys, and sections of the HMP for public review and comment. Figure 2-1 provides a screenshot of the current website homepage. (https://www.essexsheriff.com/oem-category/2020-mid-plan-update/).

O PLANO DE MITIGAÇÃO DE RISCOS DO CONDADO DE ESSEX

PROPÓSITO

O Departamento de Segurança Pública do Condado de Essex está liderando a atualização do HMP do condado. O plano descreve diversos perigos em potencial que podem afetar alguns ou todos os residentes. O plano também permitirá que o condado e os municípios participantes recebam subsídios da Agência Federal de Gestão de Emergências (FEMA) para fins de mitigação.

O objetivo do plano é identificar projetos capazes de reduzir os danos de futuros desastres. O plano incluirá uma avaliação de risco e uma estratégia de mitigação de riscos. Os principais riscos naturais que ameaçam o Condado de Essex incluem: Erosão Costeira e Aumento do Nível do Mar, Tempestades na Costa, Secas, Terremotos, Temperaturas Extremas, Inundações, Riscos Geológicos, Condições Climáticas Severas, Fortes Tempestades de Inverno e Queimadas. Os principais riscos não naturais no Condado de Essex incluem: Distúrbios Civis, Ataques Cibernéticos, Surtos de Doenças, Colapso Econômico, Substâncias Perigosas, Falta de Energia Elétrica, Terrorismo e Falha no Setor de Transportes.

O estudo será direcionado a construções existentes possíveis empreendimentos futuros, infraestrutura instalações críticas que podem ser impactados. Instalações críticas incluem, entre outras, prédios municipais e infraestrutura, como usinas de geração de energia, unidades de fornecimento de água, rodovias, ferrovias e sistemas de comunicação.

O QUE É UM PLANO DE MITIGAÇÃO DE RISCOS?

Um plano de mitigação de riscos (HMP) é "a representação do compromisso da jurisdição em reduzir riscos provenientes de desastres naturais, orientando os tomadores de decisão na alocação de recursos para redução dos efeitos dos desastres naturais" (44 CFR 201.6). Os HMPs determinam e mantêm a elegibilidade para o recebimento de subsídios. O processo de planejamento é tão importante quanto o próprio plano porque ele cria uma estrutura que permite que os governos reduzam os impactos negativos que desastres futuros podem causar nas pessoas, em bens materiais e na economia.

Planejar a mitigação de riscos pode reduzir significativamente as perdas físicas, financeiras e emocionais causadas pelos desastres. A Lei de Mitigação de Desastres de 2000 é uma lei federal que prevê um programa de mitigação de riscos pré-desastre e novas exigências para o Programa de Subsídios para Mitigação de Riscos (HMGP) pós-desastre, de âmbito nacional. Essa lei incentiva e recompensa atividades de planejamento pré-desastre locais e estaduais e promove a sustentabilidade. A elaboração de um HMP resultará em projetos de redução de risco mais efetivos e permitirá a alocação de recursos financeiros de forma mais ágil e eficiente.

Exhibit 2-4. 2020 HMP Multi-Lingual Brochure

- An online natural hazards preparedness citizen survey was developed to gauge household preparedness relevant to hazards in Essex County and to assess the level of knowledge of tools and techniques to assist in reducing risk and loss of those hazards. The questionnaire asks quantifiable questions about citizen perception of risk, knowledge of mitigation, and support of community programs, as well as several demographic questions to help analyze trends. The questionnaire was posted on the County public website in August 2019 and was available for five months to facilitate public input garnering over 100 responses. The survey results were sorted by municipality and provided to the Steering Committee and Planning Partnership members to use to identify vulnerabilities and develop mitigation strategies. A summary of survey results is provided in Appendix D (Public and Stakeholder Outreach Documentation).

Exhibit 2-5. Example Social Media Post

Exhibit 2-6. Public Outreach Example

- A hazard mitigation planning brochure (see Appendix D) 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 to distribute in their communities. It was also available for download on the hazard mitigation plan website. The brochure was made available in three languages: English, Spanish and Portuguese.

- All plan participants were encouraged to distribute the project brochure and post the links to the project webpage and citizen survey. In addition, all participating municipalities were requested to advertise the availability of the project website via local homepage links, and other available public announcement methods (e.g., Facebook, Twitter, email blasts). See Exhibit 2-5, Exhibit 2-6 and Appendix D (Public and Stakeholder Outreach Documentation) for screenshots of the municipal outreach efforts.

- All hazard mitigation Planning Partnership meetings that were open to the public were advertised on the Essex County website. One Essex County resident attended the September 2019 risk assessment meeting to learn more about the hazards of concern that the County faces.

Exhibit 2-7. Senior Wellness Event, September 24, 2019

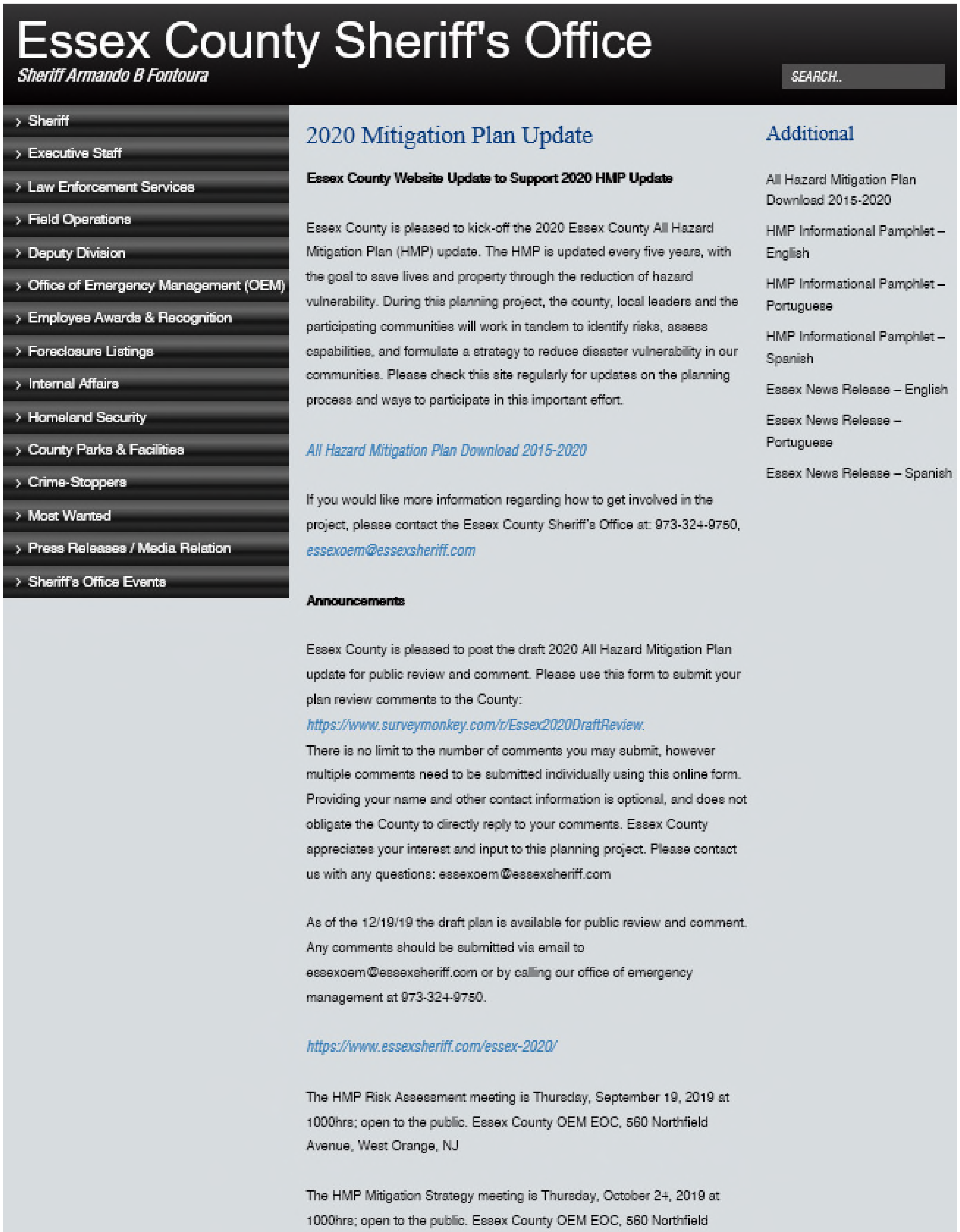
- According to the American Community Survey, the two most frequently spoken languages in the County after English are Spanish and Portuguese. The County translated the news release, brochure and social media posts in an effort to reach a larger audience. In addition, a Spanish translator was present at the Senior Wellness Day, discussed below, to further engage with residents.

- Essex County Sheriff's Office and the planning consultant attended the public event, Senior Wellness Day, to share the update process with residents; survey attendees on their preferred mitigation projects in the County; distribution of materials including the citizen survey and multi-lingual brochure. Over 80 residents stopped by the mitigation table. As noted above, the translator attended as well. Refer to Appendix D for more information regarding this event including the sign-in sheet.

- The draft HMP was posted on the Essex County Sheriff's Office website for public review and comment. All municipalities were requested to assist with advertising the plan was posted. Refer to Exhibit 2-8 for an example of this outreach effort by the Township of Belleville.

Additional examples of public outreach efforts are presented in Appendix D (Public and Stakeholder Outreach Documentation). The community residents had an opportunity to comment on the draft HMP before submittal to FEMA. The HMP was posted on the public website on December 20, 2019 for review. Public comments received through January 27, 2020 were distributed to the members of the Steering and Planning Committees for their consideration. On February 4, 2020, a draft plan finalization meeting was held to discuss pubic comments received and finalize the plan prior to submitting to NJOEM and FEMA. This meeting was open to the public.

Figure 2-1. Screenshot of the Essex County Sheriff Hazard Mitigation Website Home Page



Essex County Sheriff's Office

Sheriff Armando B Fontoura

SEARCH..

- Sheriff
- Executive Staff
- Law Enforcement Services
- Field Operations
- Deputy Division
- Office of Emergency Management (OEM)
- Employee Awards & Recognition
- Foreclosure Listings
- Internal Affairs
- Homeland Security
- County Parks & Facilities
- Crime-Stoppers
- Most Wanted
- Press Releases / Media Relation
- Sheriff's Office Events

2020 Mitigation Plan Update

Essex County Website Update to Support 2020 HMP Update

Essex County is pleased to kick-off the 2020 Essex County All Hazard Mitigation Plan (HMP) update. The HMP is updated every five years, with the goal to save lives and property through the reduction of hazard vulnerability. During this planning project, the county, local leaders and the participating communities will work in tandem to identify risks, assess capabilities, and formulate a strategy to reduce disaster vulnerability in our communities. Please check this site regularly for updates on the planning process and ways to participate in this important effort.

All Hazard Mitigation Plan Download 2015-2020

If you would like more information regarding how to get involved in the project, please contact the Essex County Sheriff's Office at: 973-324-9750, *essexoem@essexsheriff.com*

Announcements

Essex County is pleased to post the draft 2020 All Hazard Mitigation Plan update for public review and comment. Please use this form to submit your plan review comments to the County: *https://www.surveymonkey.com/r/Essex2020DraftReview.*
There is no limit to the number of comments you may submit, however multiple comments need to be submitted individually using this online form. Providing your name and other contact information is optional, and does not obligate the County to directly reply to your comments. Essex County appreciates your interest and input to this planning project. Please contact us with any questions: essexoem@essexsheriff.com

As of the 12/19/19 the draft plan is available for public review and comment. Any comments should be submitted via email to essexoem@essexsheriff.com or by calling our office of emergency management at 973-324-9750.

https://www.essexsheriff.com/essex-2020/

The HMP Risk Assessment meeting is Thursday, September 19, 2019 at 1000hrs; open to the public. Essex County OEM EOC, 560 Northfield Avenue, West Orange, NJ

The HMP Mitigation Strategy meeting is Thursday, October 24, 2019 at 1000hrs; open to the public. Essex County OEM EOC, 560 Northfield

Additional

- All Hazard Mitigation Plan Download 2015-2020
- HMP Informational Pamphlet – English
- HMP Informational Pamphlet – Portuguese
- HMP Informational Pamphlet – Spanish
- Essex News Release – English
- Essex News Release – Portuguese
- Essex News Release – Spanish

Source: https://www.essexsheriff.com/oem-category/2020-mid-plan-update/

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

The Essex County HMP update strives to use the best available technical information, plans, studies, and reports throughout the planning 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 are 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, are presented in the Risk Assessment, specifically in Section 4.2 - Methodology and Tools, as well as throughout the hazard profiles in Section 4.4 (Hazard Profiles). Further, the source of technical data and information used can be found within Volume I under *References*.

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)

A partial listing of the plans, reports, and technical documents reviewed in the preparation of this plan is included in Table 2-4. Refer to Section 9 (Jurisdictional Annexes) which outlines the updated programs, policies and plans that were researched and available for each jurisdiction.

Table 2-4. Record Review - Record of the review of existing plans and technical documents for participating jurisdictions

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Comprehensive Energy Master Plan	2011	County and all municipalities
Essex County Comprehensive Transportation Plan	June 2013	County and all municipalities
Essex County Hazard Mitigation Plan	2007, 2015	County and all municipalities
Essex County Park System Park, Recreation and Open Space Master Plan	April 2003	County and all municipalities
Environmental Resource Inventory	2007	County and all municipalities
FEMA Essex County, NJ Coastal Hazard Analysis Flood Risk Review Meeting PowerPoint	October 2013	County and all municipalities
Park, Recreation, and Open Space Master Plan	April 2003	County and all municipalities
Saint Barnabas Medical Center Community Health Needs Assessment, 2016-2018	December 16, 2016	County and all municipalities
Newark Beth Israel Medical Center Community Health Needs Assessment, 2016-2018	November 18, 2016	County and all municipalities
Clara Mass Medical Center Community Health Needs Assessment, 2016-2018	November 28, 2016	County and all municipalities
Barnabas Health Behavioral Health Center Community Health Needs Assessment, 2016-2018	December 7, 2016	County and all municipalities
NJTPA Climate Resilience Study	2019	Passaic River Basin Communities
Township of Belleville Master Plan	January 10, 2019	Township of Belleville
Township of Bloomfield Master Plan	2012	Township of Bloomfield
Township of Bloomfield Emergency Operations Plan	2011	Township of Bloomfield
Master Plan Re-Examination Report	2017	Borough of Caldwell
Open Space Plan	2007	Borough of Caldwell
Caldwell Emergency Operations Plan	2018	Borough of Caldwell
Stormwater Pollution Prevention Plan	Nd	Borough of Caldwell
Municipal Stormwater Management Plan	February 2006	Township of Cedar Grove
Stormwater Pollution Prevention Plan	Nd	Township of Cedar Grove
Comprehensive / Master Plan	July 2006	Township of Cedar Grove
Comprehensive Emergency Management Plan (EOP)	April 2019	Township of Cedar Grove
Community Forest Management Plan	Nd	Township of Cedar Grove
Master Plan 2018: Borough of Essex Fells New Jersey	2018	Borough of Essex Fells
Emergency Operations Plan	February 2017	Township of Fairfield
Borough of Glen Ridge Master Plan	2010	Borough of Glen Ridge
Borough of Glen Ridge Stormwater Management Plan	Nd	Borough of Glen Ridge
Borough of Glen Ridge Stormwater Pollution Prevention Plan	January 15, 2018	Borough of Glen Ridge
Master Plan and Reexamination of Master Plan	2002 / 2009	Township of Irvington
Comprehensive Emergency Management Plan	Unknown	Township of Livingston
Municipal Stormwater Management Plan	2019	Township of Livingston
Stormwater Pollution Prevention Plan	December 2018	Township of Livingston
Township of Livingston Master Plan	April 2018	Township of Livingston
Capital Improvement Plan	Updated annually	Township of Livingston
Community Forestry Management Plan	Unknown	Township of Livingston

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Master Plan Reexamination Report – Township of Maplewood	July 2011	Township of Maplewood
Capital Improvement Plan	Updated annually	Township of Maplewood
Stormwater Pollution Prevention Plan	2018	Township of Maplewood
Redevelopment Plan	Adopted April 3, 2012	Township of Maplewood
Stream Corridor Management Plan	2006	Township of Maplewood
Comprehensive Emergency Management Plan	2019	Township of Maplewood
Emergency Response Plan	2018	Township of Maplewood
Comprehensive Emergency Management Plan	2017	Township of Millburn
Post-Disaster Recovery Plan	2012	Township of Millburn
Environmental Resource Inventory Report	2014	Township of Millburn
Community Forestry Management Plan	Unknown	Township of Millburn
Capital Improvement Plan and South Mountain Drainage Engineering Project	2013-2020	Township of Millburn
Master Plan Updated and Adopted	December 2018	Township of Millburn
Environmental Resource Inventory	March 2014	Township of Millburn
Township of Montclair Master Plan Reexamination Report	2016	Township of Montclair
Stormwater Management Plan Element to Montclair Master Plan	2005	Township of Montclair
Conservation Element to Montclair Master Plan	2007	Township of Montclair
Unified Landuse and Circulation Element to Montclair Master Plan	2016	Township of Montclair
Township of Montclair Emergency Operations Plan	2018	Township of Montclair
Draft Sustainability Action Plan 2020	2019 (Draft)	City of Newark
Passaic River Tidal Protection Area, New Jersey Coastal Storm Risk Management Draft Integrated Hurricane Sandy General Reevaluation Report and Environmental Assessment	2018 (Draft)	City of Newark
Stormwater Management Plan	April 2019	Borough of North Caldwell
Stormwater Pollution Prevention Plan	Nd	Borough of North Caldwell
North Caldwell Redevelopment Plan	Nd	Borough of North Caldwell
North Caldwell Emergency Operations Plan	2018	Borough of North Caldwell
Borough of North Caldwell Master Plan Re-Examination Report	August 2019 (Pending Adoption)	Borough of North Caldwell
Township of Nutley Master Plan	December 2012	Township of Nutley
Township of Nutley Emergency Operations Plan	June 2016	Township of Nutley
Township of Nutley Stormwater Pollution Prevention Plan	March 31, 2005	Township of Nutley
City of Orange Township Master Plan	2018	City of Orange Township
Master Plan	November 2006. Currently in update.	Borough of Roseland
Capital Improvement Plan	Updated annually	Borough of Roseland
Stream Corridor Management Plan	02-2007	Borough of Roseland
Stormwater Management Plan	04-26-2007	Borough of Roseland
Stormwater Pollution Prevention Plan	01-26-2005	Borough of Roseland
Redevelopment Plan	11-2009	Township of South Orange Village
Master Plan	November 2006	Township of South Orange Village
Stream Corridor Management Plan	February 2007	Township of South Orange Village

Existing plan, program or technical documents	Date	Jurisdictional Applicability
Stormwater Management Plan	April 2018	Township of South Orange Village
Stormwater Pollution Prevention Plan	April 2018	Township of South Orange Village
Community Forestry Management Plan	December 2015	Township of South Orange Village
Vision Plan	October 2007	Township of South Orange Village
2009 Master Plan & Reexamination Report for Verona, New Jersey	2009	Township of Verona
Open Space Plan	2012	Township of Verona
Stormwater Pollution Prevention Plan	Nd	Township of Verona
Stormwater Management Plan	Nd	Township of Verona
Comprehensive Emergency Management Plan	August 2019	Township of Verona
Stream Corridor Management Plan	Nd	Township of Verona
Emergency Response Plan	2013	Township of Verona
Open Space Plan	1982	Township of West Caldwell
Comprehensive Plan / Master Plan/ General Plan	2007	Township of West Caldwell
Emergency Operations Plan	2017	Township of West Caldwell
Capital Improvements Plan	2010	Township of West Caldwell
Master Plan	2010	Township of West Orange
Capital Improvements Plan	Completed annually for a 5-year period	Township of West Orange
Pedestrian Safety Action Plan	2015	Township of West Orange
Open Space and Recreation Plan	Published 2010, Update March 12, 2019	Township of West Orange

Nd = No date

2.5 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 Essex County, there are many existing plans and programs that support hazard risk management, and thus it is critical that this hazard mitigation plan integrate, coordinate with, and complement, those existing plans and programs.

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).

2.6 CONTINUED PUBLIC INVOLVEMENT

Essex County and all municipalities are committed to the continued involvement of the public in the hazard mitigation process. This HMP update will be posted online at https://www.essexsheriff.com/oem-category/2020-

mid-plan-update/ and municipalities will be encouraged to maintain links to the plan website. Further, the County will make hard copies of the HMP available for review at public locations as identified on the website.

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.essexsheriff.com/oem-category/2020-mid-plan-update/.

The public will have 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 Captain Edward Esposito, Office 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 Steering and Planning Committees will assist the HMP Coordinator. Additional meetings may also be held as deemed necessary by the Planning Partnership. 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 plan 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.

Captain Edward Esposito of the Essex County OEM is identified as the ongoing County All Hazard Mitigation Plan Coordinator (see Section 7), and is responsible for receiving, tracking, and filing public comments regarding this plan. Contact information is:

Name:	Captain Edward Esposito
Email Address:	essexoem@essexsheriff.com

SECTION 3. COUNTY PROFILE

The County profile describes the general information (physical setting, population and demographics, general building stock, and land use and population trends) and critical facilities located within Essex 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).

3.1 PHYSICAL SETTING

Essex County is located in northern New Jersey, approximately 20 miles south of the New York State border, and 10 miles west of Manhattan. The County is bordered by Passaic County to the north, Bergen County to the east-northeast, Hudson County to the east, Union County to the south and Morris County to the west. The eastern and western borders of Essex County are defined by the Passaic River. The County is separated from Morris County by the eastern branch of the Passaic River. The southeast border of the County is situated on the Newark Bay with approximately 3.5 miles of shoreline (The County's topography is flat in the east and slowly rises toward the west upon the approach of the Watchung Mountains. The Watchung Mountains run roughly north south through the center of Essex County. To the west of the Watchung Mountain, the slope gently declines back to a flatter topography as it approaches the western branch of the Passaic River. The highest elevations in the County are located in three municipalities within the Watchung Mountain range: Essex Fells, North Caldwell and Verona, with the highest point of 691 feet above sea level. The lowest point in the County is located at Newark Bay in the City of Newark. The average elevation of the County is 300 feet above sea level.

Essex County is located within the Piedmont Province, which is one of the four major physiographic regions of New Jersey. The Piedmont Province has an area of approximately 1,600 square miles and makes up about one-fifth of the State. The Piedmont Province is mainly underlain by slightly folded and faulted sedimentary rocks of the Triassic and Jurassic age and igneous rocks of the Jurassic age (Dalton, 2003).

According to the New Jersey Geological Survey (NJGS), the Piedmont Province is a low rolling plain divided by a series of higher rides. The width varies from approximately 16 miles near the New York border to over 30 miles at the Delaware River. The most prominent feature of the eastern portion of the province is the Palisades, which has a maximum elevation of 547 feet near Closter and provides views of the Hudson River and New York City. Near the Newark Bay, toward its boundary with the Coastal Plain Province, the elevation is at sea level (Dalton, 2003) (Figure 3-1).

Essex County consists of 22 municipalities, with an area over 127 square miles and a total population of 783,969. The County is New Jersey's second most densely populated county, with 6,211.5 persons per square mile, based on 2010 Census data (U.S. Census, 2013). It is an urban county with outlying suburban communities. Essex County includes the City of Newark, the largest municipality in the state by population. The Borough of Caldwell is the smallest municipality in the County in terms of land area, and Essex Fells has the lowest population in the County. Generally, the eastern portion of the County is more urban compared to the more suburban western portion of the County.

Newark Liberty International Airport is located in the City of Newark and is one of the three New York metropolitan airports (LaGuardia and JFK International Airport) operated by the Port Authority of New York & New Jersey (Port Authority). Additionally, the Port Authority operates the Port Newark-Elizabeth Marine Terminal in the County, the largest port facility on the east coast and third largest nationally. The Port Newark-Elizabeth Marine Terminal is located on the Newark Bay and serves as the principal container ship facility for goods entering and leaving the New York-New Jersey metropolitan area (Essex County, 2014).

Development throughout the County continued as alternate forms of travel were developed in the 1930's and 1940's to help workers commute from industrial Newark to less crowded outlying towns. Towns such as Irvington, East Orange, Orange and Bloomfield created trolley lines to facilitate workers commuting into and out of Newark. South Orange, Maplewood, Millburn, Glen Ridge and Montclair developed a commuter railcar system to transport its residents into and out of New York City. Development of the western portion of the County in towns such as Livingston, Fairfield, Roseland, Cedar Grove, Essex Fells and the Caldwell's, remained slow until the construction of Route 280, which provided an easier transportation route to and from eastern and western Essex County. This new access to the western portion of the County lead to the development of new industrial and professional office parks, hi-tech centers, and luxury homes, condominiums and townhouses (Essex County, 2013).

3.1.1 Topology and Geology

The County's topography is flat in the east and slowly rises toward the west upon the approach of the Watchung Mountains. The Watchung Mountains run roughly north south through the center of Essex County. To the west of the Watchung Mountain, the slope gently declines back to a flatter topography as it approaches the western branch of the Passaic River. The highest elevations in the County are located in three municipalities within the Watchung Mountain range: Essex Fells, North Caldwell and Verona, with the highest point of 691 feet above sea level. The lowest point in the County is located at Newark Bay in the City of Newark. The average elevation of the County is 300 feet above sea level.

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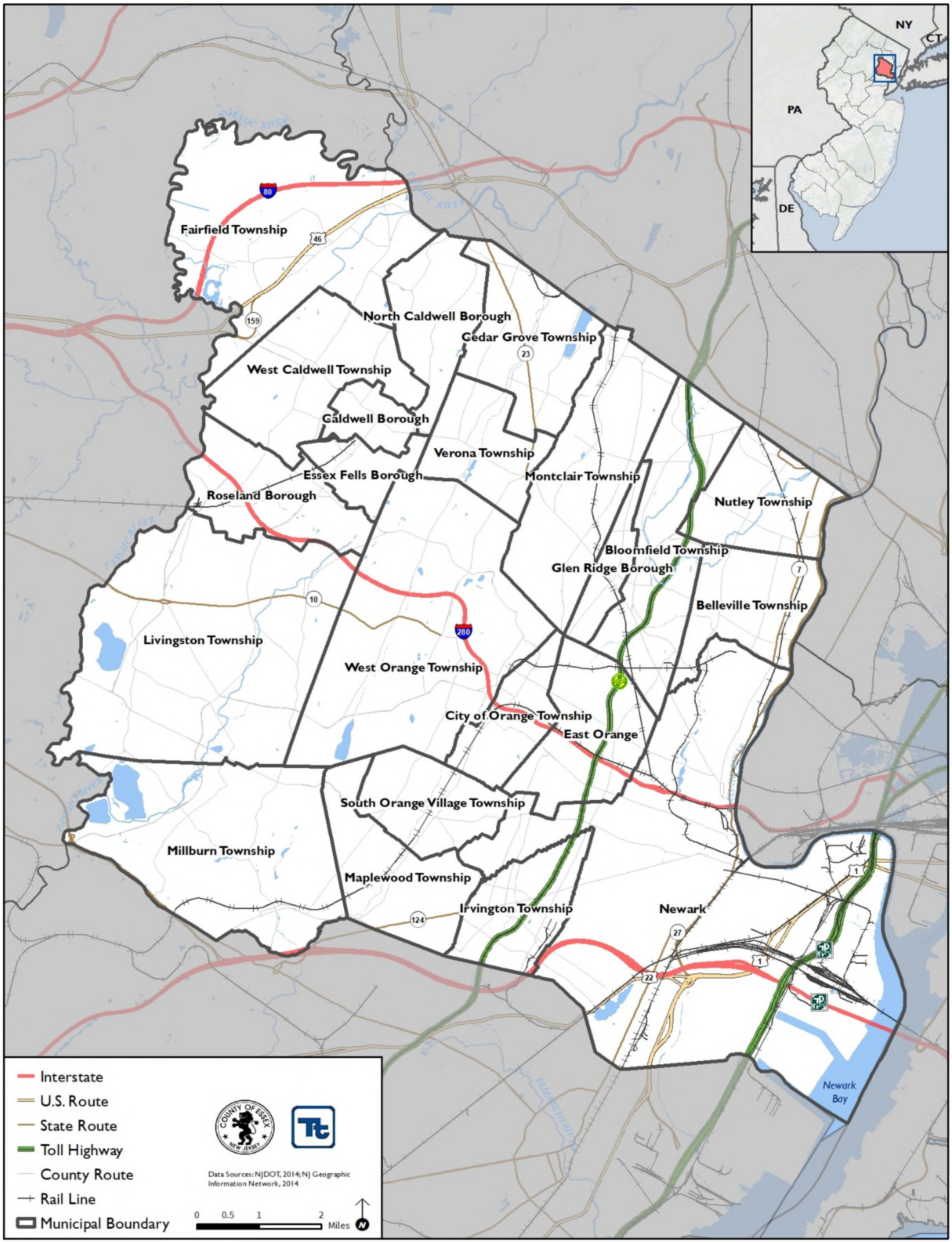
Figure 3-1. Overview Map of Essex County, New Jersey



3.1.2 Hydrography and Hydrology

Numerous ponds, lakes, creeks, and rivers make up the waterscape of Essex County. The major waterways within the County include Passaic River, Peckman River, Second River, Rahway River (east and west branches), and the Newark Bay.

Most of Essex County surface hydrology is linked to the Passaic River. The Passaic River is a 90-mile mud and sand bottom river that takes a course from Morris County to Newark Bay. It follows the Millington Gorge, forming the Paterson Falls, defining both the eastern and western boundaries of Essex County. The Passaic River and much of its associated wetlands are the remnants of a huge 11,000 year-old post-glacial lake originally centered in the wetland complexes of Morris County. The lake was the result of meltwater from the retreating Wisconsin Glacier (Essex County Environmental Resource Inventory 2007).

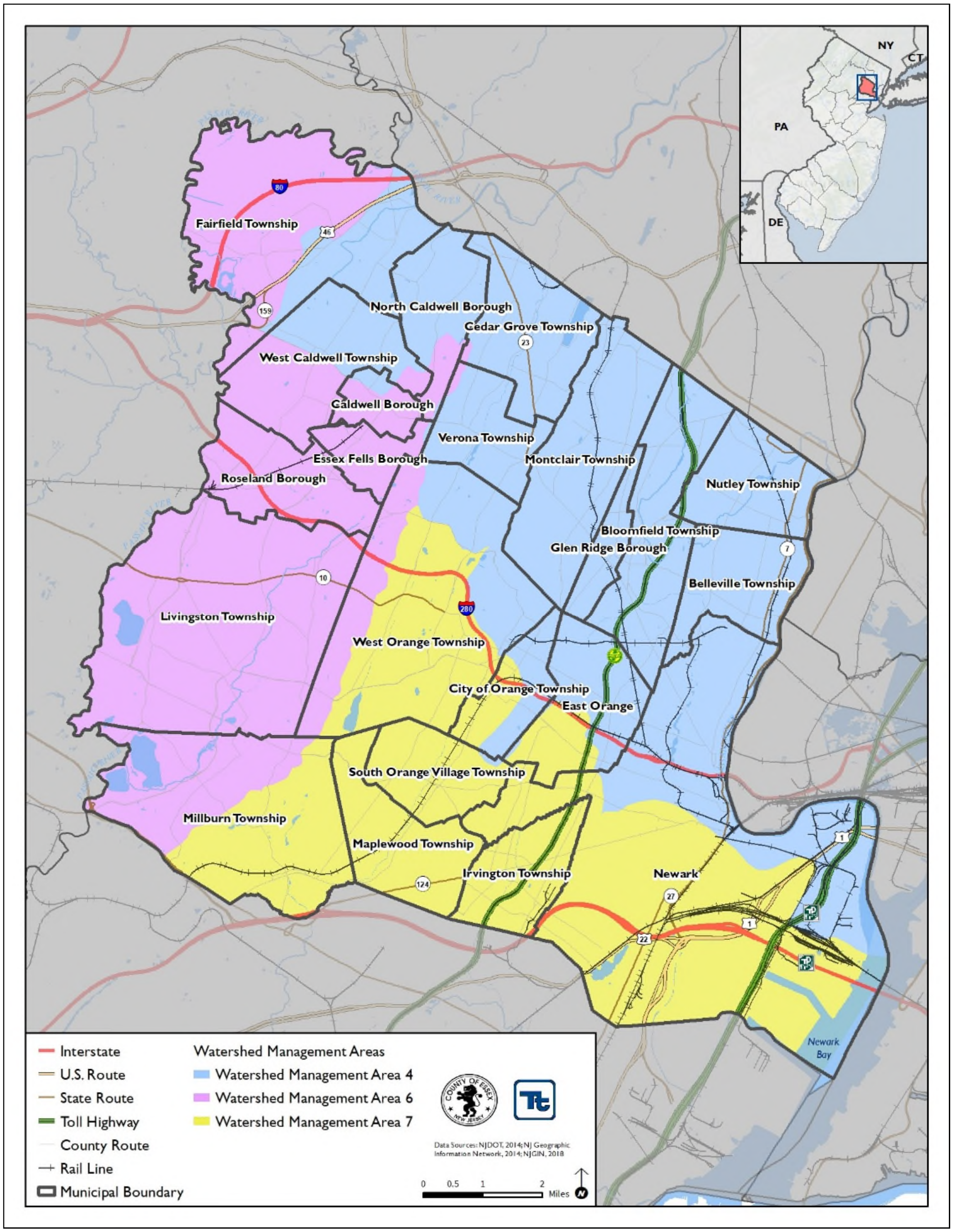
Watersheds come in all shapes and sizes and can cross municipal and county boundaries. Twenty watersheds make up the State of New Jersey. Essex County is located in three of the 20 watersheds: Arthur Kill (Watershed Management Area 7); Lower Passaic, Saddle River ((Watershed Management Area 4); and the Upper and Mid Passaic, Whippany, Rockaway (Watershed Management Area 6). These are represented in Figure 3-2 as Watershed Management Areas. Most of the Essex County land in the watershed has been developed. None of the streams or the Lower Passaic River itself is currently being used for drinking water supplies (Essex County Park, Recreation and Open Space Master Plan 2003).

The Arthur Kill Watershed Management Area 7 (WMA 7) is represented by large portions of Essex, Union, and Middlesex Counties. The mainstem of the Rahway River is 24 miles long, flowing from Union into the Arthur Kill near Linden. It is tidal from the Pennsylvania Railroad Bridge at Rahway down to the mouth. Key tributaries include the East Branch Rahway River, Woodbridge River, and Robinson's Branch. Major impoundments are the Middlesex Reservoir, Orange Reservoir, Lower and Upper Echo Lakes, and Diamond Mill Pond. The Elizabeth River is 11 miles long; much of it channelized for flood control purposes. Land uses in the Rahway and Elizabeth Watersheds are mainly residential, commercial and industrial (NJDEP 2012).

The Lower Passaic, Saddle Watershed Management Area 4 (WMA 4), includes the Lower Passaic River (from the Pompton River confluence downstream to the Newark Bay) and its tributaries, including the Saddle River. The drainage area is approximately 180 square miles and lies within the portions of Passaic, Essex, Hudson, Morris and Bergen Counties. The 129 square miles of land in the Lower Passaic River Watershed is primarily urban/suburban. As a result, water quality conditions along this 33-mile section of the Passaic River are poor, reflective of numerous point sources, significant nonpoint source contributions, and high sediment oxygen demands. Reflecting the area's industrialized history, the conditions are affected by the number of hazardous waste sites and contamination problems found in these areas. The Saddle River Watershed has a drainage area of 51 square miles. This watershed is extensively developed and contains many older cities and industrial centers including Newark, Paterson, Clifton, and East Orange. Like the Lower Passaic, the Saddle River's water quality is affected by its industrial past, current point sources of pollution and urban runoff (NJDEP, 2012).

The Upper and Mid-Passaic, Whippany, Rockaway Watershed Management Area 6 (WMA 6) represents the area drained by waters from the upper reaches of the Passaic River Basin. This includes the Passaic River from its headwaters in Morris County to the confluence of the Pompton River. Extensive suburban development and reliance upon ground water sources for water supply characterize this watershed. The Upper Passaic River represents a significant source of drinking water for a large portion of northeastern New Jersey. About one half of the land in this watershed is undeveloped or vacant with the rest primarily residential and commercial. This watershed has experienced key development in the more rural undeveloped areas (NJDEP, 2012). The land use patterns in the Rockaway River area are complex and include wooded/vacant areas, parklands, and residential development. There are also some areas having industrial and commercial uses. Suburban development is on the rise. Urban/suburban development is causing the water quality of the Whippany River to be degraded. Runoff from construction activity, stormwater discharges, urban surfaces, and the loss of riparian vegetation are suspected of contributing to siltation in the river. This has resulted in reduction in the trout-holding capacity of the waterway.

Figure 3-2. Essex County Watershed Management Areas



3.1.3 Climate

The State of New Jersey is located approximately halfway between the equator and the North Pole, resulting in a climate that is influenced by wet, dry, hot and cold airstreams, making a highly variable environment. The southern portion of New Jersey tends to be more temperate than the north. The dominant feature of the atmospheric circulation over North America, including New Jersey, is the broad, undulating flow from west to east across the middle latitudes of the continent. This pattern exerts a major influence on the weather throughout the State (Office of the New Jersey State Climatologist [ONJSC] nd).

Average annual precipitation ranges from approximately 40 inches along the southeast coast to 51 inches in the north-central portion of the State. Most areas in New Jersey average between 43 and 47 inches of precipitation annually. Snow typically falls from October 15 to April 30 in the Highlands and from around November 15 to April 15 in the southern counties. Most locations in New Jersey receive between 25 and 30 thunderstorms each year, with fewer storms near the coast than inland. New Jersey experiences measurable precipitation; approximately 120 days each year. The fall months are typically the driest, with an average of eight days of measurable precipitation. Other seasons average between nine and 12 days each month with measurable precipitation. New Jersey also has approximately five tornadoes each year, which generally tend to be weak (ONJSC nd).

The State of New Jersey is divided into five distinct climate zones. Distinct variations in the day-to-day weather between each of the climate zones is due to the geology, distance from the Atlantic Ocean, and prevailing atmospheric flow patterns. Essex County is located in the Central Climate Zone. The Central Zone has a northeast to southwest orientation, running from New York Harbor and the Lower Hudson River to the Great Bend of the Delaware River near the City of Trenton. The northern edge of the Central Zone is often the boundary between freezing and non-freezing precipitation in the State (ONJSC nd).

The climate in Essex County is temperate as the County experiences all four seasons. Average yearly temperatures are around 54°F with temperatures, on average, as low as 24°F in January and high temperatures topping out, on average, in July at 86°F. The average rainfall/precipitation for the County is between 44 and 48 inches a year and is distributed moderately-evenly each month at 3.1 to 4.7 inches per month, with no seasonable dry months or wet months.

3.1.4 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 An understanding of land use 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. For example, significant development in a hazard area increases the building stock and population exposed to that hazard.

Essex County contains a wide range of land uses and environmental resources. According to the United States Geologic Survey (USGS) 2016 National Land Cover Dataset most of the land in Essex County is classified as urban, forest, or water. The eastern portion of Essex County is primarily classified as urban with pockets of wetland area. Central Essex County has a concentration of forested land in addition to the urban areas. Western Essex County is comprised of urban, forest, and wetland land cover classifications. Wetlands cover a significant portion of Fairfield Township, West Caldwell Township, Roseland Borough, Livingston Township, and some of the northwestern edges of Millburn Township. Table 3-1 summarizes the Land Cover classifications throughout Essex County which is displayed in Figure 3-3 below.

Table 3-1. Land Cover Summary for Essex County

Land Cover Category	2016 NLCD Data	
	Acreage	Percent of Essex County
Agriculture	246	< 1%
Barren Land	38	< 1%
Forest	7,610	9.2%
Open Water	2,042	2.5%
Urban	66,156	79.7%
Wetlands	6,931	8.3%
Total	83,023	100%

Source: USGS 2019 (2016 NLCD)

Open Space

The County maintains greater than 6,000 acres of parkland that includes 28 parks, five reservations and various facilities. Essex County parks and reservations contain a wide range of facilities including open waters for fishing, boating and canoeing; opportunities for wildlife viewing; numerous fields and facilities for sports and recreation; interpretive trails; and walking and hiking paths. The largest wildlife preserves in the County are South Mountain and West Essex Park (Essex County Environmental Resource Inventor, 2007). Table 3-2 lists the parks, acreage and location in Essex County.

Table 3-2. Essex County Parks

County Park	Acreage	Municipality
Anderson	14.85	Montclair
Becker	147	Roseland
Belleville	32.70	Belleville
Branch Brook	359.72	Newark
Brookdale	121.41	Montclair
Eagle Rock Reservation	408.33	West Orange
Francis A. Byrne Golf Course	167.71	West Orange
Glenfield	20.01	Montclair
Grover Cleveland	41.61	Essex Fells
Hendricks Field Golf Course	124.99	Belleville
Hilltop Reservation	284.16	Cedar Grove
Independence	12.69	Newark
Irvington	24.38	Irvington
Ivy Hill	19.96	Newark
Kip's Castle Park	11	Verona and Montclair
Mills Reservation	157.19	Cedar Grove
Monte Irvin Orange Park	47.63	Orange
Riker Hill Complex	204.68	Livingston
Riverbank	10.77	Newark
South Mountain Reservation	2,047.14	West Orange

Table 3-2. Essex County Parks

County Park	Acreage	Municipality
Vailsburg	30.32	Newark
Verona	54.32	Verona
Walter Kidde Dinosaur	16	Roseland
Watsessing	69.67	Bloomfield
Weequahie	311.33	Newark
West Essex	1,361.33	Eagle Rock Ave. and Passaic River
West Side	31.36	Newark
Yanticaw	28.75	Nutley

Source: Essex County Environmental Resource Inventory, 2007

In addition to County parks, there are 176 municipal, school and private recreation and open space areas within Essex County. Of those, 70 are identified as municipal parks. The largest non-park open space areas are private golf courses, many of which are located in western Essex County. The remainder of these areas is recreation areas (picnic areas, campgrounds, lawns, cultural centers, etc.) and playgrounds (Essex County Environmental Resource Inventory 2007).

Forests

The Watchung Mountains contain the most forest area in the County. Deciduous forests are the dominant upland forest community, occupying approximately 9,620 acres (11.6%). Approximately 881 acres of the County are considered shrub forest. Coniferous forest in Essex County covers approximately 223 acres of land. These areas are typically small patches of planted coniferous stands comprised of various species in the County. Coniferous forest land can be found in the South Mountain reservation in the County (Essex County Environmental Resource Inventory 2007).

Recreational

Recreational coverage represents areas that include ball fields, golf courses, and similar areas dominated by maintained cool season grasses and utilized for sports activities. Recreational land use is scattered throughout the County. The largest recreational areas in Essex County are represented by golf courses (Essex County Environmental Resource Inventory 2007).

Urban Land

Urban land includes most of what normally would be considered developed land. Residential areas, commercial areas, services and institutions, industrial areas, and those developed for transportation and utilities are the primary land uses included in urban land. There are several other open land categories that are included with urban land. Developed recreation areas, whether a part of a park, educational facility, or private concern (e.g. golf course), are also considered a part of urban land. Also included are areas such as large, landscaped lawns in corporate businesses and service centers, parks, and residential areas (NJDEP 2014).

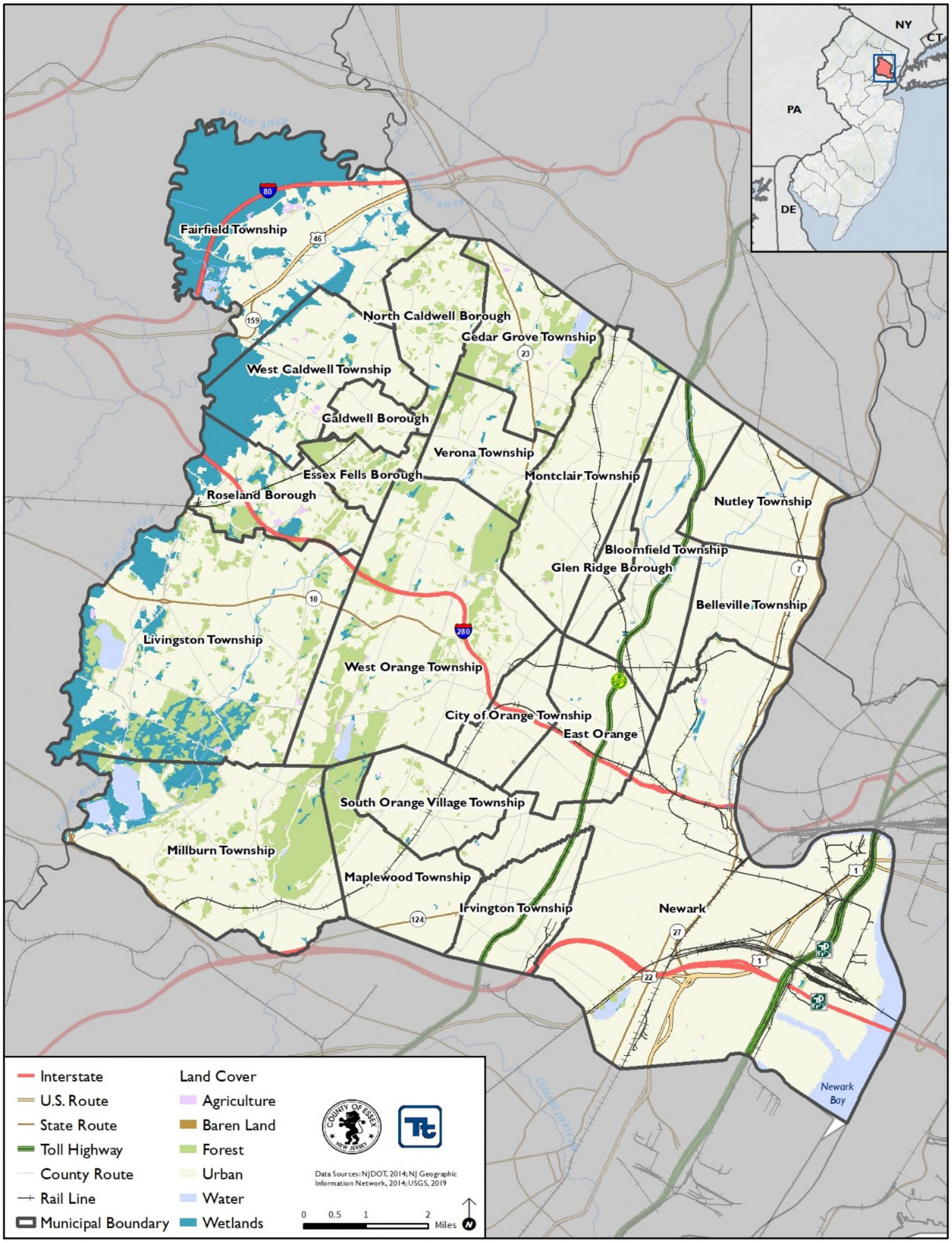
Urban land encompasses more area in Essex County than any other type of land use, approximately 66,156 acres of the County. It is the County's primary land use and includes residential land use as well. Areas classified as urban land have been altered, excavated, or disturbed to a significant extent and no longer have distinguishable morphologic features (Essex County Environmental Resource Inventory, 2007).

Wetlands

The largest wetland areas in Essex County are Great Piece Meadows and Hatfield Swamp, both of which are associated with the Passaic Meadows complex in northwestern Essex County. Forested wetland floodplains are mapped along the Passaic River in southwestern Essex County south of Hatfield Swamp from Willow Brook to the area around Canoe Brook Reservoir. Within southwest Essex County, wetlands are associated with Passaic River tributaries including Slough Brook, Canoe Brook and Taylor Brook in Millburn Township. In central Essex County, wetlands are primarily limited to smaller areas following creek corridors with some more extensive patches in Eagle Rock Reservation. Mapped wetlands within eastern Essex County are generally limited to small isolated patches (Essex County Environmental Resource Inventory, 2007).

Much of the wetland hydrology in Essex County is due to groundwater discharge to the surface or surface water runoff, in the form of sheet flow or flooding from adjacent open waters. Water tables are usually highest in the late winter and into early spring. During this period, water may pond or flood the wetlands for variable periods. In May or June, the water table usually begins to drop to its lowest levels, which occur in September or October. Fluctuations relate mainly to rainfall patterns, temperatures, and rates of evapotranspiration (the rate of water uptake from vegetation) (Essex County Environmental Resource Inventory, 2007).

Figure 3-3. 2016 Land Cover for Essex County



3.1.5 Land Use Trends

Although there has been a slight decrease in the County's population since 2000, there has been growing demand for housing in urban centers spurred by the emergence of the millennia's demand for housing. This has led to the redevelopment of many of the urban cores and revitalization of many of the State's older cities. Successful redevelopment projects in sections of the County including, the Ironbound section of Newark, downtown South Orange and downtown Montclair have facilitated mixed use growth, inclusive of residential development. This trend of urbanized living with proximity to a diversity of cultural activities and public transportation options has also enticed older generations to relocate to urban centers further increasing the demand for housing in these areas. The continued redevelopment in the urban areas of the County proximate to public transportation will likely remain an important component of the future development of the County.

According to the 2013 Essex County Transportation Plan, approximately 270 acres of new development has been approved and may begin construction in the near future. Much of this development will be in the form of redevelopment of existing developed properties. Many of the future development projects in the County are Transit Oriented Development (TOD) projects which are mixed-use developments that are proximate to transportation hubs. Where the information was available, specific development projects are listed in each municipality's annex in Section 9 (Jurisdictional Annexes).

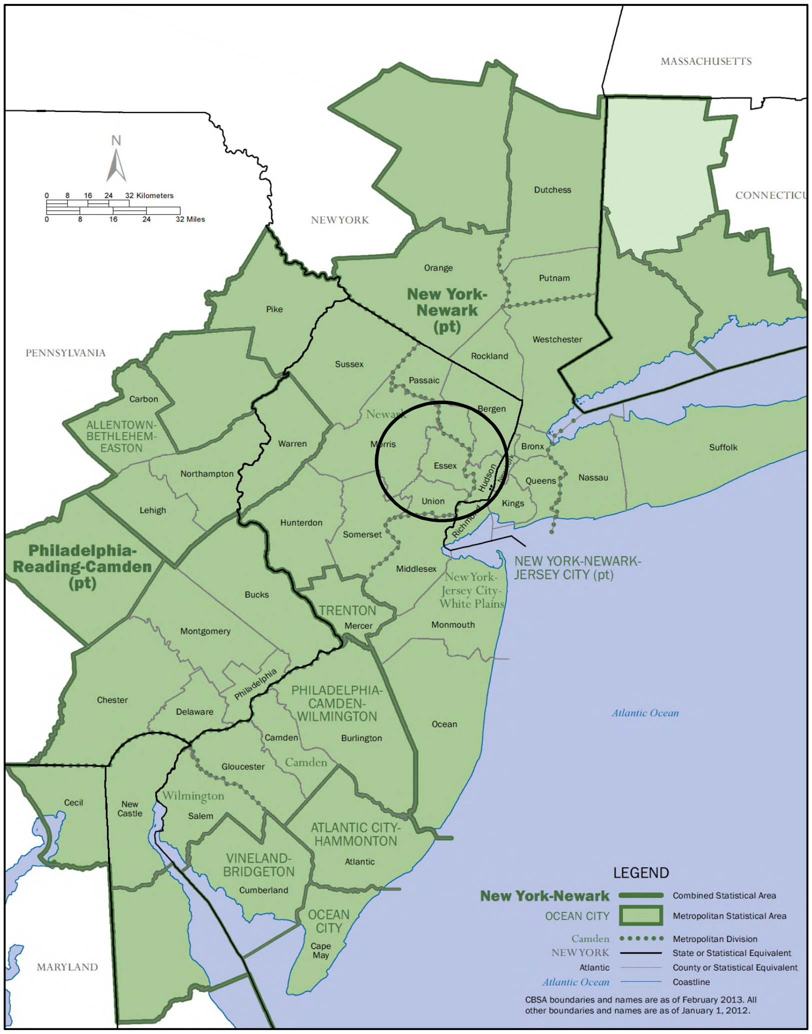
3.2 POPULATIONS AND DEMOGRAPHICS

According to the 2013-2017 American Community Survey 5-Year Estimates, Essex County had a population of 800,401 people which represents a slight increase from the 2010 U.S. Census population of 793,633 people; refer to Table 3-3. Overall, Essex County has experienced population growth between the 2010 Decennial Census and the 2013-2017 American Community Survey 5-Year Estimates. The City of Newark is the largest municipality by population with an estimated population of 282,803 persons. The smallest municipality by population is the Borough of Essex Fells. The Borough of North Caldwell saw the largest population increase with 7.3 percent population growth, followed by the Township of Maplewood with 3.5 percent population increase. The Borough of Essex Fells was the only municipality to experience population decrease in Essex County between 2010 and 2017, but the decrease was only 0.9 percent. Figure 3-5 below illustrates the distributions of population throughout Essex County based on the Census Bureau's census block geography.

Essex County is urbanized and developed with a population density of 6,174 people per square mile. The Census Bureau classifies 'urban' as all territory, population, and housing units located within an urbanized area (UA) or an urban cluster (UC). With a population of over 300,000 and a population density of over 1,000 people per square mile, Essex County is considered an urban area.

Essex County is one of the 23 counties in the New York–Northern New Jersey–Long Island NY-NJ-PA Metropolitan Statistical Area, which is the most populous metropolitan area in the United States and the fourth most populous in the world. The largest urbanized area in the United States is at the heart of the metropolitan area, the New York-Newark, NY-NJ-CT Urbanized Area (with an estimated 2018 population of 18,776,233 by the U.S. Census), which includes Essex County (U.S. Census Bureau). Based on commuting patterns, the Census Bureau also defines a wider functional metropolitan area, the *New York-Newark-Bridgeport, NY-NJ-CT-PA* Combined Statistical Area with an estimated population of 23,522,861 (as of 2018). This metropolitan area is made up of various divisions as shown on Figure 3-4.

Figure 3-4. New York-Northern New Jersey-Long Island, NY-NJ-PA Metropolitan Statistical Area



Source: U.S. Census, 2014

Note: Essex County is located in the Newark-Union, NJ-PA Metropolitan Division (circle)

Table 3-3. Essex County Population Statistics

Municipality	U.S. Census 2010							American Community Survey 2013-2017						
	Total	Pop. 65+	% Pop. 65+	Population Under 5	% Under 5	Low-Income Pop.*	% Low-Income Pop.	Total*	Pop. 65+*	% Pop. 65+	Population Under 5	% Under 5	Pop. Poverty**	% Below Poverty Level
Township of Belleville	35,926	4,263	11.9%	2,193	6.1%	2,827	7.9%	36,383	4,600	12.6%	2,147	5.9%	3,529	9.7%
Township of Bloomfield	47,315	5,665	12.0%	3,006	6.4%	3,747	7.9%	48,892	6,586	13.5%	3,031	6.2%	4,009	8.2%
Borough of Caldwell	7,822	1,257	16.1%	362	4.6%	545	7.0%	8,032	1,338	16.7%	393	4.9%	578	7.2%
Township of Cedar Grove	12,411	2,947	23.7%	602	4.9%	431	3.5%	12,638	3,289	26.0%	488	3.9%	240	1.9%
City of East Orange	64,270	7,572	11.8%	4,650	7.2%	9,798	15.2%	65,151	8,254	12.7%	4,193	6.4%	12,444	19.1%
Borough of Essex Fells	2,113	341	16.1%	120	5.7%	11	0.5%	2,095	378	18.0%	103	4.9%	21	1.0%
Township of Fairfield	7,466	1,528	20.5%	356	4.8%	230	3.1%	7,671	1,653	21.5%	449	5.9%	31	0.4%
Borough of Glen Ridge	7,527	718	9.5%	549	7.3%	78	1.0%	7,668	773	10.1%	427	5.6%	291	3.8%
Township of Irvington	53,926	4,829	9.0%	4,240	7.9%	7,324	13.6%	54,715	5,928	10.8%	4,268	7.8%	12,639	23.1%
Township of Livingston	29,366	4,942	16.8%	1,671	5.7%	792	2.7%	29,955	5,579	18.6%	1,380	4.6%	689	2.3%
Township of Maplewood	23,867	2,623	11.0%	1,849	7.7%	867	3.6%	24,706	2,867	11.6%	1,869	7.6%	1,334	5.4%
Township of Millburn	20,149	2,275	11.3%	1,240	6.2%	427	2.1%	20,387	2,492	12.2%	1,397	6.9%	489	2.4%
Township of Montclair	37,669	4,266	11.3%	2,191	5.8%	2,184	5.8%	38,572	4,678	12.1%	2,394	6.2%	3,086	8.0%
City of Newark	277,140	23,699	8.6%	20,924	7.5%	40,752	14.7%	282,803	27,341	9.7%	21,115	7.5%	80,033	28.3%
Borough of North Caldwell	6,183	870	14.1%	350	5.7%	93	1.5%	6,637	1,245	18.8%	156	2.4%	133	2.0%
Township of Nutley	28,370	4,115	14.5%	1,520	5.4%	2,241	7.9%	28,829	4,810	16.7%	1,634	5.7%	1,528	5.3%
City of Orange Township	30,134	3,364	11.2%	2336	7.8%	3,986	13.2%	30,731	4,161	13.5%	2,420	7.9%	7,375	24.0%
Borough of Roseland	5,819	1,282	22.0%	258	4.4%	226	3.9%	5,907	1,456	24.6%	229	3.9%	219	3.7%
Township of South Orange Village	16,198	1,705	10.5%	1,024	6.3%	710	4.4%	16,503	1,930	11.7%	827	5.0%	1,749	10.6%
Township of Verona	13,332	2,570	19.3%	771	5.8%	881	6.6%	13,585	2,697	19.9%	847	6.2%	380	2.8%
Township of West Caldwell	10,759	2,094	19.5%	551	5.1%	437	4.1%	10,932	2,462	22.5%	565	5.2%	328	3.0%
Township of West Orange	46,207	7,362	15.9%	3,056	6.6%	2,978	6.4%	47,609	8,277	17.4%	2,472	5.2%	3,618	7.6%
Essex County (TOTAL)	**783,969**	**90,287**	**11.5%**	**53,819**	**6.9%**	**81,565**	**10.4%**	**800,401**	**102,794**	**12.8%**	**52,804**	**6.6%**	**133,667**	**16.7%**

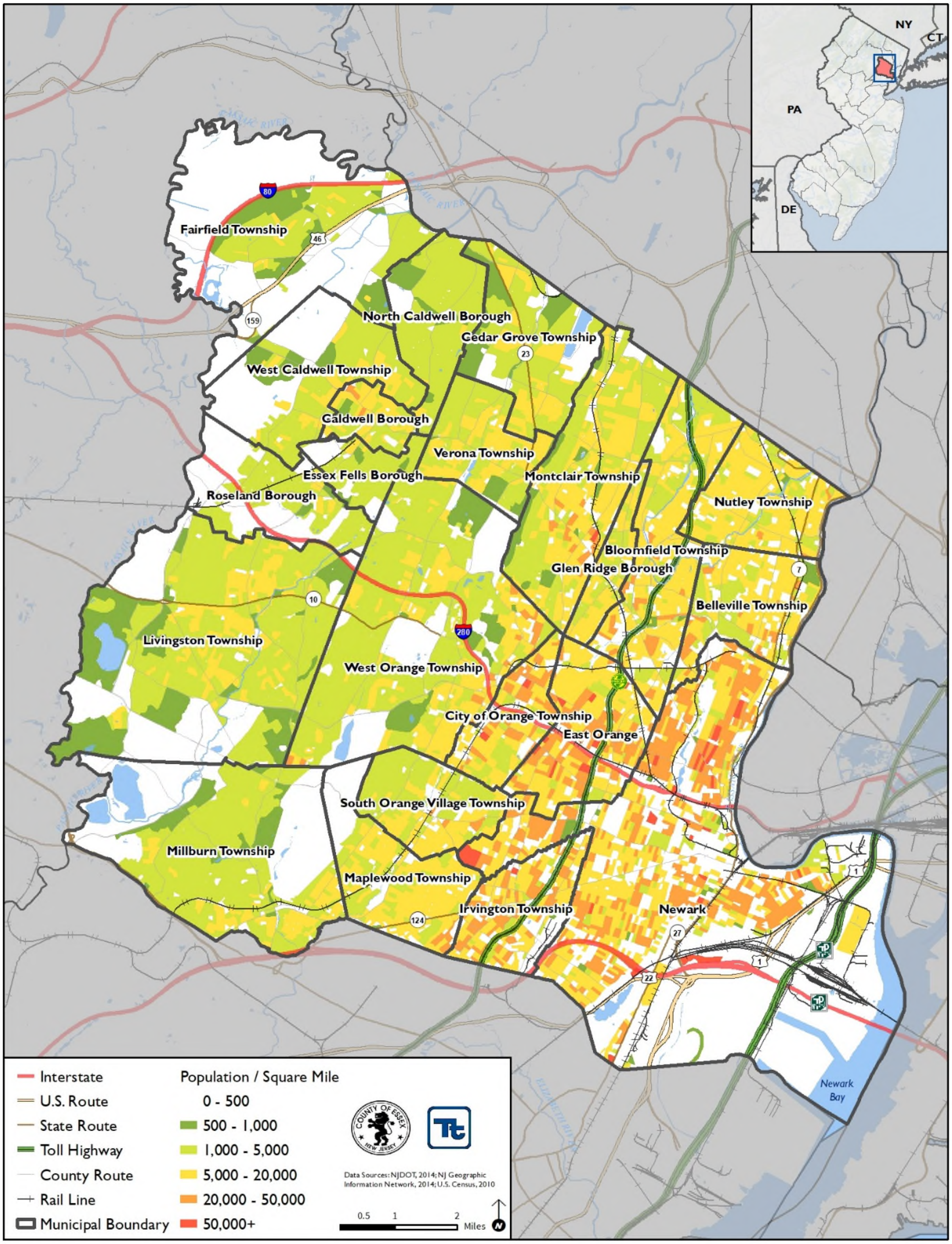
Source: U.S. Census 2010, 2018 (U.S. Census Bureau); HAZUS-MH v4.2 (for 2010 U.S. Census low income data)

Note: Pop. = population

** Low income population from HAZUS-MH v4.2 is the total of individuals with income $0-$10,000 and $10,000-$20,000 and $20,000-$30,000/year .*

********Low income population from the 2013-2017 ACS 5-Year Estimate is provided as percentage (%) of the municipal population, therefore the value displayed are calculated based on the percentage provided.*

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



3.2.1 Vulnerable Populations

Socially vulnerable populations can be more susceptible to hazard events, 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 population exposure to the hazards of concern identified in Essex County was evaluate for the following (1) the elderly (persons aged 65 and over), (2) those living in low-income households, (3) individuals with a disability, and (4) people who speak English less than "very well." Identifying concentrations of vulnerable populations can assist communities in targeting preparedness, response and mitigation actions.

Age

Children are considered vulnerable to hazard events because they are dependent on others to safely access resources during emergencies and may experience increased health risks from hazard exposure. 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. The elderly also are more likely to live in senior care and living facilities where emergency preparedness occurs at the discretion of facility operators

According to the 2013-2017 American Community Survey 5-Year Estimates, the median age in Essex County was 37.3 years. Of the estimated 2017 population, 52,804 (6.6 percent) of the County's population is under the age of 5 and 102,794 people (12.8 percent) of the County's total population were age 65 and older. Figure 3-6 and Figure 3-6 shows the distribution of persons under the age of 5 and over 65 in purple and orange respectively based on the United States Census Bureau's census block geography.

Income

The Census data for household income provided in HAZUS-MH includes three ranges ($0-10,000, $10,000-$20,000, and $20,000-$30,000/year) that were totaled to provide the "low-income" data used for the HMP update. This does not correspond exactly with the "poverty" thresholds established for 2010 by the U.S. Census Bureau, which identifies households with two adults and two children with an annual household income below $22,113 per year as "low income" in the United States. This difference is not believed to be significant for the purposes of this planning effort.

The 2013-2017 American Community Survey 5-Year Estimates provides that the median household income in Essex County was $57,365, and the per capita income was $35,133. The 2017 poverty threshold identified by U.S. Census Bureau identifies households with two adults and two children with an annual household income below $24,858 per year as *low income* (U.S. Census 2017). There are approximately 69,188 households in Essex County reported as having an annual income of less than $25,000 (U.S. Census 2018). The 2013-2017 American Community Survey 5-Year Estimates indicates a total of 133,667 (16.7 percent) persons below the poverty level residing in the County. Figure 3-6 shows the distribution of low-income persons in red based on the United States Census Bureau's census tract geography.

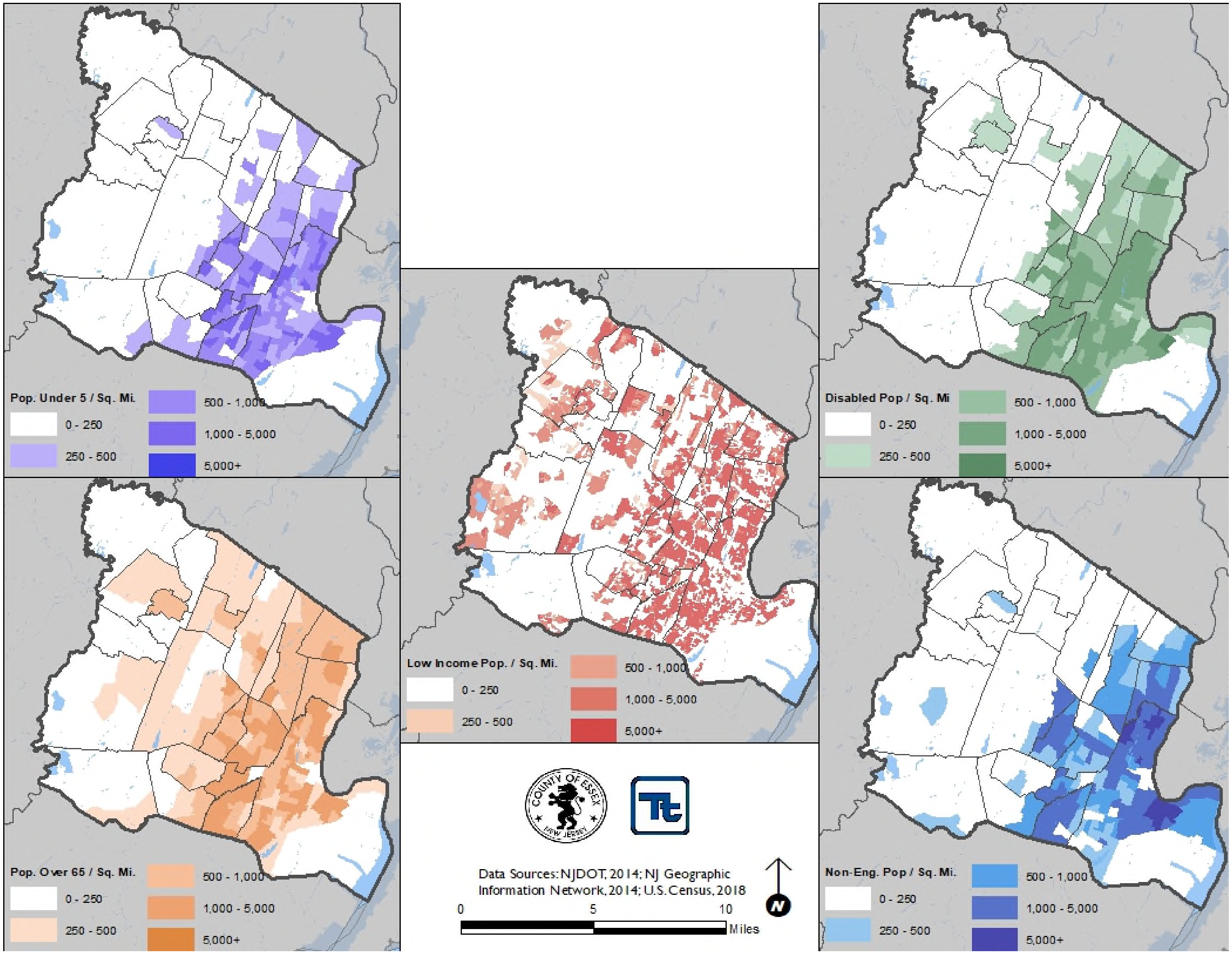
Physically or Mentally Disabled

According to the Centers for Disease Control, "Persons with a disability include those who have physical, sensory, or cognitive impairment that might limit a major life activity (Centers for Disease Control 2015)." Cognitive impairments can increase the level of difficulty that individuals might face during an emergency and reduce an individual's capacity to receive, process, and respond to emergency information or warnings. Individuals with a physical or sensory disability can face issues of mobility, sight, hearing, or reliance on specialized medical equipment. According to the 2013-2017 American Community Survey, 95,957 (12.2 percent) residents in Essex County are living with a disability. Figure 3-6 shows the geographic distribution of disabled individuals throughout Essex County, including individuals living with hearing, vision, cognitive, ambulatory, self-care, and independent living difficulties in green based on the United States Census Bureau's census tract geography.

Non-English Speakers

Individuals who are not fluent or working proficiency in English are considered vulnerable to hazard event impacts because they may have difficulty understanding emergency alert information. Cultural differences also can add complexity to how information is being conveyed to populations with limited proficiency of English (Centers for Disease Control 2015). According to the 2013-2017 American Community Survey, 109,897 persons (14.7 percent) of the County's population over the age of 5 are reported as speaking English "less than very well." Figure 3-6 shows the geographic distribution of individuals who speak English less than "very well" in blue based on the United States Census Bureau's census tract geography.

Figure 3-6. Distribution of Socially Vulnerable Populations in Essex County, New Jersey



3.2.2 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.

Essex County's population increased between 1990 and 2000 by approximately 2 percent. From 2000 to 2010 Essex County's population slightly decreased by approximately 1.2 percent. According to the 2013-2017 American Community Survey 5-Year Estimates, Essex County's total population is approximately 800,401 people, which is 2 percent increase from the 2010 population of 783,969 persons. Table 3-4 displays the change in population from 1990 to 2017 in Essex County.

Table 3-4. Essex County Population Trends, 1990 to 2017

Year	Population	Change in Population	Percent (%) Population Change
1990	778,206	-72,910	-8.6%
2000	793,633	15,427	2.0%
2010	783,969	-9,664	-1.2%
2011*	781,668	-2,301	-0.3%
2012*	783,840	2,172	0.3%
2013*	785,853	2,013	0.3%
2014*	789,616	3,763	0.5%
2015*	791,609	1,993	0.3%
2016*	792,586	977	0.1%
2017*	800,401	7,815	1.0%

Source: U.S. Census Bureau, 2000, 2010-2018

Note: Change in population and percent in population change was calculated from available data

**Population values from 2011-2017 represent the American Community Survey 5-Year Estimates products from the U.S. Census Bureau*

Between 2010 and 2017, all but one of Essex County's municipalities experienced an increase in population. The Borough of North Caldwell experienced the largest increase in population (7.3 percent). The Borough of Essex Fells was the only municipality to experience a population decrease; a decrease of 18 persons or 0.9 percent of the Borough's total population. Table 3-5 reports the 2010 and the 2013-2017 American Community Survey 5-Year Estimates population and the change in population for each respective municipality.

Table 3-5. Population Change by Municipality (2010-2017)

Municipality	2010 Census	2017 ACS	Change in Population	Percent (%) Population Change
Township of Belleville	35,926	36,383	457	1.3%
Township of Bloomfield	47,315	48,892	1577	3.3%
Borough of Caldwell	7,822	8,032	210	2.7%
Township of Cedar Grove	12,411	12,638	227	1.8%
City of East Orange	64,270	65,151	881	1.4%

Municipality	2010 Census	2017 ACS	Change in Population	Percent (%) Population Change
Borough of Essex Fells	2,113	2,095	-18	-0.9%
Township of Fairfield	7,466	7,671	205	2.7%
Borough of Glen Ridge	7,527	7,668	141	1.9%
Township of Irvington	53,926	54,715	789	1.5%
Township of Livingston	29,366	29,955	589	2.0%
Township of Maplewood	23,867	24,706	839	3.5%
Township of Millburn	20,149	20,387	238	1.2%
Township of Montclair	37,669	38,572	903	2.4%
City of Newark	277,140	282,803	5,663	2.0%
Borough of North Caldwell	6,183	6,637	454	7.3%
Township of Nutley	28,370	28,829	459	1.6%
City of Orange Township	30,134	30,731	597	2.0%
Borough of Roseland	5,819	5,907	88	1.5%
Township of South Orange Village	16,198	16,503	305	1.9%
Township of Verona	13,332	13,585	253	1.9%
Township of West Caldwell	10,759	10,932	173	1.6%
Township of West Orange	46,207	47,609	1,402	3.0%

Source: U.S. Census Bureau 2010, 2018

The North Jersey Transportation Planning Authority (NJTPA) generates regional forecasts for population, households, and employment every four years, as part of updating its Regional Transportation Plan. Overall, it is projected that the County will reach a population of 909,020 in the year 2045, which is a 15-percent population increase. The Borough of Essex Fells is projected to have the highest population increase with a projected change of 28.8 percent. The Borough of North Caldwell is projected the have the lowest population increased with a projected population chance of 6.7 percent. Table 3-6 displays the population, household, and employment projections for each municipality within Essex County.

Table 3-6. NJTPA Population and Employment Forecast (2015-2045)

Municipality Name	2015 Population	2045 Population	Annualized % Population Change 2015-2045	2015 Households	2045 Households	Annualized % Household Change 2015-2045	2015 Employment	2045 Employment	Annualized % Employment Change 2015-2045	Projected Population Change % (2015-2045)*
Township of Belleville	35,989	41,246	0.5%	13,626	16,018	0.5%	9,360	11,120	0.6%	14.6%
Township of Bloomfield	47,462	55,005	0.5%	18,704	22,327	0.6%	12,987	15,935	0.7%	15.9%
Borough of Caldwell	7,834	8,972	0.5%	3,417	4,009	0.5%	2,420	2,847	0.5%	14.5%
Township of Cedar Grove	12,442	14,364	0.5%	4,601	5,440	0.6%	5,099	5,772	0.4%	15.4%
City of East Orange	64,458	71,358	0.3%	25,385	28,971	0.4%	15,104	18,084	0.6%	10.7%
Borough of Essex Fells	2,122	2,733	0.8%	741	1,000	1.0%	280	475	1.8%	28.8%
Township of Fairfield	7,490	8,645	0.5%	2,691	3,178	0.6%	23,960	25,148	0.2%	15.4%
Borough of Glen Ridge	7,543	8,589	0.4%	2,519	2,935	0.5%	1,098	1,368	0.7%	13.9%
Township of Irvington	54,118	59,045	0.3%	20,486	22,977	0.4%	8,945	10,905	0.7%	9.1%
Township of Livingston	29,449	34,385	0.5%	10,162	12,183	0.6%	22,575	24,634	0.3%	16.8%
Township of Maplewood	23,925	27,523	0.5%	8,382	9,951	0.6%	6,271	7,567	0.6%	15.0%
Township of Millburn	20,195	22,947	0.4%	6,930	8,100	0.5%	16,947	18,305	0.3%	13.6%
Township of Montclair	37,788	44,553	0.6%	15,349	18,688	0.7%	21,043	24,172	0.5%	17.9%
City of Newark	282,102	328,809	0.5%	97,269	118,483	0.7%	157,852	180,960	0.5%	16.6%
Borough of North Caldwell	6,196	6,612	0.2%	2,128	2,330	0.3%	306	447	1.3%	6.7%
Township of Nutley	28,439	33,531	0.6%	11,509	13,972	0.6%	10,787	15,472	1.2%	17.9%
City of Orange Township	30,200	34,720	0.5%	11,395	13,481	0.6%	7,007	8,776	0.8%	15.0%
Borough of Roseland	5,836	6,673	0.4%	2,385	2,790	0.5%	12,693	13,399	0.2%	14.4%
Township of South Orange Village	16,245	18,650	0.5%	5,611	6,686	0.6%	7,676	8,673	0.4%	14.8%
Township of Verona	13,352	15,373	0.5%	5,407	6,379	0.6%	4,486	5,211	0.5%	15.1%
Township of West Caldwell	10,789	12,001	0.4%	3,980	4,558	0.5%	10,129	10,870	0.2%	11.2%
Township of West Orange	46,314	53,287	0.5%	17,079	20,174	0.6%	15,687	18,193	0.5%	15.1%

Source: North Jersey Transportation Planning Authority Approved Demographic and Employment Forecasts 2017

Note: Projected population change percentage was calculated based off of the values displayed in the 2015 and 2045 Population columns.

3.3 GENERAL BUILDING STOCK

The 2013-2017 American Community Survey 5-Year Estimates data identifies 280,327 households (315,186 housing units) in Essex County. The 2010 U.S. Census reported 283,712 households (312,954 housing units) in Essex County. The County experienced an 0.7 percent increase in housing units from 2010 to 2017, but a 1.2 percent decrease in the number of households. The U.S. Census defines household as all the persons who occupy a housing unit, and a housing unit as a house, an apartment, a mobile home, a 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 Essex County was estimated at $362,300 (U.S. Census, 2018).

For the plan update, the default general building stock in HAZUS-MH was updated and replaced with a custom-building inventory for Essex County; refer to Section 4.2 (Methodology and Tools) for further details regarding the data used to develop the inventory. There are 162,388 structures included in the custom-building inventory. The total replacement cost value of the structures is an estimated $73 billion. Estimated content value was calculated by using 50-percent of the residential improvement value, and 100-percent of the non-residential improvement values. Using this methodology, there is approximately $51 billion in contents within these improved properties. The total replacement cost of structure and contents value in Essex County combined is $125 billion. Approximately 88-percent of the total buildings in the County are classified as residential, 5.3-percent of buildings are classified as commercial, and 1.1-percent of buildings are classified as industrial. Table 3-7 presents building stock statistics by general occupancy class for residential, commercial, and industrial buildings in Essex County.

Table 3-7. Number of Buildings and Improvement Value by General Occupancy Class

Municipality	All Occupancies				Residential		Commercial		Industrial	
	Count	RCV (Structure Only)	RCV (Contents Only)	Total RCV (Structure + Contents)	Count	Total RCV (Structure + Contents)	Count	Total RCV (Structure + Contents)	Count	Total RCV (Structure + Contents)
Township of Belleville	7,910	$2,698,371,020	$1,784,879,118	$4,483,250,138	7,279	$2,740,475,708	357	$652,508,025	106	$689,435,812
Township of Bloomfield	11,720	$3,668,749,043	$2,352,340,844	$6,021,089,887	10,903	$3,949,224,597	468	$1,035,039,905	23	$180,373,161
Borough of Caldwell	1,738	$711,283,402	$471,921,579	$1,183,204,981	1,525	$718,085,469	121	$179,064,829	0	$0
Township of Cedar Grove	3,944	$1,812,062,362	$1,195,983,423	$3,008,045,785	3,643	$1,848,236,818	127	$258,578,794	43	$409,346,827
City of East Orange	7,908	$3,661,597,262	$2,429,169,650	$6,090,766,912	7,164	$3,697,282,838	386	$868,105,632	34	$155,254,899
Borough of Essex Fells	766	$337,961,118	$189,668,544	$527,629,662	716	$444,877,721	7	$16,158,273	0	$0
Township of Fairfield	3,121	$3,280,911,340	$2,801,908,028	$6,082,819,367	2,410	$1,437,009,936	264	$1,144,523,441	295	$3,084,965,050
Borough of Glen Ridge	2,256	$694,958,216	$400,516,047	$1,095,474,263	2,179	$883,326,507	21	$79,855,000	0	$0
Township of Irvington	7,934	$3,187,766,948	$2,197,071,869	$5,384,838,816	7,150	$2,972,085,238	416	$804,704,169	103	$805,195,796
Township of Livingston	9,795	$4,683,896,484	$3,007,480,327	$7,691,376,811	9,231	$5,029,248,470	278	$1,178,303,530	42	$231,013,392
Township of Maplewood	6,738	$2,187,933,750	$1,387,461,850	$3,575,395,600	6,366	$2,401,415,698	219	$523,721,327	23	$126,884,560
Township of Millburn	6,437	$3,227,413,370	$2,014,153,766	$5,241,567,136	6,035	$3,639,778,812	241	$941,235,812	43	$180,888,294
Township of Montclair	9,436	$3,592,077,078	$2,253,899,052	$5,845,976,130	8,645	$4,014,534,076	531	$840,037,607	4	$13,753,523
City of Newark	43,085	$22,631,425,110	$18,339,124,315	$40,970,549,425	33,549	$12,876,902,385	3,662	$6,634,946,442	974	$7,477,529,170
Borough of North Caldwell	2,095	$1,092,780,064	$634,987,378	$1,727,767,442	2,010	$1,373,378,058	13	$37,018,019	2	$11,238,510
Township of Nutley	7,945	$2,394,461,023	$1,447,092,699	$3,841,553,722	7,431	$2,842,104,973	369	$570,093,785	16	$40,822,569
City of Orange Township	3,890	$2,049,714,805	$1,471,150,904	$3,520,865,708	3,195	$1,735,691,703	349	$717,480,738	25	$92,400,329
Borough of Roseland	1,794	$1,141,841,136	$813,646,144	$1,955,487,279	1,567	$984,584,977	75	$259,646,418	26	$147,611,682
Township of South Orange Village	4,188	$1,776,332,135	$1,101,042,051	$2,877,374,186	3,916	$2,025,870,251	125	$197,079,511	5	$15,132,547
Township of Verona	4,113	$1,371,207,640	$842,130,973	$2,213,338,613	3,841	$1,587,230,002	169	$324,706,785	10	$24,452,220
Township of West Caldwell	3,730	$2,040,415,478	$1,492,629,342	$3,533,044,820	3,458	$1,643,358,407	131	$385,512,019	73	$1,204,333,072
Township of West Orange	11,845	$5,124,878,158	$3,233,905,700	$8,358,783,858	10,682	$5,672,917,373	389	$1,170,913,430	27	$153,979,701
Essex County	**162,388**	**$73,368,036,940**	**$51,862,163,602**	**$125,230,200,542**	**142,895**	**$64,517,620,015**	**8,718**	**$18,819,233,493**	**1,874**	**$15,044,611,113**

Source: New Jersey Office of Information Technology, Office of GIS 2019

The 2013-2017 American Community Survey 5-Year Estimates data identified that the majority of housing units (34.8% or 97,473 units) in Essex County are single-family detached units. The 2016 U.S. Census Bureau's County Business Patterns data identified 18,763 business establishments employing 289,030 people in Essex County. The retail trade industry has the greatest number of establishments in the County(a total of 2,676). This is followed by the health care and social assistance industry with 2,490 establishments and the professional, scientific, and technical services industry with 2,151 establishments (U.S. Census, 2018).

Figure 3-14 through Figure 3-16 show the distribution and exposure density of residential, commercial and industrial buildings in Essex County. The densities are shown in units of $1,000,000 ($M) per square mile. Viewing exposure distribution maps, such as Figure 3-7 through Figure 3-9, can assist communities in visualizing areas of high exposure and in evaluating aspects of the study area in relation to the specific hazard risks.

Figure 3-7. Distribution of Residential Building Stock and Value Density in Essex County

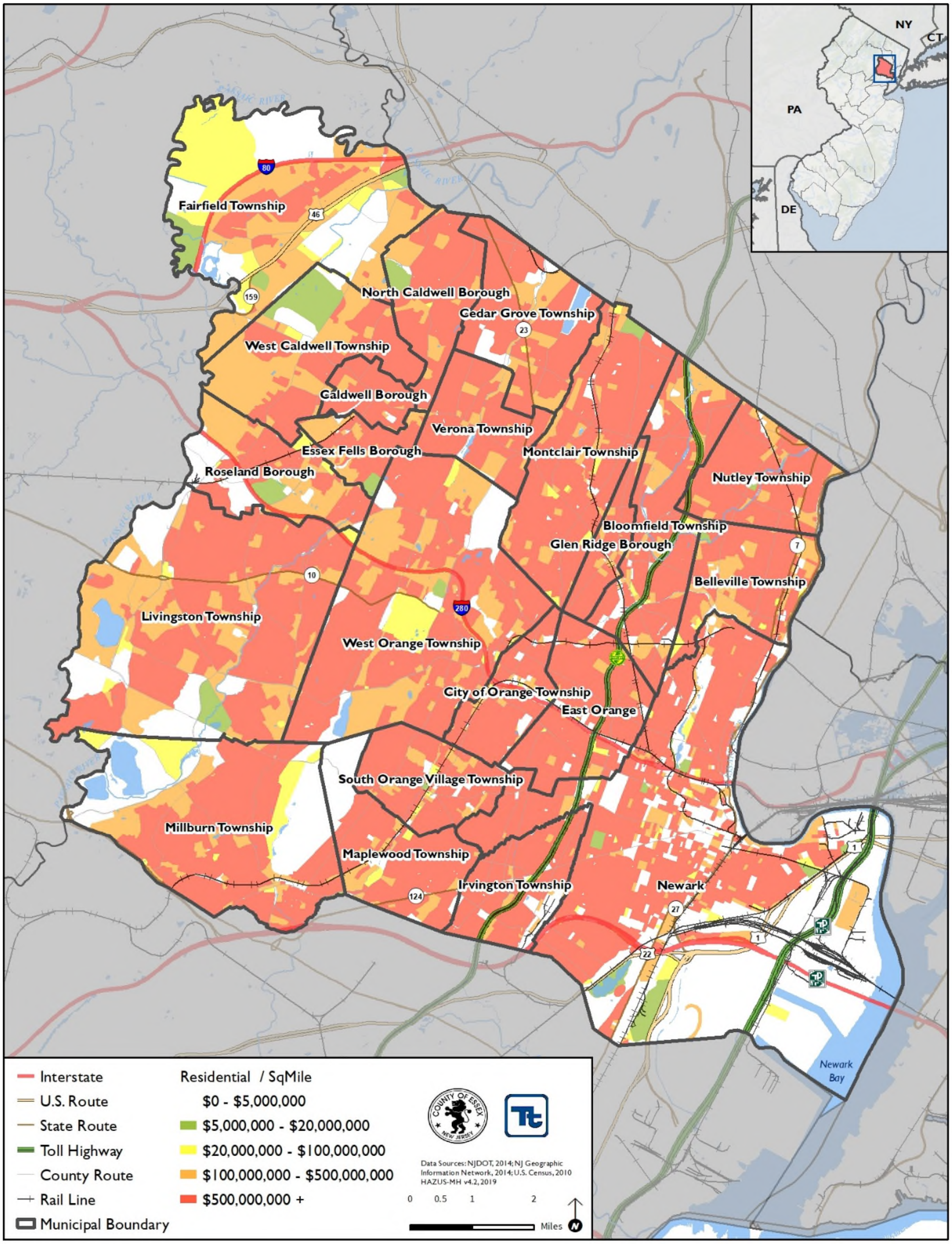


Figure 3-8. Distribution of Commercial Building Stock and Exposure Density in Essex County

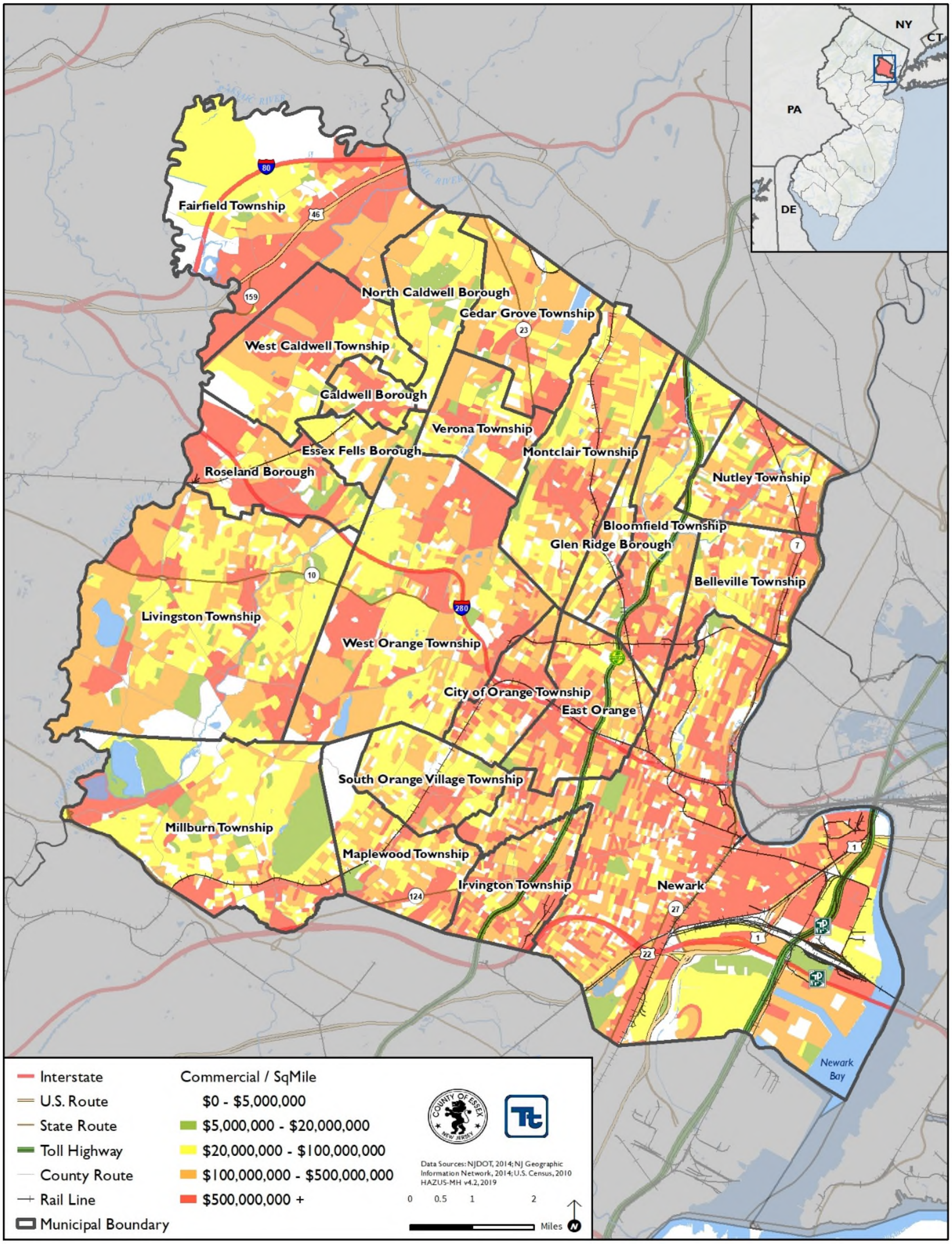
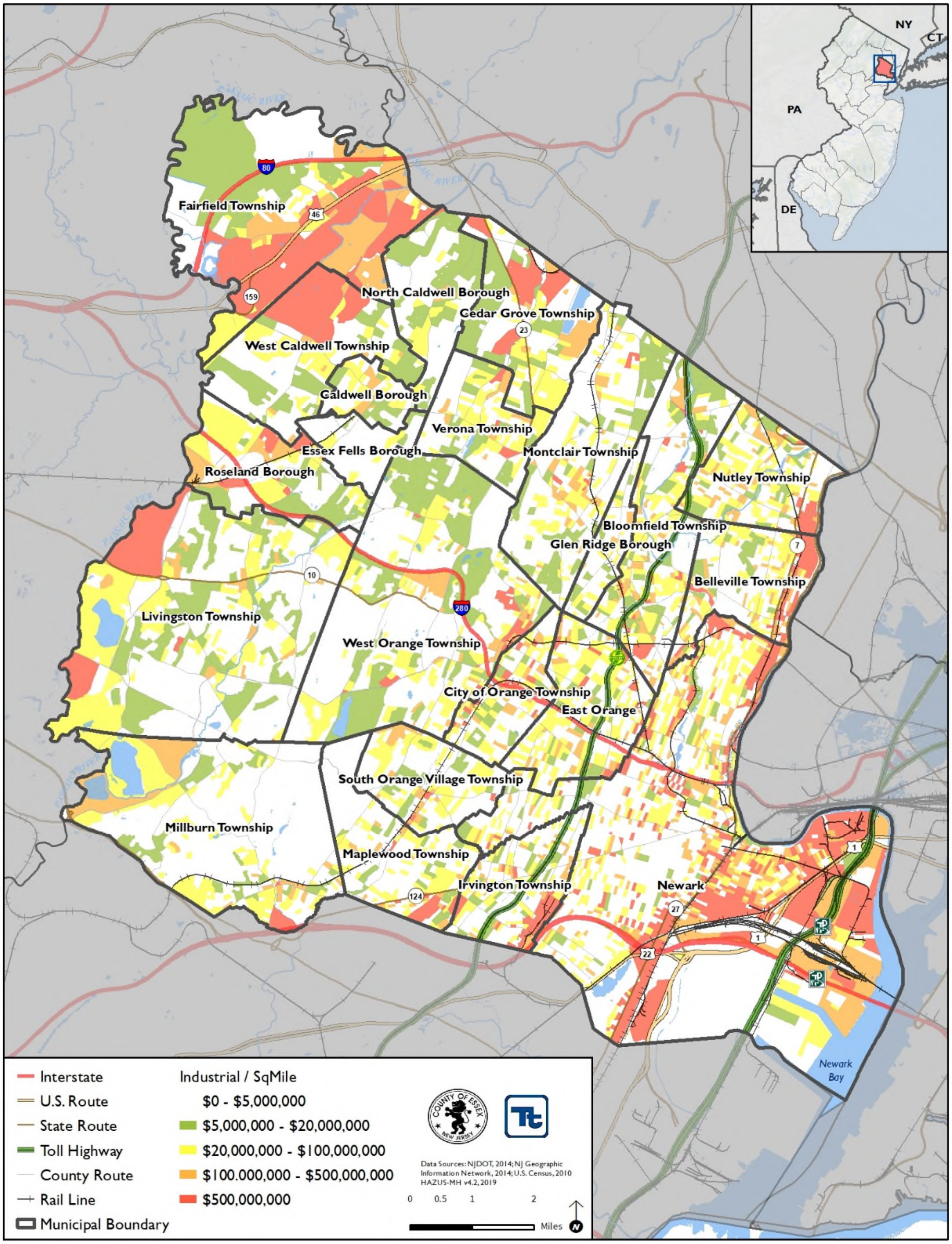


Figure 3-9. Distribution of Industrial Building Stock and Value Density in Essex County



3.4 DEVELOPMENT TRENDS AND NEW DEVELOPMENT

Essex County is highly developed and built out with approximately 80% of the land cover within the County being classified as Urban area. Because of this build out within the County, redevelopment of existing land to maximize community needs is becoming the growing focus. The Together North Jersey (TNJ) created a regional Comprehensive Economic Development Strategy (CEDS) for the North Jersey Region. This plan identifies regional economic development strategies. Strategies within this plan include providing incentives for targeted job creation, private sector investment in underutilized land for mixed-use development, using the regional transportation and utility system for future investment, and leveraging the strategic location and infrastructure as a source of economic growth (TNJ, 2015). The Essex County 2015-2019 Consolidated Plan and 2018 One Year Action Plan identifies goal and objectives within the County which will be funded through CDBG, HOME, and ESG grant funding. The top goal identified in the plan was to "create and retain affordable housing units" with the total estimate construction or rehabilitation of 34 housing units (Essex County, 2015).

Each municipality identified areas of recent development and proposed development in their community which were then geocoded using the provided address or Parcel ID. Potential future development in the County as identified by each municipality is noted in Table 3-8 and Figure 3-10. Refer to Section 4.3 for a discussion regarding the spatial relationship between the proposed new development and the hazards of concern.

Table 3-8. Potential New Development in Essex County

Municipality	Property Name	Type	Number of Structures	Address/Block and Lot	Description/Status
Township of Belleville	Former Essex County Property	Mixed-Use	Unknown	570 Belleville Ave.	Recently Sold
Township of Belleville	Former Roche Diagnostic	Mixed-Use	Unknown	11 Franklin Ave.	In Progress
Township of Belleville	Former School #1	Mixed-Use	Unknown	190 Cortland St.	In Progress
Township of Belleville	Liquid Carbonic	Mixed-Use	Unknown	666 Washington Ave.	On Hold
Township of Belleville	Senior Citizen Housing	Residential	Unknown	125 Franklin Ave.	In Progress
Township of Bloomfield	192 Bloomfield, LLC	Mixed-Use	312 units	B: 64 L: 1, 4	App/Rej.
Township of Bloomfield	Glenwood Village Redevelopment	Mixed-Use	224 units/60000 SF Commercial	B: 228 L: 1, 4, 5, 7, 8, 10, 11, 13, 14, 15, 16, 17, 18, 19, 21, 24, 27, 28, 29, 30, 31, 33, 35	N/A
Township of Bloomfield	Urban Smart Growth	Residential	114 units	B: 335 L: 26, 30	App/Rej.
Borough of Caldwell	Sisters of St. Dominic of Caldwell	Institutional	33 units	B: 64 L: 1, 2	App.
Township of Cedar Grove	Grove Avenue LLC	Residential	24 units	B: 71 L: 2	App/Rej.
City of East Orange	120 Halstead Street	Residential	50+ units	120 Halstead St.	In progress
City of East Orange	125 South Harrison	Residential	103 units	125 South Harrison	Planned
City of East Orange	144 South Harrison	Residential	50+ units	144 South Harrison	Planned
City of East Orange	20 Evergreen Place	Residential		20 Evergreen Pl.	Planned
City of East Orange	30 Evergreen Place	Residential	200 units	30 Evergreen Pl.	Planned

Table 3-8. Potential New Development in Essex County

Municipality	Property Name	Type	Number of Structures	Address/Block and Lot	Description/Status
City of East Orange	742 Park Avenue	Residential	50+ units	742 Park Ave.	Planned
Township of Fairfield	Oak Park Construction	Residential	18 units	B: 5003 L: 3 / B: 4701 L: 3.03	Preliminary approval
Township of Irvington	Hilltop Partners, LLC	Residential	704 units	B: 324 L: 1	Municipal Hospital sold for site redevelopment as a 700 unit residential community. Project has been approved by the Planning Board.
Township of Irvington	Valley Plaza Mall	Commercial	1 unit	480 Chancellor Ave.	Rehabilitation/upgrading of existing commercial structure.
Township of Livingston	Hillside Northfield	Residential	80 units	B: 5500 L: 5, 7, 8, 9	PB approved
Township of Livingston	Squiretown	Residential	220 units	B: 5900 L: 33, 34, 35, 36, 37, 42	PB approved

Table 3-8. Potential New Development in Essex County

Municipality	Property Name	Type	Number of Structures	Address/Block and Lot	Description/Status
Township of Maplewood	71 Dunnell Road	Residential	10 units	67-79 Dunnell Rd.	PB approved
Township of Maplewood	CVS	*Commercial*	13,000 SF	453 Valley St.	PB approved
Township of Maplewood	DAIBES	Commercial	6 units/10,000 SF Commercial	1611 Springfield Ave.	5% Complete
Township of Maplewood	Elite Properties	Residential	126 units	B: 48.47 L: 5.01, 6.01, 7	50% complete
Township of Maplewood	Elite Properties	Residential	134 units	92 Burnett Ave.	N/A
Township of Maplewood	Parke Place at Maplewood LLC	Residential	235 units	B: 44.02 L: 2	N/A
Township of Maplewood	Post Office Redevelopment	Mixed-Use	24 units/15,000 SF Commercial	160 Maplewood Ave.	Conceptual
Township of Maplewood	PSEG Redevelopment	Residential	235 units	200 Boyden Ave.	Redevelopment, Approved by Planning Board
Township of Millburn	Special Improvement District	Mixed-Use	Unknown	179 Millburn Ave.	Storm Water/Sewer
Township of Millburn	Stop and Shop (Springfield NJ) Bordering Short Hills	Commercial	1 unit	520-550 Millburn Ave.	Unknown
Township of Millburn	Toll Brothers-The Enclaves	Residential	30 units	1 Short Hills Ave.	Installed Tension Basin/Relocate Join Meeting Line
Township of Montclair	190-192 Bloomfield Avenue	Residential	11 units	190-192 Bloomfield Ave.	Under Construction
Township of Montclair	Centro Verde	Mixed-Use	226 units/ 40,000 SF Commercial	638 Bloomfield Ave.	Under Construction
Township of Montclair	Kensington	Residential	88 units	65 Church St.	Construction
Township of Montclair	Montclairion II	Residential	40 units	10 Pine St.	Planning Board
Township of Montclair	HD Orange 2013 Urban Renewal	Commercial	148 room hotel	Block 1401, Lot 1.01	
City of Newark	Chadwick Capital/Clinton Newark, LLC	Residential	7 Story Building	505-509 Clinton Ave.	N/A

Table 3-8. Potential New Development in Essex County

Municipality	Property Name	Type	Number of Structures	Address/Block and Lot	Description/Status
City of Newark	HELP | Springfield Avenue Urban Renewal Company LP	Residential	45 units	B: 2614 L: 1, 2, 4, 5, 30, 31, 32, 33, 34	App/Rej.
City of Newark	Hess NEC, LLC	Industrial	655 MW Electrical Generation Plant	B: 5074 L: 25, 25.01	N/A
City of Newark	Mid-Atlantic Investment Alliance, LLC	Residential	24 units	90-96 Clinton Ave.	N/A
City of Newark	TDAF | Springfield Avenue Urban Renewal Company LP	Mixed-Use	152 units	B: 236 L: 1.01, 1.02, 1.03, 1.04	App.
City of Newark	The Plaza at Springfield, LP	Mixed-Use	5 Story Mixed-Use w/ 50 units	B: 253 L: 27, 29, 30, 37	N/A
Borough of North Caldwell	Block 50, Lots 1 & 2	Residential	5 units	600 Mountain Ave.	5 single family homes/ Approved
Borough of North Caldwell	Hilltop Drive	Residential	62 units	B: 101 L: 3	62 single family homes/Planning
Township of Nutley	East Centre Street	Residential	3 structures	B: 9604 L: 13	Project completed
Township of Nutley	East Centre Street	Residential	4 structures	B: 9700 L: 1	Project initiated
Township of Nutley	Hillside Avenue	Mixed-Use	Unknown	B: 2000 L: 27	Project not yet determined
Township of Nutley	River Road	Residential	2 structures	B: 9701 L: 7	Project completed
Township of Nutley	Roche	Mixed-Use	Unknown	B: 102 L: 2, 9	Project not yet determined
Township of Nutley	Roche	Mixed-Use	Unknown	B: 2101 L: 1	Project not yet determined
Township of Nutley	Roche	Mixed-Use	Unknown	B: 2000 L: 4, 5	Project not yet determined
Township of Nutley	Roche	Mixed-Use	Unknown	B: 200 L: 2, 3, 4, 5, 6, 24	Project not yet determined
Township of Nutley	Roche	Mixed-Use	Unknown	B: 201 L: 1	Project not yet determined
Township of Nutley	Roche	Mixed-Use	Unknown	B: 300 L: 1	Project not yet determined
Township of Nutley	Roche	Mixed-Use	Unknown	B: 2304 L: 18 Q: C0001-C0003	Project not yet determined
Township of Nutley	Roche	*Mixed-Use*	Unknown	B: 2100 L: 9 Q: C0101-C0107 B: 2100 L: 9 Q: C0110-C0111	Project not yet determined

Table 3-8. Potential New Development in Essex County

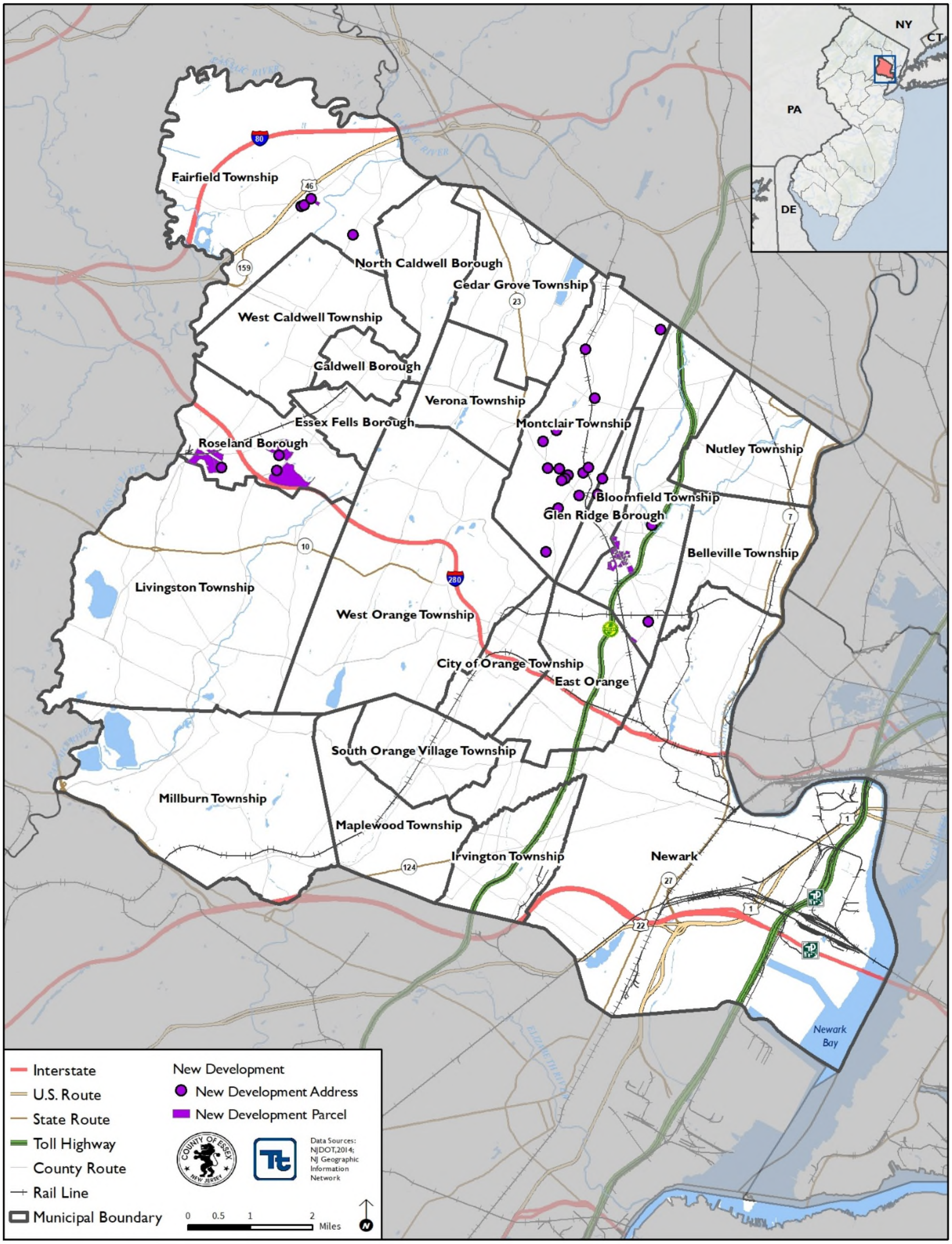
Municipality	Property Name	Type	Number of Structures	Address/Block and Lot	Description/Status
City of Orange Township	Franklin Development Group, LLC	Residential	14 units	B: 2201 L: 21	App.
City of Orange Township	Franklin Development Group, LLC	Residential	136 units	B: 2201 L: 19, 20	App.
City of Orange Township	Berg Hat Factory-HANDS	Mixed-Use	38 units	475 S. Jefferson St.	App.
City of Orange Township	Harvard Development Association	Residential	128 units	550 Central Ave.	Remediation plan approved
City of Orange Township	L&M Development	Mixed-Use	74 units	50 & 55 S. Essex Ave.	Under construction
City of Orange Township	Living Fountain	Mixed-Use	40 units	169-177Central Ave.	Site plans approved
City of Orange Township	Nat West Realty	Mixed-Use	19 units	555 Central Ave.	Under construction
Borough of Roseland	Avalon Bay Subdivision, Locust Avenue	Residential	130 units	55 Locust Ave.	130 unit apartment complex rentals
Borough of Roseland	Avalon Bay Communities, Inc.	Residential	136 units	B: 32 L: 13	App.
Borough of Roseland	Eagle Rock Avenue, B-1 zone office development	Commercial	1 unit	161 Eagle Rock Ave.	Multi-office; 6,000 square feet
Borough of Roseland	Woodland Road redevelopment office site	Unknown	Unknown	9 Woodland Rd.	Unknown
Township of South Orange Village	The Gateway	Residential	57 units	9-25 W. South Orange Ave.	57 Apartments / 9100 feet retail space
Township of South Orange Village	Third & Valley	Residential	215 units	165 Valley St.	215 Apartments / 3000 square feet retail space
Township of South Orange Village	Third & Valley Urban Renewal, LLC	Mixed-Use	215 units	B: 2304 L: 3, 4, 5, 6, 7, 8, 9	App/Rej.
Township of Verona	163 Bloomfield Avenue	Mixed-Use	Unknown	163 Bloomfield Ave.	Planning stage
Township of Verona	200 Bloomfield Avenue	Mixed-Use	Unknown	200-210 Bloomfield Ave.	Planning stage
Township of Verona	623-625 Bloomfield Avenue	Commercial	Unknown	623-625 Bloomfield Ave.	Planning stage
Township of Verona	860 Bloomfield Avenue	Commercial	Unknown	860 Bloomfield Ave.	Planning stage

Table 3-8. Potential New Development in Essex County

Municipality	Property Name	Type	Number of Structures	Address/Block and Lot	Description/Status
Township of Verona	DMH 2, LLC	Mixed-Use	15 units/7000 SF Commercial	B: 8 L: 1, 23	App.
Township of Verona	US Home Corporation d/b/a Lennar	Residential	33 units	B: 72 L: 1	In progress. Multiple townhouses and single family homes have been built.
Township of West Orange	Harvard Development Urban Renewal Associates	Residential	228 Units	B: 9 L: 1, 7, 44, 50, 56	See Orange SP 061113
Township of West Orange	Prism Green Urban Renewal Associates	Residential	334 units	B: 66 L: 1, 5, 7	App/Rej.

Source: Planning Committee

Figure 3-10. Potential New Development in Essex County



3.5 CRITICAL FACILITIES

> ***Critical facilities*** are those facilities considered critical to the health and welfare of the population and that are especially important following a hazard. As defined for this HMP, critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities and hazardous material facilities.
>
> ***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).

Critical facilities include essential facilities, transportation systems, utility systems, high potential loss facilities, and hazardous materials facilities. Essential facilities include police, fire, EMS, EOCs, schools, shelters, senior facilities and medical facilities. Transportation systems include roadways, bridges, airways, and waterways. Utility systems include potable water, wastewater, oil, natural gas, electric power facilities, and emergency communication facilities.

An enhancement to the 2020 HMP was the identification of community lifelines across Essex County. FEMA defines a lifeline as: "*providing 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.

The 2020 HMP critical facility inventory was reviewed and updated by the Planning Partnership. Plan participants then identified which of the critical facilities are considered lifelines. The inventory presented in this section represents the current state of this effort at the time of the publication of the HMP update and used for the risk assessment in Section 4.

The inventory of critical facilities and lifelines identified for the HMP 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.

3.5.1 Essential Facilities

This section provides information on emergency facilities, hospital and medical facilities, schools, shelters and senior care and living facilities.

Emergency Facilities

The infrastructure of Essex County is a highly developed network of civil services, healthcare, utility, education, and transportation facilities. All services are interconnected through the Essex County Office of Emergency Management (OEM). The OEM maintains a list of each service. In the case of an emergency, the OEM can coordinate response activities with each service relative to the emergency issue. For the HMP, emergency facilities include police, fire, emergency medical services (EMS) and emergency operations centers (EOC).

Every municipality maintains its own police department, fire department and emergency operations center (EOC). The one exception is the Borough of Glen Ridge whose fire services are provided through the Township of Montclair's Fire Department. In addition, municipalities offer their services to neighboring communities in times of emergency. There are 15 major medical and hospital centers located in the County.

Correctional Facilities

The mission of the Essex County Department of Corrections is to ensure that all persons committed to the County correctional institutions are confined with the level of custody necessary to protect the public and that they are provided with the care, discipline, training, and treatment needed to prepare them for reintegration into the community. Essex County maintains one prison facility and one juvenile detention center, both located in the City of Newark.

Schools

Essex County has a rich diversity of people served by close to 400 schools ranging from elementary to post-secondary education. Schools can function as shelters or warming/cooling centers in times of needs and are important resources for the community. Identification of schools is important due to the daytime population of each facility and the potential impacts of disasters. Additionally, there are several colleges and universities within Essex County. There are 380 schools, and 11 colleges and universities within Essex County.

Senior Facilities

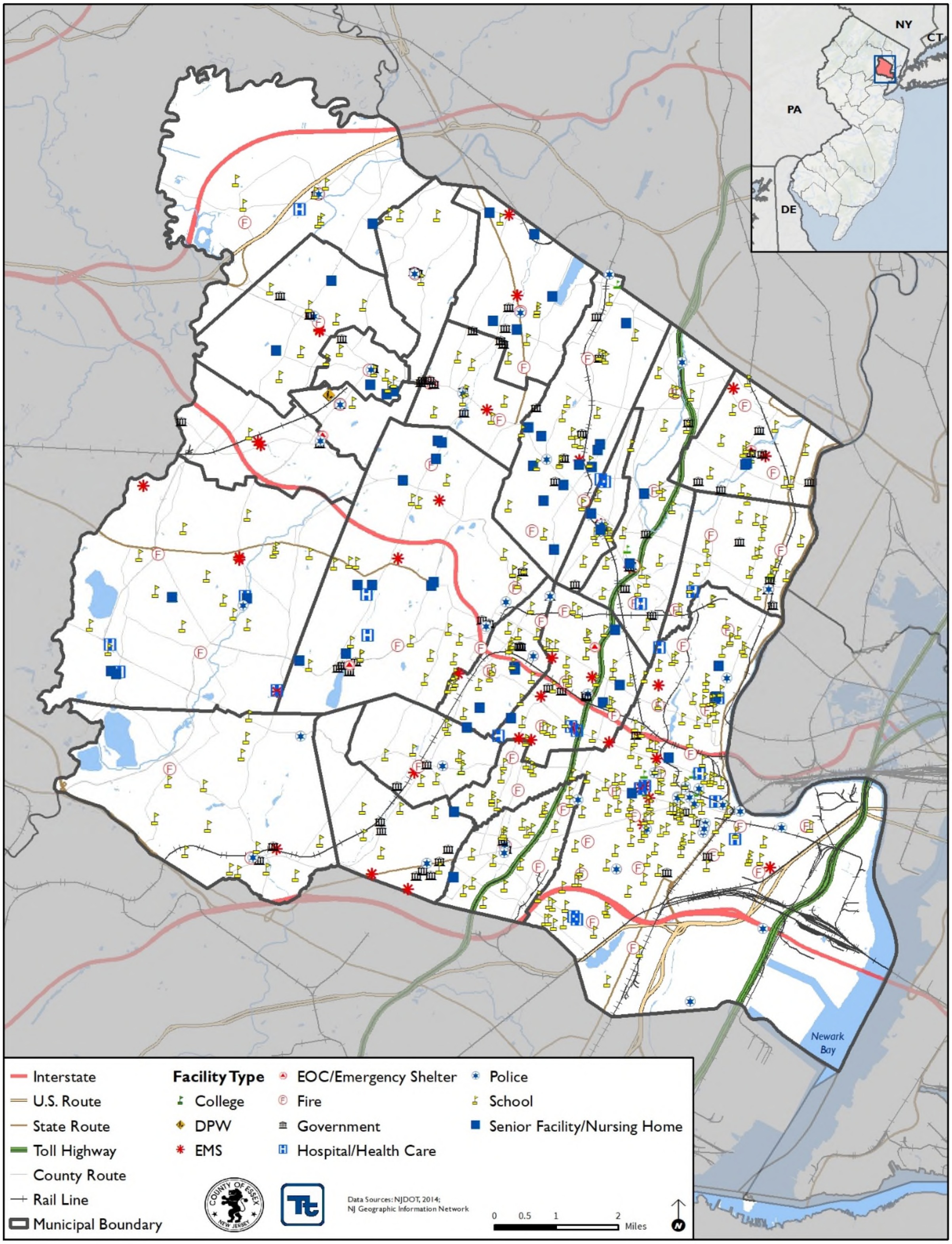
It is important to identify and account for senior facilities, as they are highly vulnerable to the potential impacts of disasters. Understanding the location and numbers of these types of facilities can help manage an effective response plan post disaster. There are 54 senior facilities located in Essex County.

Government Buildings

In addition to the facilities discussed, county and municipal buildings, department of public works facilities and public health departments are essential to the continuity of operations pre-, during and post-disasters. These facilities are included in the risk assessment. There are approximately 81 government facilities within Essex County.

Figure 3-11 illustrates the inventory of these emergency and government facilities in Essex County.

Figure 3-11. Emergency and Government Facilities in Essex County



3.5.2 Transportation Systems

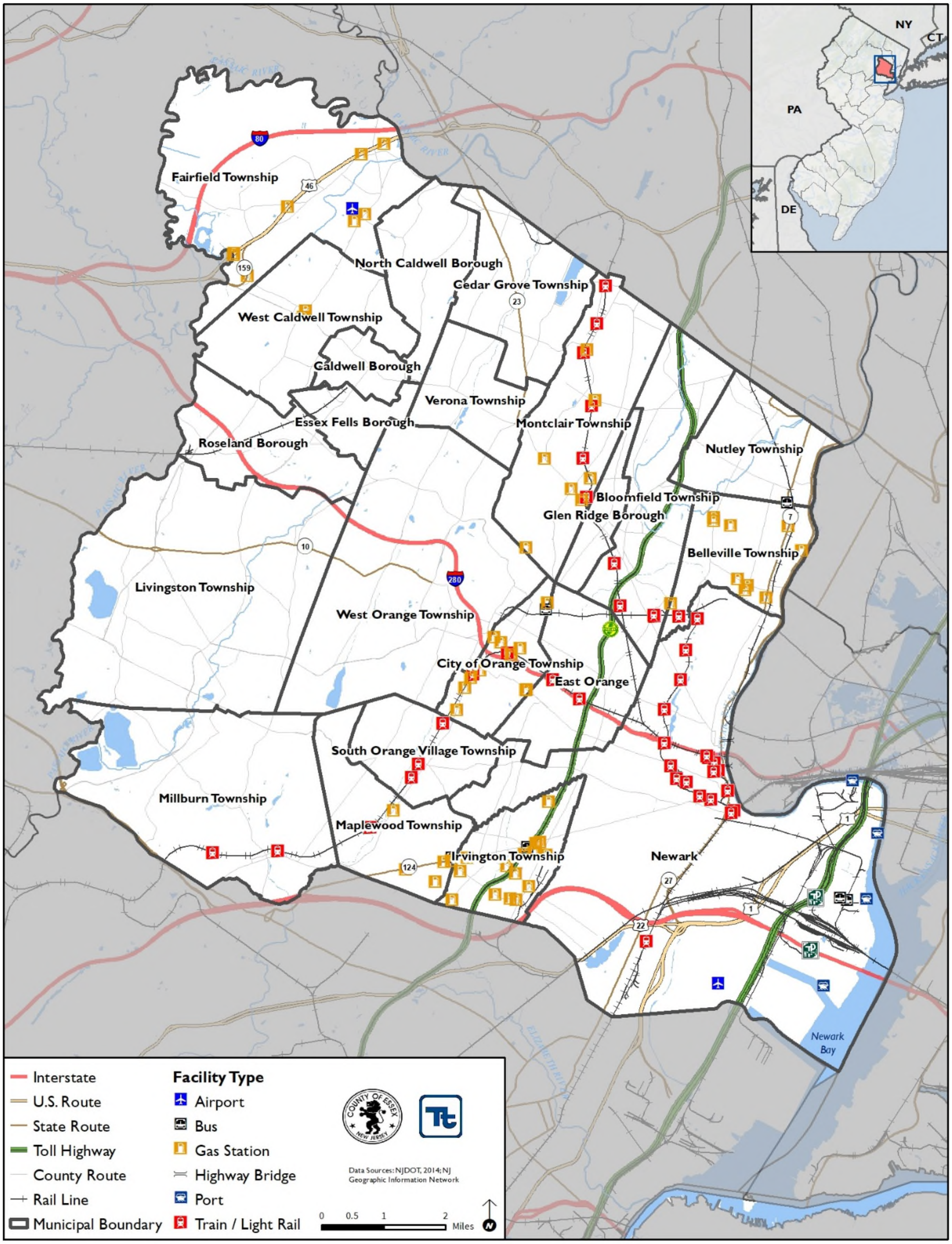
Essex County transportation system is a network of roadways, highways, airports, rail lines and waterways that provide for the movement of goods and people on an enormous scale. Port Newark is equally important to the transfer of goods, shipping, and receiving due to its convenient and accessible location on the Newark Bay in Newark. Truck and rail are also major components for the shipment of materials as well as the transportation of person to and from the County. This section presents available inventory data for roadways, airports, railways and other transportation systems in Essex County.

Major state roadways include the Garden State Parkway which bisects the County and provides access to New Jersey shore destinations to the south and the New York Thruway to the north. Interstate (I)-280 provides access across the County. I-280, which is approximately 18 miles long, is a spur from I-80 in Parsippany-Troy Hills, Morris County to the City of Newark, and I-95 (the New Jersey Turnpike) in Kearny. I-80 crosses the northwest corner of the County and I-78 crosses the southeast corner of the County. In addition to these major roadways, numerous state routes and county routes are (i.e., Essex County 2013). The area maintains two commercial airports: Newark Liberty International Airport in Newark and Essex County Airport in Fairfield.

Essex County has an extensive transportation network that includes numerous rail and fixed route bus services. A majority of fixed route service in Essex County is provided by New Jersey Transit, with 46 bus and light rail routes and two commuter rail lines (Essex County Coordinated Transportation Plan, 2008). New Jersey Transit operates commuter rail, light rail, and bus service in Essex County. Commuter rail service is provided on the Morris and Essex and Montclair-Boonton Rail Lines. Morris and Essex service operates to Hoboken Terminal and New York Penn Stations. Rail service is also provided to Hoboken on the Boonton Line. Over 80 bus routes are identified to travel throughout Essex County and approximately 4,500 bus stops are located within Essex County (Essex County 2013).

Figure 3-12 illustrates the regional transportation lifelines serving the County. The transportation inventory included as part of this HMP includes airports, major bus stations, ports, rail and light rail stations, and bridges.

Figure 3-12. Transportation Facilities in Essex County



3.5.3 Utility Systems

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

Communication

Essex County has a network of radio and cell towers that are considered essential. These locations are included in the inventory and risk assessment.

Potable Water

In Essex County, water is supplied by 21 sources. The community water systems of the County utilize water from four different sources: wells within the individual system; surface water intakes such as reservoirs; surface water purchased from an outside location; or groundwater purchased from an outside location (Essex County Environmental Resource Inventory, 2007).

Wastewater Facilities

Wastewater treatment facilities and wastewater pump stations in the County were identified and included in the risk assessment.

Energy Resources

JCP&L and PSE&G are the primary electric and gas utility companies in Essex County. There is oil (Sun Pipe Line Company and Tidewater Oil), natural gas (Algonquin Gas Transmission Company and Texas Eastern Transmission Company), electric and communication (AT&T, Verizon, and Embarq) lines that run throughout the County.

A number of utility providers supply various services throughout the County as noted in Table 3-9. Figure 3-13 shows the distribution of the utility lifelines within the County.

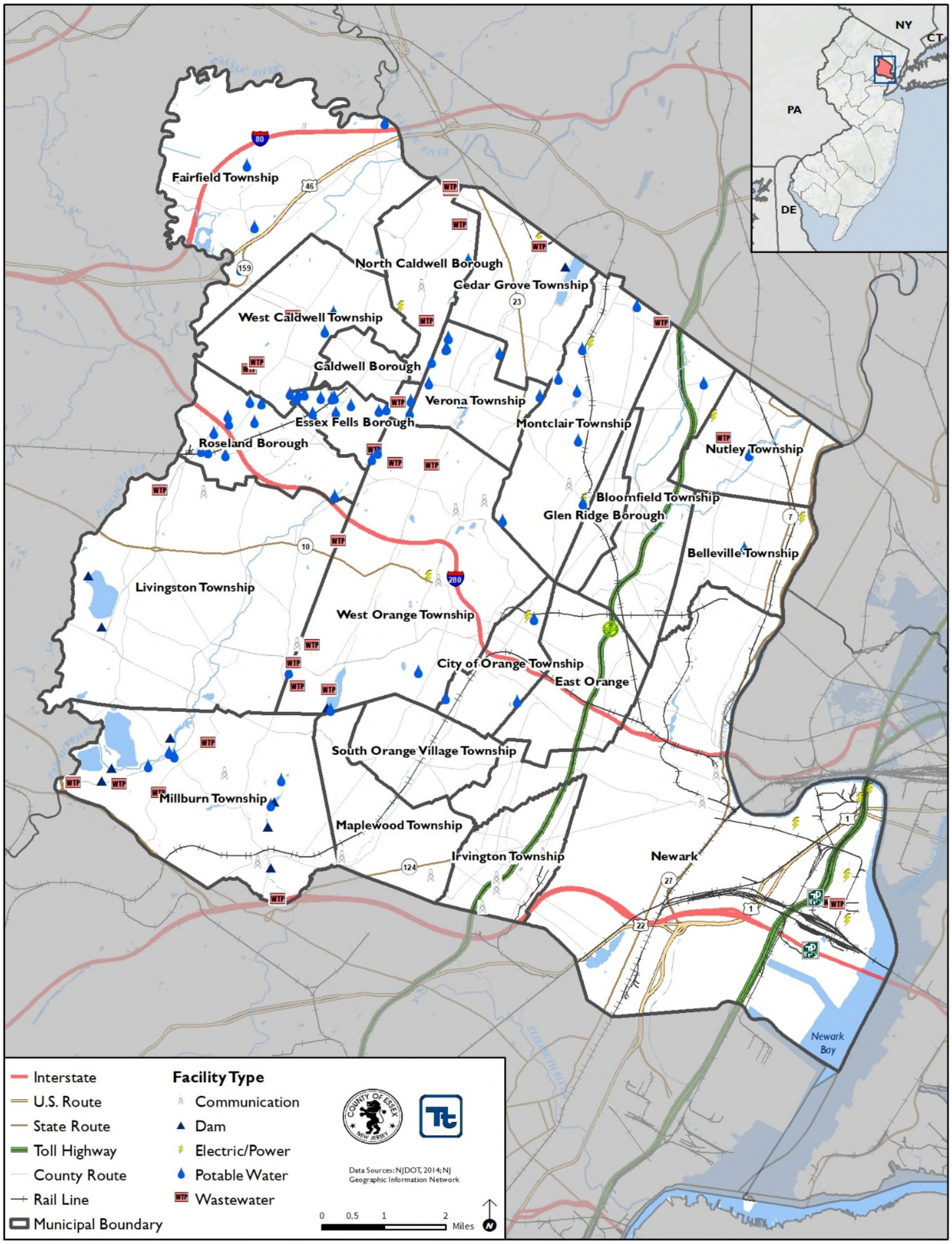
Table 3-9. Utility Service Providers in Essex County

Utility Provider	Service
Passaic Valley Sewer Commission	Sewer and Water
New Jersey American Water	Water
Essex County Improvement Authority	Airport
NJ Transit	Train, Bus, Light Rail, Subway
Port Authority of NY and NJ	Airport, Bus, Train, PATH, Tunnels, Bridges
Public Service Electric and Gas	Natural Gas, Electricity
Constellation New Energy, Inc	Natural Gas, Electricity
Jersey Central Power and Light	Electricity
Direct Energy Services, LLC	Electricity
Comcast	Cable Television, Internet, Telephone
Cablevision	Cable Television, Internet, Telephone

Utility Provider	Service
Verizon	Communications
AT&T	Communications
Sprint	Communications
IDT	Communications

Source: Essex County OEM

Figure 3-13. Utility Lifelines in Essex County



3.5.4 High-Potential Loss Facilities

High-potential loss facilities include dams, levees, chemical storage facilities and military installations. There are two New Jersey National Guard armories and two U.S. Army Corps levees located in Essex County. Figure 3-14 displays the general locations of these facilities in the County.

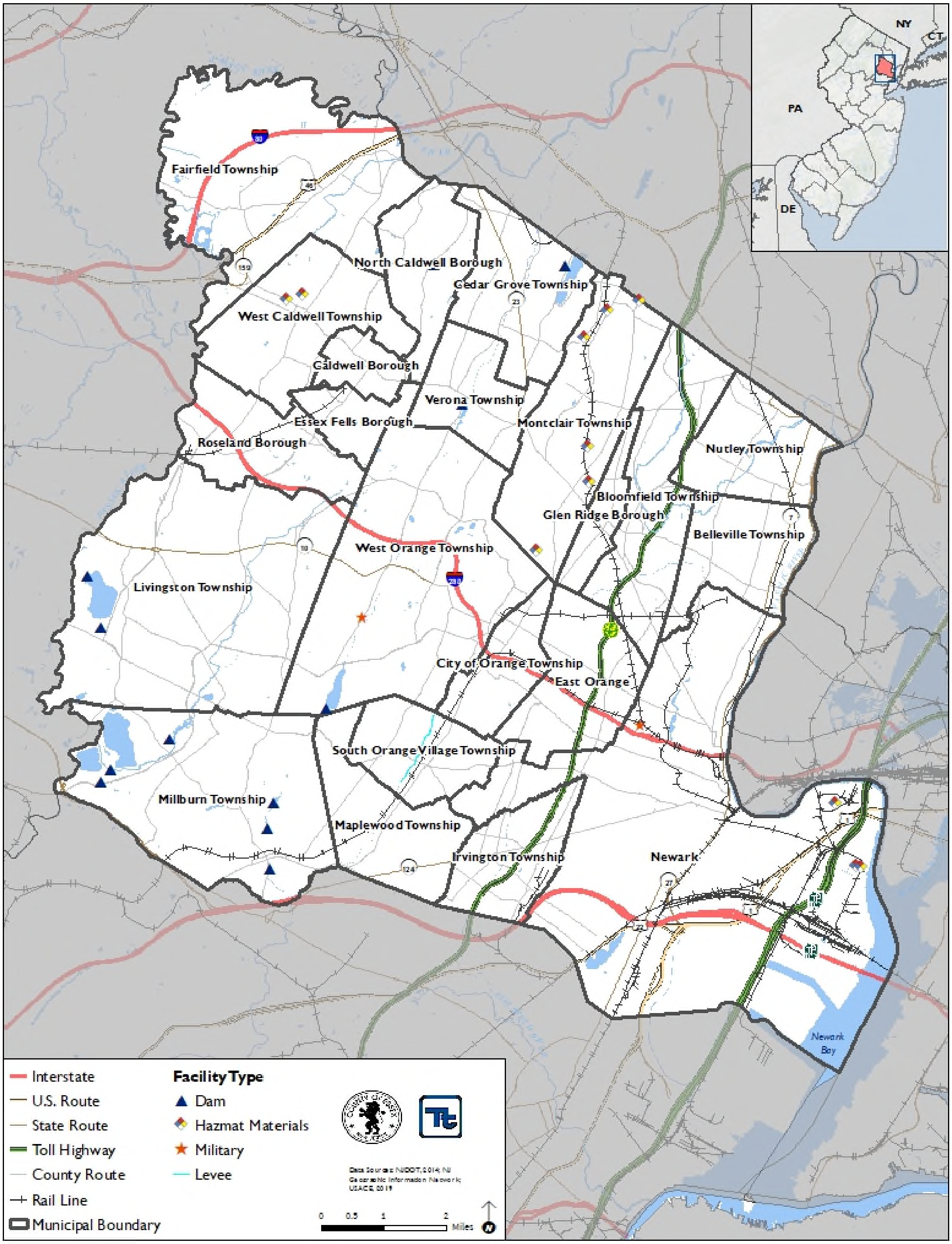
Dams and Levees

According to the New Jersey Department of Environmental Protection (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 33 dams located in Essex County, eight (8) of which are classified with a high-hazard potential.

Figure 3-14. High-Potential Loss Facilities in Essex 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 the County and each jurisdiction. The Essex County risk assessment presented in Section 4 and outlined as follows:

- Identification of hazards of concern that impact Essex 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

2020 HMP Changes

- The sections in the 2020 HMP have been realigned to increase the readability of the plan. Section 4.1 (formerly Section 5.2 in the 2015 HMP) now comprises the Identification of Hazards of Concern section of the plan.
- Radon was considered as a hazard of concern.
- Economic collapse was added as a hazard of concern evaluated for the 2020 HMP.
- The flood hazard has been expanded to discuss urban flooding.
- The Power Failure hazard has been renamed to Utility Interruption and expanded to include interruption of other utilities (water, gas, etc.).

To provide a strong foundation for mitigation strategies considered in Section 6 (Mitigation Strategy), Essex 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 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.

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.

Tables 4.1-1 and 4.2-2 document the process of identifying the natural and non-natural hazards of concern for further profiling and evaluation, respectively. As in the 2015 HMP, the Planning Partnership continued to include non-natural hazards that are of concern to the County in the 2020 HMP as well. However, the DMA 2000 regulations do not require consideration of such hazards.

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

Hazard	Is this a hazard that may occur in Essex 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 Essex 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 between 1998 and 2014. • Input from the Planning Partnership
Coastal Erosion	Yes	Yes	• 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. A small portion of Essex County (City of Newark only) is bounded by coastal waters; therefore, coastal erosion was identified as a hazard of concern by the county. • The eastern border of Essex County is located in the Coastal Erosion Hazard Area (CEHA); therefore, these areas are vulnerable to erosion. • As for sea level rise, 28 people in Essex County are located in the seal level rise +1-ft inundation area, which increases to almost 10 times	• NJ HMP • NOAA • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			that to 251 people located in the sea level rise + 3-ft inundation area.	

Coastal Storm	Yes	Yes	• The NJ HMP identifies hurricanes/tropical storms and nor'easters as hazards of concern for New Jersey.
			• The southeastern portion of the County is bounded by coastal waters. Due to its close proximity to the Atlantic Ocean, Essex County is susceptible to hurricanes, tropical storms, and Nor'Easters.
			• Between 2014 and 2019, Essex County was included in two FEMA declarations related to flooding:
			  • January 22-24, 2016– FEMA-DR-4264 – Severe Winter Storm and Snowstorm
			  • March 6-7, 2018 – FEMA-DR-4368 – Severe Winter Storm and Snowstorm
			• Between 1842 and 2019, 32 tropical cyclones tracked within 65 nautical miles of Essex County, with no occurring between 2014 and 2019.
				• NJ HMP
				• FEMA
				• NOAA
				• NOAA-NCDC Storm Database
				• Input from the Planning Partnership

Drought	Yes	Yes	• The NJ HMP identifies drought as a hazard of concern for New Jersey. • According to the NJHMP, counties most often affected	• NJ HMP • USGS • NRCC • NOAA • NOAA-NCDC Storm Database

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			by a drought are densely populated areas that rely on above-ground reservoirs for water supplies. Essex County fits into this description. The drought hazard is a concern for Essex 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. • Since 2014, the County has been impacted three periods of drought: o Moderate drought status from May 26 - June 1, 2015 o Moderate drought status from September 1, 2015 – January 25, 2016. o Moderate drought status from June 14 - October 24, 2016, severe drought status from October 25, 2016 – January 23, 2017, and moderate drought status from January 24 – March 20, 2017 • Essex County is located in the Northern Climate Division. According to the NRCC, this climate division has been impacted by the following periods of severe and extreme drought:	• Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			o August – September 1932 o November 1949 – January 1950 o September – November 1957 o August 1964 – August 1966 o December 1980 – January 1981 o March – April 1985 o August – September 1995 o July – August 1999 o December 2001 – May 2002 o July – September 2002 o October 2016 - January 2017	
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). Between 1783 and 2017, there have been 214 documented earthquakes in New Jersey. Three of these events have been epicentered in Essex County.	• NJ HMP • NJDEP • NJGS • Input from the Planning Partnership
Expansive Soils	No	No	• The NJ HMP does identify expansive soils as a hazard of concern for New Jersey; however, the Planning	• NJ HMP • USGS 1989 Swelling Clays Map of the Conterminous U.S.

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			Committee did not identify this as a hazard of concern for Essex County. • USGS indicated that less than 50% of Essex County is underlain by soils with abundant clays of slight to moderate swelling potential and there are areas in Essex County underlain by soils with little to no clays with swelling potential.	• Input from the Planning Partnership
Extreme Temperature	Yes	Yes	• The NJ HMP identifies extreme temperature as a hazard of concern for New Jersey as a type of severe weather. • The NOAA-NCDC storm event database indicated that between January 2014 and March 2019, Essex County had two reported extreme temperature events; all of which were identified as excessive heat events.	• NJ HMP • NOAA – NCDC Storm Database • ONJSC • Input from the Planning Partnership
Flood (Riverine and Dam Flooding)	Yes	Yes	• NJHMP identifies flooding as a hazard of concern in New Jersey. However, ice jams were not identified as a hazard of concern in Essex County due to the fact that they have not occurred and/or impacted the County. • The northwestern and southeastern corners of Essex County are located in the 1% annual chance flood zone. There are 32,128 people in Essex County living in the 1% annual	• NJ HMP • FEMA • FEMA FIS • NFIP • NOAA-NCDC Storm Database • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			chance flood zone and 52,366 living in the 0.2% annual chance flood zone. Over 16,000 acres of the County is located in the 1% annual chance flood zone and over 21,000 acres in the 0.2% zone. • The County has 4,221 NFIP policies with total loss payments equaling over $110 million. • Areas around the Passaic, Peckman, Second, and Third Rivers are subject to flooding. • Essex County has a total of 33 dams; eight of which are identified as high hazard. • Between 2014 and 2019, Essex County was included in two FEMA declarations related to flooding: o January 22-24, 2016– FEMA-DR-4264 – Severe Winter Storm and Snowstorm o March 6-7, 2018 – FEMA-DR-4368 – Severe Winter Storm and Snowstorm • According to NOAA NCDC storm database, Essex County had 16 flood events reported between January 2014 and March 2019.	
Geological Hazards	Yes	Yes	• The NJ HMP identifies geological hazards as a hazard of concern for New Jersey.	• NJHMP • NJGWS • NJDEP

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			• For the 2014 Plan Update, the Planning Committee identified landslides and land subsidence as hazards of concern for Essex County. • Essex County contains a number of steep slope areas, particularly along the Watchung Ridges in central Essex County. • A majority of the County does not have landslide susceptibility. There are small areas in the central portion of the County that are susceptible to landslide events (Class AI, AII, AIV, AVI, BIII, and BIV). The Township of West Orange and the Township of Montclair have the largest areas landslide susceptible areas. Overall, approximately 870 square miles of Essex County (1% of the total County area) is susceptible to landslides. • Between 2014 and 2019, there have been two identified geological hazard events in Essex County.	• Input from the Planning Partnership
Hailstorm	Yes	Yes	Please see Severe Storm	
Hurricane (and other Tropical Cyclones)	Yes	Yes	Please see Coastal Storm	
Ice Storm	Yes	Yes	Please see Severe Winter Storm	
Disease Outbreak	Yes	Yes	• The NJ HMP does not identify disease outbreak as	• NJ HMP • CDC • NJDOH

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			a hazard of concern for New Jersey. • The Planning Committee considers disease outbreak as a hazard of concern for Essex County due to its high population density and proximate to urban areas. The County has a high risk to Lyme disease, caused by infected ticks. Essex County has also had history of known human cases of West Nile Virus. • Between 2014 and 2019, Essex County was impacted by numerous cases of Lyme Disease, West Nile Virus, and Zika Virus.	• Lyme Disease Association • Input from the Planning Partnership
Land Subsidence	Yes	No	Please see Geological Hazards	
Landslide	Yes	No	Please see Geological Hazards	
Nor'Easters	Yes	Yes	Please see Coastal Storms	
Radon	Yes	No	• Essex County and municipalities are in Tiers 2 and 3 with moderate to low potential of having radon concentrations greater than or equal to 4 pCi/L, respectively. This hazard was not evaluated further for the 2020 HMP.	• NJDEP: https://www.njradon.org/radonin.htm
Severe Storm (Windstorms, Thunderstorms, Hail, Lightning, and Tornados)	Yes	Yes	• The NJ HMP identifies severe weather as a hazard of concern for New Jersey. • According to FEMA, between 2014 and 2019, Essex County was included in four declarations	• NJ HMP • NOAA – NCDC • FEMA • NJ OEM • SPC • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			associated with severe storm events. o January 22-24, 2016– FEMA-DR-4264 – Severe Winter Storm and Snowstorm o March 6-7, 2018 – FEMA-DR-4368 – Severe Winter Storm and Snowstorm • NOAA's NCDC storm events database indicates that Essex County was impacted by approximately 20 severe storm events between January 2014 and March 2019 causing no injuries or fatalities but resulting in approximately $336 thousand in property damages. • New Jersey has experienced 91 tornadoes between 1986 and 2016, with two of those occurring in Essex County.	
Severe Winter Storm (Heavy Snow, Blizzards, Freezing Rain/Sleet, Ice Storms)	Yes	Yes	• The NJHMP identifies severe winter weather as a hazard of concern for New Jersey. • Normal seasonal snowfall in Essex County is approximately 25.2 inches. • Between 2014 and 2019, Essex County was included in two FEMA declarations related to flooding: • January 22-24, 2016– FEMA-DR-4264 – Severe	• NJ HMP • FEMA • NOAA – NCDC Storm Database • ONJSC • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			Winter Storm and Snowstorm • March 6-7, 2018 – FEMA-DR-4368 – Severe Winter Storm and Snowstorm • NOAA-NCDC has indicated that Essex County has experienced the impacts of 24 winter storm events between January 2014 and March 2019.	
Tornado	Yes	Yes	Please see Severe Storm	
Tsunami	No	No	• The NJ HMP does identify tsunami as a hazard of concern for New Jersey. • Only the City of Newark is bounded by coastal waters; therefore, tsunami is not identified as a hazard of concern by Essex County.	• NJ HMP • Input from the Planning Partnership
Volcano	No	No	• The NJ HMP does not identify volcano as a hazard of concern for New Jersey.	• NJ HMP
Wildfire	Yes	Yes	• The NJHMP identifies as wildfire as a hazard of concern for New Jersey. • In Essex County, 38.76 square miles of the County are located in the low to moderate NJFFS Risk Area and 2.05 square miles is located in the high to extreme risk area. The northwestern corner of the County has the highest risk. • Between January 2014 and March 2019, there have no	• NOAA – NCDC Storm Events Query • USGS • NJ HMP • NJFFS • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			reports of wildfires in Essex County. However, based on input from the Planning Committee, wildfire is considered a hazard of concern for Essex County. • Approximately <1% of the County's population is exposed to an extreme/very high/high risk area.	
Windstorm	Yes	Yes	Please see Severe Storm	

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 ($)*
M	*Millions ($)*
NCDC	*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 Essex County

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
Civil Disorder	Yes	Yes	• The NJ HMP identifies civil unrest as a hazard of concern for New Jersey. • Any areas of Essex County can experience a civil disorder; however, government facilities, landmarks, prisons, and universities are common locations for civil disorders. • According to the NJ HMP, between 2014 and 2019, Essex County did not experience any civil disorder events. • The Planning Committee identified civil disorder as a hazard of concern for Essex County due to its vulnerability and impact on the County and the previous occurrences.	• NJ HMP • NJ.com • Input from the Planning Partnership
Cyber Attack	Yes	Yes	• The NJ HMP identifies cyber-attack as a hazard of concern for New Jersey. • Although there are have been no major direct attacks impacted Essex County, the Planning Committee identified cyber as a hazard of concern for Essex County due to its vulnerability and impact on the County and the previous occurrences. • New Jersey is a vulnerable target to cyber-attacks due to its location, critical information infrastructures,	• NJ HMP • Choose NJ • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			and home to many Fortune 500 companies. In Essex County, there are several Fortune 500 companies. Any disruption to these businesses could have an impact on the County and State's economy. • The Planning Committee identified cyber-attack as a hazard of concern for Essex County due to its vulnerability and impact on the County.	
Economic Collapse	Yes	Yes	• The NJ HMP identifies economic collapse as a hazard of concern for New Jersey. • An economic collapse, depending on severity, may impact portions or all of Essex County. • While there have been no previous occurrences of total economic failure in Essex County or the United States, there have been periods of economic recession and depression that have heavily impacted the County. • The Planning Committee identified economic failure as a hazard of concern for Essex County due to its vulnerability and impact on the County and the previous occurrences.	
Hazardous Substances	Yes	Yes	• The NJ HMP identifies hazardous substances as a hazard of concern for New Jersey.	• NJ HMP • NJ.com • USEPA • PHMSA

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			• Essex County contains numerous roadways, railways, and ports that transport hazardous substances. Between 2014 and 2016, there have been 198 hazardous material incidents in the County (61 air; 135 highway; and 2 rail). Between 2014 and 2016, the County had a total of over 168,000 gallons of chemical released on-site and 528,000 gallons released off-site. Other incidents in the County include fuel oil spills and chemical explosions. • The Planning Committee identified hazardous substances as a hazard of concern for Essex County due to its extensive transportation network and vulnerability.	• Input from the Planning Partnership
Utility Interruption	Yes	Yes	• The NJ HMP identifies power failure as a hazard of concern for New Jersey. • Between 2014 and 2019, there have been numerous weather events that have caused extensive power outages in Essex County. • Between 2014 and 2019, there have been several water utility interruptions. • Utility gas failure could threaten building heating and backup power. • Lack of water could impact potable supplies as well as	• NJ HMP • NJ.com • NOAA • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			decrease fire-fighting capabilities. generators. • The Planning Partnership expanded the Power Failure hazard to be Utility Interruption due to its population and vulnerability.	
Terrorism	Yes	Yes	• The NJ HMP identifies terrorism as a hazard of concern for New Jersey. • Between 2007 and 2014, there have been no terrorism events in Essex County; however, there was on event in the vicinity of the County. • Due to the County's proximity to New York City, its population and vulnerability, the Planning Committee identified terrorism as a hazard of concern for Essex County.	• NJ HMP • Input from the Planning Partnership
Transportation Failure	Yes	Yes	• The NJ HMP does not identify transportation failure as a hazard of concern for New Jersey. • Essex County is located adjacent to New York City and along the major transportation routes connecting the New York and Philadelphia metropolitan areas. Port Newark is also located within the County. Traffic flow through the County is critical to economic prosperity in the entire region. • Between 2007 and 2014, there have been numerous transportation failure	• NJ HMP • NJDOT • Federal Railroad Administration • NTSB • Input from the Planning Partnership

Hazard	Is this a hazard that may occur in Essex County?	If yes, does this hazard pose a significant threat to the County?	Why was this determination made?	Source(s)
			incidents in the County, including vehicular accidents, railroad/highway collisions, and aviation accidents. • The Planning Committee identified transportation failure as a hazard of concern for Essex County due to its extensive transportation network and vulnerability.	

DR	*Presidential Disaster Declaration Number*
EM	*Presidential Disaster Emergency Number*
FEMA	*Federal Emergency Management Agency*
HMP	*Hazard Mitigation Plan*
NJ	*New Jersey*
NJDOT	*New Jersey Department of Transportation*
NOAA	*National Oceanic and Atmospheric Administration*
NTSB	*National Transportation Safety Board*
OEM	*Office of Emergency Management*

According to input from the County, and review of all available resources, a total of 10 natural hazards and eight human-caused hazards of concern were identified as significant hazards affecting the entire planning area, to be addressed at the county level in this plan:

Natural Hazards of Concern

- Coastal Erosion and Sea Level Rise
- Coastal Storm (including Nor'Easter, Hurricane, Tropical Storm, Storm Surge)
- Drought
- Earthquake
- Extreme Temperature
- Flood (including Dam Failure and Urban Flooding)
- Geological Hazards
- Severe Weather (High Winds, Tornadoes, Thunderstorms, Hail)
- Severe Winter Storm (Heavy Snow, Blizzards, Ice Storms)
- Wildfire

Human-Caused Hazards of Concern

- Civil Disorder
- Cyber Attack
- Disease Outbreak
- Economic Collapse
- Hazardous Substances (Fixed Sites and Transportation)
- Terrorism
- Transportation Failure (Bridge, Railway, Roadway, Aviation)
- Utility Interruption

Other natural and human-caused hazards of concern have occurred within Essex County, but have a low potential to occur and/or result in significant impacts within the County. Therefore, these hazards will not be further addressed within this version of the HMP. However, if deemed necessary by the County, these hazards may be considered in future versions of the HMP.

4.2 METHODOLOGY AND TOOLS

2020 HMP Changes

- The risk assessment was updated using best available information.
  - Hazard events and associated impacts were researched and summarized from 2014 to 2019
  - 2013-2017 American Community Survey 5-year estimates were utilized
  - Building footprints from Microsoft and Open Street Map, updated parcels and RS Means 2019 were used to develop a structure-level building inventory and estimate replacement cost value for each building.
  - The 2015 critical facility was reviewed and updated by the Planning Partnership.
  - Lifelines were identified in the critical facility inventory to align with FEMA's lifeline definition
  - HAZUS-MH v4.2 was used to estimate potential impacts to the flood, wind and seismic hazards
  - Best available hazard data was used as described in this section.

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

4.2.1 Asset Inventories

Essex County assets were identified to assess potential exposure and loss associated with the hazards of concern. For the HMP update, Essex County assessed exposure vulnerability of the following types of assets: population, buildings and critical facilities/infrastructure and the environment. Some assets may be more vulnerable because of their physical characteristics or socioeconomic uses. To protect individual privacy and the security of critical facilities, information on properties assessed is presented in aggregate, without details about specific individual personal or public properties.

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

Population

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 Essex County included in the risk assessment are children, elderly, population below the poverty level, the physically or mentally disabled, non-English speakers and the medically or chemically dependent.

Total population statistics from the 2013-2017 American Community Survey 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. Population counts at the Census tract level were averaged among the residential structures in the County to estimate the population at the structure level. This estimate is a more precise distribution of population across the County compared to only using the Census block or Census tract boundaries. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate for planning purposes.

Buildings

The building stock inventory was updated countywide with a custom developed building inventory. The 2018 parcels and MODIV tax assessor data obtained from the New Jersey Geographic Information Network Open Data portal and building footprint spatial layers from Microsoft and Open Street Maps were utilized. Attributes provided in the spatial files were used to further define each structure in terms of occupancy class, construction type, etc. 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 utilizing available assessor data and RSMeans 2019 values; a regional location factor for Essex County was applied (1.21 for residential structures; 1.17 for non-residential structures). 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-MH v4.2 were condensed into the following categories (residential, commercial, industrial, agricultural, religious, governmental, and educational) to facilitate the analysis and the presentation of results. Residential loss estimates address both multi-family and single-family dwellings.

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 2015 HMP critical facility inventory, which includes essential facilities, utilities, transportation features and user-defined facilities was updated by the Planning Partnership. The update involved a review for accuracy, additions or deletions of new/moved critical assets, identification of backup power for each asset (if known) and whether the critical facility is considered a lifeline in accordance with FEMA's definition; refer to Appendix E (Risk Assessment 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 assessing the vulnerability of the built environment, Essex County examined recent and anticipated new development. Each jurisdiction was asked to provide a list by parcel ID or address of major development that has taken place over the last 5 years and anticipated major development over the next 5 years. An exposure analysis was conducted in GIS to determine hazard exposure. Identifying these changes and integrating into the risk assessment provides communities information to consider when developing the mitigation strategy to reduce these vulnerabilities in the future (one tool in the Mitigation Toolbox discussed in Section 6 – Mitigation Strategy). The identified new development is listed in Section 3 (County Profile) and hazard 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, Essex County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three different levels of analysis were used depending upon the data available for each hazard as described below. Table 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 are located in the hazard area and may incur future impacts.
3. **Loss estimation** — The FEMA HAZUS modeling software was used to estimate potential losses for the following hazards: flood, earthquake, hurricane. In addition, an examination of historic impacts and an exposure assessment was conducted for these spatially-delineated hazards.

Table 4.2-1. Summary of Risk Assessment Analyses

Hazard	Population	General Building Stock	Critical Facilities	New Development
Coastal Erosion and Sea Level Rise	E	E	E	E
Coastal Storms	E, H	E, H	E, H	E
Drought	Q	Q	Q	Q
Earthquake	E, H	E, H	E, H	E
Extreme Temperatures	Q	Q	Q	Q
Flood	E, H	E, H	E, H	E
Geological Hazards	E	E	E	E
Severe Weather	Q	Q	Q	Q
Severe Winter Storm	Q	Q	Q	Q
Wildfire	E	E	E	E
Civil Disorder	Q	Q	Q	Q
Cyber Attack	Q	Q	Q	Q
Disease Outbreak	Q	Q	Q	Q
Economic Collapse	Q	Q	Q	Q
Hazardous Substances	Q	Q	Q	Q
Power Outages	Q	Q	Q	Q
Terrorism	Q	Q	Q	Q
Transportation Failure	Q	Q	Q	Q

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

Hazards U.S. – Multi-Hazard (HAZUS-MH)

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or HAZUS. HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. HAZUS was expanded into a multi-hazard methodology, HAZUS-MH with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. HAZUS-MH 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-MH uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems and utility systems. To generate this information, HAZUS-MH uses default HAZUS-MH 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, and economic impact) depending on the hazard and available local data. HAZUS-MH's 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-MH is available at http://www.fema.gov/hazus.

In general, probabilistic analyses were performed to develop expected/estimated distribution of losses (mean return period losses) for the flood, wind and seismic hazards. The probabilistic model generates estimated damages and losses for specified return periods (e.g., 100- and 500-year). For annualized losses, HAZUS-MH calculates the maximum potential annual dollar loss resulting from various return periods averaged on a "per year" basis. It is the summation of all HAZUS-supplied return periods (e.g., 10, 50, 100, 200, 500) multiplied by the return period probability (as a weighted calculation). In summary, the estimated cost of a hazard each year is calculated. Table 4.2-2 displays the various levels of analyses that can be conducted using the HAZUS-MH software.

Table 4.2-2. Summary of HAZUS-MH Analysis Levels

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

Coastal Erosion and Sea Level Rise

A USGS report for the National Assessment of Shoreline Change entitled *Historical Shoreline Change along the New England and Mid-Atlantic Coasts* was released in 2011. The New England and Mid-Atlantic shores were subdivided into a total of 10 analysis regions for the purpose of reporting regional trends in shoreline change rates. The average rate of long-term shoreline change for the New England and Mid-Atlantic coasts was -0.5 meters per year. The average net long-term rate of shoreline changes for the New Jersey 'North' region (located from Sandy Hook to south to Little Egg Inlet) was -0.6 meters per year. Meanwhile, the long-term net shoreline change rate in the New Jersey 'South' region (located from Little Egg Inlet south to Cape May Point).

There are no NJDEP-identified shoreline types in Essex County characterized as vulnerable to erosion. However, to estimate exposure to long-term coastal erosion for purposes of this risk assessment, the entire shoreline was analyzed. To generate the extent of the estimated coastal erosion hazard area (CEHA), an erosion rate of 0.5 meters per year was multiplied by 60 to include all structure types and developed/undeveloped areas (annual erosion rate of 0.5 meters x 60 years = 30 meters or approximately 98 feet). Therefore, population, buildings, and infrastructure within 98 feet of the shoreline are identified as vulnerable to long-term coastal erosion. Please note this methodology assumes that once lost to erosion, an area of land is not subsequently restored. This methodology is consistent with that used to evaluate coastal erosion in the 2019 New Jersey State Hazard Mitigation Plan.

In addition, projected sea-level rise data (in one-foot increments) available from the NOAA Office of Coastal Management (https://coast.noaa.gov/slrdata/) was considered and used for this analysis. Please note these levels do not include additional storm surge due to a hurricane or Nor'easter. The current Flood Insurance Rate Maps (FIRMs) also do not include the effects of sea-level rise. Rutgers University Science and Technical Advisory Panel (STAP) Report, entitled, Assessing New Jersey's Exposure to Sea-Level Rise and Coastal Storms: Report of the New Jersey Climate Adaptation Alliance Science and Technical Advisory Panel details several projected sea level rise scenarios for New Jersey between 2030 and 2100. Using these estimates, the sea level rise +1 ft and sea level rise +3 ft inundation areas were chosen and used in the 2019 New Jersey State Hazard Mitigation Plan. To be consistent with the State HMP, these spatial datasets were used for the 2020 Essex County HMP update.

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

Sea level rise data available from the New Jersey Northern Transportation Planning Authority (NJTPA) will be added to the plan update prior to FEMA submittal.

Coastal Storm

A HAZUS-MH v4.2 probabilistic analysis was performed to analyze the wind hazard losses for Essex County. The probabilistic HAZUS-MH hurricane hazard 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 Essex County. HAZUS-MH 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. Annualized losses and the 100- and 500-year MRPs were examined for the wind/severe storm hazard. Default demographic and updated building and critical facility inventories in HAZUS-MH v4.2 were used for the analysis.

There is currently a FEMA-acknowledged issue with importing user-defined facilities in HAZUS-MH v4.2. To estimate potential losses to user-defined facilities identified by Essex County, they were appended to the Emergency Operation Centers input in HAZUS-MH Comprehensive Data Management System (CDMS) and uploaded to the program.

In addition to estimating potential losses due to wind, an exposure analysis was conducted using the "Sea – Lake Overland Surge from Hurricanes – SLOSH Model, which represents potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide were used to estimate exposure. Please note these inundation zones do not include riverine flooding caused by hurricane surge or inland freshwater flooding. The model, developed by the NOAA National Hurricane Center to forecast surges that occur from wind and pressure forces of hurricanes, considers only storm surge height and does not consider the effects of waves. The SLOSH spatial data includes boundaries for Category 1 through Category 4 hurricane events.

Asset data (population, building stock, critical facilities, 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 storm surge, the County's assets were overlaid with the SLOSH hazard area. Assets with their centroid located in the hazard area were totaled to estimate the totals and values exposed to the hazard.

Drought

To assess the vulnerability of Essex County to drought and its associated impacts, a qualitative assessment was conducted. The United States Department of Agriculture (USDA) Census of Agriculture 2017 was used to estimate economic impacts. Information regarding the number of farms, land area in farms, total market value of products sold, etc. was extracted from the report and summarized in the vulnerability assessment. Additional resources from the Center for Disease Control and the U.S. Environmental Protection Agency were used to assess the potential impacts to the population from a drought event.

Earthquake

A probabilistic assessment was conducted for Essex County for the 100-, 500- and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH v4.2 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-MH Earthquake User Manual, "*Uncertainties are inherent in any loss estimation methodology. They arise in part from incomplete scientific knowledge concerning earthquakes and their effects upon buildings and facilities. They also result from the approximations and simplifications that are necessary for comprehensive analyses. Incomplete or inaccurate inventories of the built environment, demographics and economic parameters add to the uncertainty. These factors can result in a range of uncertainty in loss estimates produced by the HAZUS Earthquake Model, possibly at best by a factor of two or more*" (FEMA 2015f). However, HAZUS' potential loss estimates are acceptable for the purposes of this HMP.

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

An exposure analysis was also conducted for the County's assets (population, building stock, critical facilities, and new development) using the NEHRP soil data and liquefaction susceptibility data. NEHRP Soil Classes Type D and Type E and liquefaction susceptibility Class 4 were used to determine what assets are exposed to the soils most susceptible to seismic activity. Assets with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to these soil types.

Data from the New Jersey Geologic and Water Survey was used in HAZUS-MH v4.2 to replace default NEHRP, liquefaction susceptibility, and landslide susceptibility conditions. Groundwater was set at depth of five (5) feet (default setting). The default assumption is a magnitude 7.0 earthquake for all return periods. Damage and loss due to liquefaction, landslide, or surface fault rupture were not included in this analysis. Although damages are estimated at the census tract level, results were presented at the municipal level.

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.

In addition to the probabilistic scenarios cited, an annualized loss run was conducted to estimate annualized general building stock dollar losses in the County. The loss methodology combines estimated losses associated with ground shaking for eight return periods: 100-, 250-, 500-, 750-, 1,000-, 1,500-, 2,000-, and 2,500-year, which are based on values from USGS seismic probabilistic curves.

Extreme Temperatures

A qualitative assessment was conducted for the extreme temperatures hazard. Information from the Center for Disease Control, Essex County, stakeholder plans/reports and the Planning Partnership were used to assess the potential impacts to the County's assets.

Flood

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

The effective Essex County FEMA Digital Flood Insurance Rate Map (DFIRM) with a Letter of Map Revision dated December 2018 and the preliminary Essex County FEMA DFIRMs dated May 2014 and June 2017 were used to evaluate exposure and determine potential future losses. A depth grid was generated using the effective and preliminary DFIRMs and USGS 1-meter resolution Digital Elevation Model (DEM). The FEMA Risk Map depth grids for the 1-percent annual chance flood event from May 2017 and September 2018 were also used. The final depth grid was integrated into the HAZUS-MH v4.2 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 DFIRM flood boundaries, updated assets (population, building stock, critical facilities, and new development) with their centroid in the hazard areas were totaled to estimate the numbers and values vulnerable to a flooding event. A Level 2 HAZUS-MH v4.2 riverine flood analysis was performed. Both the critical facility and building inventories were formatted to be compatible with HAZUS-MH v4.2 and its Comprehensive Data Management System (CDMS). Once updated with the inventories, the HAZUS-MH v4.2 riverine flood model was run to estimate potential losses in Essex County for the 1-percent annual chance flood event. A user-defined analysis was performed for the building stock; buildings located within the floodplain were imported as user-defined facilities to estimate potential losses to the building stock at the structural level. HAZUS-MH v4.2 calculated the estimated potential losses to the population (default 2010 U.S. Census data) and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default HAZUS-MH v4.2 damage functions in the flood model.

Locations identified as repetitive and severe repetitive properties were geocoded with the understanding that differences (and variations in those differences) were possible between listed longitude and latitude coordinates of properties and actual locations of property addresses—namely, that indications of some locations were more accurate than others.

Areas of forests, wetlands, and critical habitat landscapes located within the 1- and 0.2-percent annual chance flood event boundaries were also calculated to estimate impacts on the environment. The boundaries of these areas were intersected with the floodplains in ArcGIS to calculate the areas exposed to the 1- and 0.2-percent annual chance flood events.

Geological Hazards

The New Jersey Geologic and Water Survey delineated a landslide susceptibility layer that differentiates areas based on the ground surface and slope. This layer was updated in July 2016 and utilized for this analysis. The categories are defined as follows:

- Class A
  - AI – Strongly cemented rock; slope angle of 15-20 degrees
  - AII – Strongly cemented rock; slope angle of 20-20 degrees
  - AIV – Strongly cemented rock; slope angle of 30-40 degrees
  - AVI – Strongly cemented rock; slope angle of greater than 40 degrees
- Class B
  - BIII – Weakly cemented rock and sandy soil; slope angle of 10-15 degrees
  - BIV – Weakly cemented rock and sandy soil; slope angle of 15-20 degrees

  - BV – Weakly cemented rock and sandy soil; slope angle 20-30 degrees
- Class C
  - CVI – Shales and clayey soil; slope angle of 10-15 degrees
  - CVII – Shales and clayey soil; slope angle of 15-20 degrees
  - CIX – Shales and clayey soil; slope angle of 20-40 degrees if dry or 10-15 degrees if groundwater at surface
  - CX – Shales and clayey soil, groundwater at surface; slope angle greater than 15 degrees

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

Severe Weather

A qualitative assessment was conducted for the severe weather hazard. Information from Essex County and the Planning Partnership were used to assess the potential impacts to the County's assets.

Severe Winter Storm

The entire general building stock inventory in Essex 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. Given professional knowledge and the 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.

To determine what assets are exposed to wildfire, the County's assets (population, building stock, critical facilities, and new development) 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.

Civil Disorder

A qualitative assessment was conducted for the civil disorder hazard.

Cyber Attack

A qualitative assessment was conducted for the cyber-attack hazard.

Disease Outbreak

A qualitative assessment was conducted for the disease outbreak hazard.

Economic Collapse

A qualitative assessment was conducted for the economic collapse hazard.

Utility Interruption

A qualitative assessment was conducted for the utility interruption hazard.

Terrorism

A qualitative assessment was conducted for terrorism.

Transportation Failure

A qualitative assessment was conducted for the transportation failure hazard.

Considerations for Mitigation and Next Steps

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

- All Hazards
    - Utilize updated and current demographic data. If 2020 U.S. Census demographic data is available at the U.S. Census block level during the next plan update, use the census block estimates and residential structures for a more precise distribution of population, or the current American Community Survey 5-Year Estimate populations counts at the Census tract level.
- Coastal Erosion and Sea Level Rise
    - If available during the next plan update, update the risk assessment using a comprehensive coastal erosion hazard area map and updated sea level rise inundation areas.
    - Collect data on historic costs incurred to reconstruct buildings, cultural resources and/or infrastructure due to coastal erosion impacts.
- Coastal Storms
    - The general building stock inventory can be updated to include attributes regarding protection against strong winds, such as hurricane straps, to enhance loss estimates.
    - Estimate storm surge related losses using the HAZUS-MH flood model, if the data is available.
- Flood
    - Integrate the updated FEMA Coastal Restudy for Essex and Hudson Counties from Risk MAP into the next HMP update; restudy currently in progress. The restudy addresses issues raised during previous coastal appeal processes (i.e., extratropical storm validation, representation of tidal effects and inclusion of post-2009 storm events).
    - 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-MH loss analysis for more frequent flood events (e.g., 10 and 50-year flood events).
    - Further refine the repetitive loss area analysis.
- Earthquake
    - Identify unreinforced masonry in critical facilities and privately-owned buildings (i.e., residences) by accessing local knowledge, tax assessor information, and/or pictometry/orthophotos. These buildings may not withstand earthquakes of certain magnitudes and plans to provide emergency response/recovery efforts at these properties can be developed.
- Extreme Temperatures

  - Track extreme temperature data for injuries, deaths, shelter needs, pipe freezing, agricultural losses, and other impacts to determine distributions of most at risk areas.
- 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, the slopes greater than 25% should be used to delineate the hazard area for the vulnerability assessment. Additional environmental and soil characteristics used in the Schenectady County plan can be collected and used to follow the methodology and further delineate Essex County's most at risk areas.
- Wildfire
  - General building stock inventory can be updated to include attributes such as roofing material or fire detection equipment or integrate distance to fuels as another measure of vulnerability.
- Civil Disorder, Cyber Attack, Disease Outbreak, Economic Collapse, Hazardous Substances, Utility Failure, Terrorism, Transportation
  - Additional information regarding localized concerns and past impacts may be collected and analyzed.

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	2010; 2017	Digital (GIS) format
Building footprints	Microsoft; Open Street Map	2018; 2019	Digital (GIS) format
MODIV Tax Assessor data	NJ Office of Information Technology	2018	Digital (GIS/Tabular) format
Critical facilities	Essex County Steering Committee and Planning Committee	2019	Digital (GIS) format
Digitized effective FIRM maps	FEMA	2018	Digital (GIS) format
Digitized preliminary FIRM maps (2014)	FEMA	2014	Digital (GIS) format
Digitized preliminary FIRM maps (2017)	FEMA	2017	Digital (GIS) format
Essex County Coastal Project Area Risk Map	FEMA	2017	Digital (GIS) format
Hackensack-Passaic Watershed Risk Map	FEMA	2018	Digital (GIS) format
NEHRP Soil	NJGWS	2016	Digital (GIS) format
Liquefaction Susceptibility	NJGWS	2016	Digital (GIS) format
Landslide Susceptibility	NJGWS	2016	Digital (GIS) format
Wildfire Fuel Hazard	NJFFS	2012	Digital (GIS) format
Census of Agriculture	USDA	2017	Digital (PDF Report) format
1-foot Sea Level Rise	NOAA	2016	Digital (GIS) Format
3-foot Sea Level Rise	NOAA	2016	Digital (GIS) Format

Data	Source	Date	Format
Sea-Lake Overland Surge from Hurricanes (SLOSH) Model	NOAA	2016	Digital (GIS) Format
1-meter Resolution Digital Elevation Model	USGS	2015	Digital (GIS) Format

Limitations

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

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

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

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

4.3 HAZARDS OF CONCERN

The Essex 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 Population
  - Impact to Buildings
  - Impact to Critical Facilities and Lifelines
  - Impact to Economy
  - Future Changes that may Impact Vulnerability
  - Vulnerability Changes Since 2015

4.3.1 Coastal Erosion and Sea Level Rise

2020 HMP Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2014 and 2019.
- Updated sea level rise data from NOAA was used in the Vulnerability Assessment. The 1-foot and 3-foot sea level rise boundaries from NOAA's 2016 dataset were used to align with the 2019 New Jersey State HMP.

4.3.1.1 Profile

Hazard Description

Coastal Erosion

Coastal erosion is the gradual breakdown and removal of land material into a sea or lake due to physical and chemical, natural processes such as wind, wave and tide action, with contribution from man-made interferences. Coastal erosion can take place at two different rates: gradual erosion which occurs on a daily basis along all coastlines; and sudden or catastrophic events primarily due to storms which can result in changes to coasts over a very short period of time (Essex County HMP 2008).

Many natural factors affect erosion of the shoreline, including shore and nearshore morphology, shoreline orientation, and the response of these factors to storm frequency and sea level rise. Coastal shorelines change constantly in response to wind, waves, tides, sea-level fluctuation, seasonal and climatic variations, human alteration, and other factors that influence the movement of sand and material within a shoreline system.

Unsafe tidal conditions, as a result of high winds, heavy surf, erosion, and fog are ordinary coastal hazard phenomena. Some or all of these processes can occur during a coastal storm, resulting in an often detrimental impact on the surrounding coastline. Factors including: (1) storms such as Nor'Easters and hurricanes, (2) decreased sediment supplies, and (3) sea-level rise contribute to these coastal hazards. Nor'easters and hurricanes are further discussed in Section 4.3.2 Coastal Storm.

Coastal erosion can result in significant economic loss through the destruction of buildings, roads, infrastructure, natural resources, and wildlife habitats. Damage often results from an episodic event with the combination of severe storm waves and dune or bluff erosion.

Sea Level Rise

There is evidence that global sea is rising at an increased rate and will continue rising over the next century. The two major causes of sea level rise are thermal expansion caused by the warming of the oceans and the loss of land-based ice (glaciers and polar ice caps) due to increased melting. Thermal expansion can account for 50% of sea level rise and is a result of warming atmospheric temperatures and subsequent warming of ocean waters causing the expansion. Since 1900, records and research have shown that sea level has been steadily rising at a rate of 0.04 to 0.1 inches per year (NOAA 2013).

There are two ways sea level rise is discussed: global and relative. Global sea level rise refers to the increase currently observed in the average global sea level trend (primarily attributed to changes in ocean volume due to ice melt and thermal expansion). The melting of glaciers and continental ice masses can contribute significant amounts of freshwater input to the earth's oceans. In addition, a steady increase in global atmospheric temperature creates an expansion of saltwater molecules, increasing ocean volume.

Relative sea level refers to the height of the water as measuring along the coast relative to a specific point on land. Water level measurements at tide stations are referenced to stable vertical points on the land and a known relationship is established. Measurements at any given tide station include both global sea level rise and vertical land motion (subsidence, glacial rebound, or large-scale tectonic motion). The heights of both the land and water are changing; therefore, the land-water interface can vary spatially and temporally and must be defined over time. Relative sea level trends reflect changes in local sea level over time and are typically the most critical sea level trend for many coastal applications (coastal mapping, marine boundary delineation, coastal zone management, coastal engineering, and sustainable habitat restoration) (NOAA 2013).

Short-term variations in sea level typically occur on a daily basis and include waves, tides, or specific flood events. Long-term variations in sea level occur over various time scales, from monthly to several years and may be repeatable cycles, gradual trends, or intermittent differences. Seasonal weather patterns (changes in the earth's declination), changes in coastal and ocean circulation, anthropogenic influences, vertical land motion, etc. may influence changes in sea level over time. When estimating sea level trends, a minimum of 30 years of data are used in order to account for long-term sea level variations and reduce errors in computing sea level trends based on monthly mean sea level (NOAA 2013).

Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity are captured in long-term sea level records. Sea levels provide a key to understanding the impact of climate change (NOAA 2013). Sea level rise increases the risks coastal communities face from coastal hazards (floods, storm surges, and chronic erosion). It may also lead to the loss of important coastal habitats. The historical rate of sea level rise along the New Jersey coast over the past 50 years was 0.12 to 0.16 inches per year (Miller and Kopp 2013).

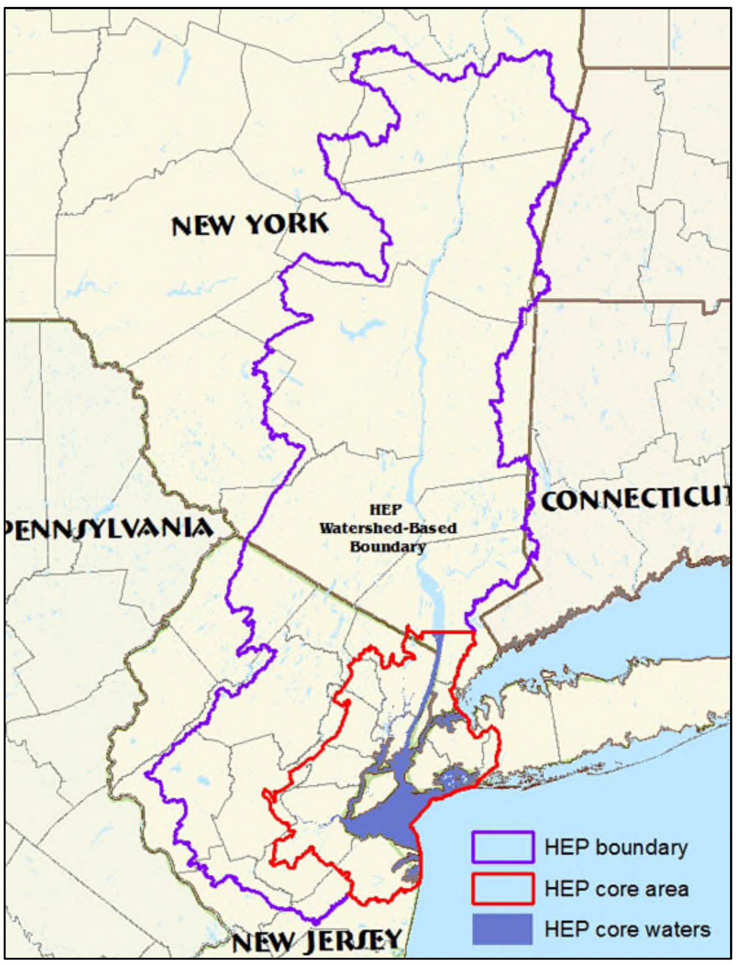
Location

The coastal boundary of New Jersey encompasses the Coastal Area Facility Review Act (CAFRA) area and the New Jersey Meadowlands District. The coastal area includes coastal waters to the limit of tidal influence including: the Atlantic Ocean (to the limit of New Jersey's seaward jurisdiction); Upper New York Bay, Newark Bay, Raritan Bay and the Arthur Kill; the Hudson, Raritan, Passaic, and Hackensack Rivers, and the tidal portions of the tributaries to these bays and rivers. As previously stated, a coastal area is any land adjacent to a tidally influenced waterway; therefore, Essex County is considered a coastal county because the City of Newark lies along the tidal portion of the Hudson River.

New York-New Jersey Harbor Estuary (Newark Bay)

Essex County has a very limited coastline, present only in the City of Newark and significant coastal erosion is not identified along the limited coastline, which is only present in the City of Newark (Essex County HMP 2008). The County is located within the New York-New Jersey Harbor Estuary (Newark Bay). An estuary is a body of water where rivers meet the ocean and saltwater meets fresh water. The Harbor Estuary is positioned at the confluence of the Hudson River and smaller rivers such as the East, Hackensack, and Raritan Rivers. It then opens into the New York Bight and Long Island Sound. The watershed of the Harbor Estuary encompasses a large area that includes the Hudson River watershed up to the Troy Dam, as well as the watersheds of the Raritan, Passaic, and Hackensack Rivers. Coastal storms can cause significant impacts to coastlines, both to the built and natural environments. In an urban region like the Harbor Estuary, the impacts to the built environment can exacerbate the level of impact incurred by natural systems (New York-New Jersey Harbor & Estuary Program 2014). Figure 4.3.1-1 shows the location of the New York-New Jersey Harbor Estuary and its boundaries.

Figure 4.3.1-1. New York-New Jersey Harbor Estuary



Source: New York-New Jersey Harbor & Estuary Program 2014

Extent

Coastal Erosion

Coastal erosion is measured as the rate of change in the position or horizontal displacement of a shoreline over a period of time (FEMA 1996). A number of factors determine whether a community exhibits greater long-term erosion or accretion:

- Exposure to high-energy storm waves,
- Sediment size and composition of eroding coastal landforms feeding adjacent beaches,
- Near-shore bathymetric variations which direct wave approach,
- Alongshore variations in wave energy and sediment transport rates,
- Relative sea level rise,
- Frequency and severity of storm events, and
- Human interference with sediment supply (e.g. revetments, seawalls, jetties) (Woods Hole Sea Grant 2003).

Such erosion may be intensified by activities such as boat wakes, shoreline hardening, or dredging. Natural recovery after erosive episodes can take months or years. If a dune or beach does not recover quickly enough via natural processes, coastal and upland property may be exposed to further damage in subsequent events. Coastal erosion can cause the destruction of buildings and infrastructure (FEMA 1996).

Erosion is typically expressed as a rate: rate of linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year). Erosion rates are cited as positive numbers, with corresponding shoreline change rates as negative numbers. For example, an erosion rate of two feet per year is equivalent to a shoreline change rate of -2 feet per year. Accretion rates are stated as positive numbers, with corresponding shoreline change rates as positive numbers. For example, an accretion rate of two feet per year is equivalent to a shoreline change rate of two feet per year.

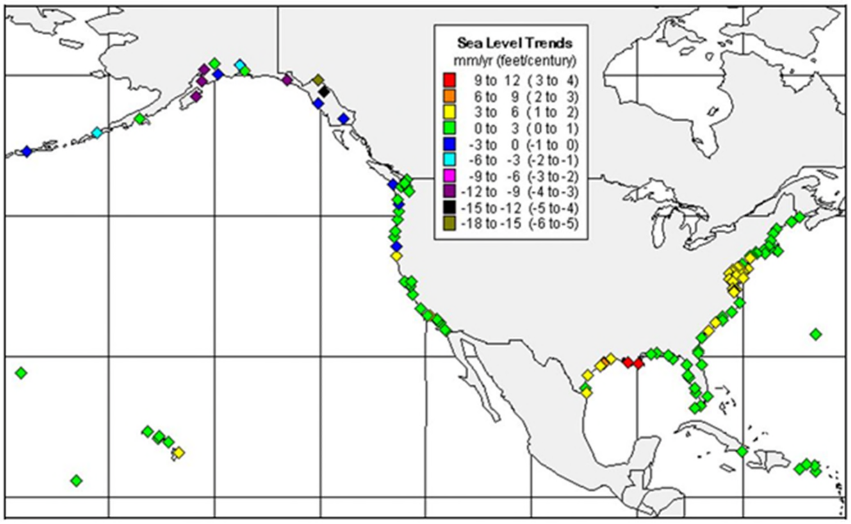
Erosion rates are usually computed and cited as long-term, average annual rates. However, erosion rates are not uniform in time or space and can vary substantially. This includes from one location along the shoreline to another, even when the two locations are only a short distance apart; over time at a single location; or seasonally.

Sea Level Rise

The Center for Operational Oceanographic Products and Services has been measuring sea level for over 150 years, with tide stations of the National Water Level Observation Network operating on all coastlines of the United States. Changes in mean sea level (MSL), either a sea level rise or sea level fall has been computed at 128 long-term water level stations using a minimum span of 30 years of observations at each location. The measurements have been averaged by month to remove the effect of higher frequency phenomena (storm surge) in order to compute an accurate linear sea level trend (NOAA 2013).

Figure 4.3.1-2 is a map of regional MSL in the United States. This map provides an overview of variations in the rates of relative local MSL at long-term tide stations. The variations in sea level trends primarily reflect differences in rates and sources of vertical land motion. Areas that experienced little-to-no change in MSL are shown in green, including stations consistent with average global sea level rise rate of 1.7 to 1.8 mm/year. These stations do not experience significant vertical land motion. Stations that experienced positive sea level trends (yellow to red) experience both global sea level rise and lowering or sinking of the local land, causing an apparent exaggerated rate of relative sea level rise. Stations that are blue to brown have experienced global sea level rise and a greater vertical rise in local land, causing an apparent decrease in relative sea level. The rates of relative sea level rise reflect actual observations and must be accounted for in any coastal planning or engineering applications (NOAA, 2013).

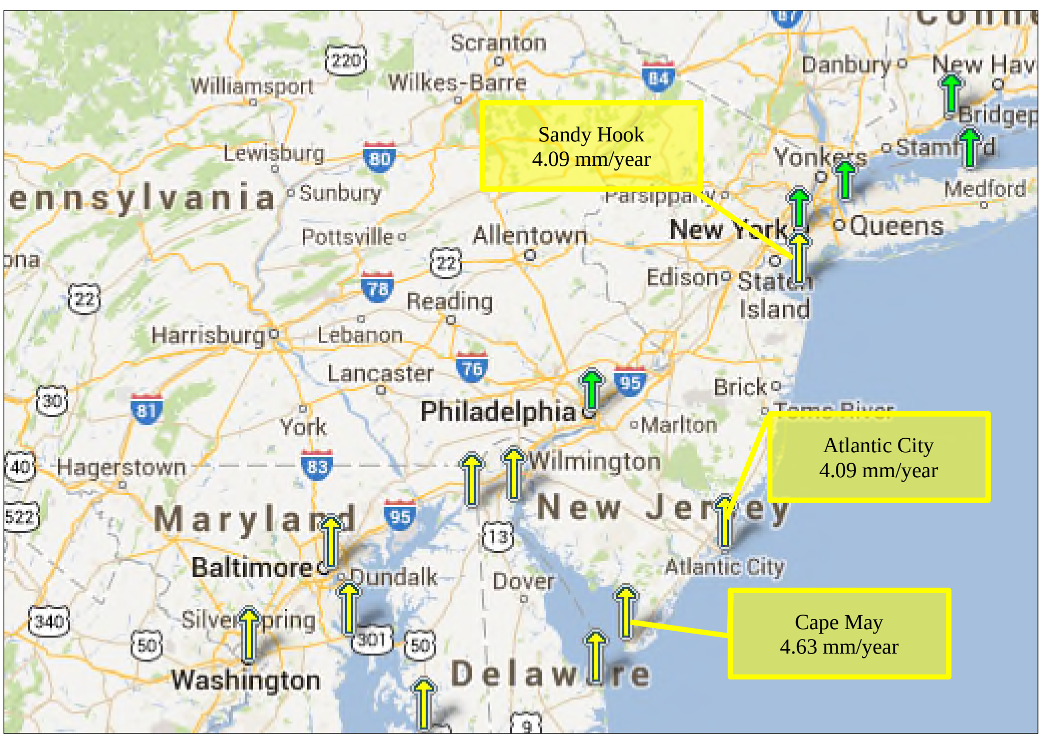
Figure 4.3.1-2. Relative Sea Level Variations of the United States



Source: NOAA, 2013

Figure 4.3.1-3 presents the most recent NOAA relative sea level variations along the Mid-Atlantic coast. Three NOAA tide gauge stations are located on the New Jersey coastline, where tide gauge measurements are made with respect to a local fixed reference level on land: Sandy Hook, Atlantic City and Cape May.

Figure 4.3.1-3. Sea Level Trends in New Jersey



Source: NOAA 2019

Previous Occurrences and Losses

Coastal erosion can occur gradually as a result of natural processes or from episodic events such as hurricanes, Nor'easters, and tropical storms. Coastal erosion also results from sea-level rise. Many sources provided historical information regarding previous occurrences and losses associated with coastal erosion events throughout the State of New Jersey and Essex County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events 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.

Coastal erosion events that have impacted Essex County between 2014 and 2019 are identified in Table 4.3.1-1. For events prior to 2015, refer to Appendix E (Risk Assessment Supplement). Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Table 4.3.1-1. Coastal Erosion Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
November 2, 2014	Strong Wind	N/A	N/A	Eastern Essex County	A strong low pressure system passed south then east of Long Island. At Newark International Airport, a measured wind of 32 mph was reported at 12:40 pm.
December 9, 2014	Flood	N/A	N/A	East Newark	A coastal storm passed just south and east of the area causing strong winds and heavy rain with isolated flooding in portions of Northeast New Jersey. Passaic Ave. was closed between Central Ave. and Johnston Ave. in East Newark due to flooding.
January 24, 2015	Winter Weather	N/A	N/A	Eastern Essex County	Low pressure moved out of the northern Gulf of Mexico on the morning of the 23rd, to the Mid Atlantic coast on the morning of the 24th, then rapidly intensified on its way northeast to the Canadian Maritimes the following day. This low brought heavy snow to parts of northeast New Jersey on the 24th. Trained spotters measured an average snowfall of 5 inches. The public measured snowfall of 6 inches in Cedar Grove. A trained spotter measured snowfall of 5.6 inches in Bloomfield. Newark Airport measured 5.1 inches of snow.
January 26, 2015	Winter Storm	N/A	N/A	Eastern Essex County	A potent Alberta Clipper low moved from southwestern Canada on January 24th to the Plains states and Ohio Valley on the 25th. The low then redeveloped off the Mid Atlantic coast on the 26th and rapidly intensified into a strong nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. Newark Liberty Airport reported snowfall of 6.5 inches, and north winds gusted up to 33 mph, with blowing and drifting of snow.
January 22-23, 2016	Winter Storm, Blizzard	DR-4264	Yes	Essex County	Low pressure moving across the deep South on Thursday January 21st and Friday January 22nd intensified and moved off the Mid Atlantic coast on Saturday January 23rd, bringing heavy snow and strong winds to northeast New Jersey, and blizzard conditions to the urban corridor and some nearby areas. Governor Chris Christie declared a state of emergency for New Jersey on Friday January 22nd. New Jersey Transit stopped running trains, buses and light rail at 2 AM Saturday January 23rd. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday. Travel in and out of airports lagged through Monday January 25th as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area airports were cancelled, and Teterboro Airport were shuttered due to whiteout conditions.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
					At Newark Airport, the storm total snowfall was 24.5 inches, where winds gusted to 39 mph. Newark Airport ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph through the day and into the early evening on Saturday January 23rd.
February 5, 2016	Winter Weather	N/A	N/A	Western Essex County	Low pressure developing along a cold front moving through the region on Thursday February 4th moved off the southern Mid Atlantic coast on Friday February 5th, bringing locally heavy snow to parts of interior Northeast New Jersey on the fifth. Trained spotters reported a widespread 4 to 5 inch snowfall, with locally up to 6 inches in North Caldwell.
November 15, 2016	Flood	N/A	N/A	Bloomfield, Silver Lake	Low pressure moving north along the east coast of the United States resulted in a widespread 1-3 inch rainfall event across northeast New Jersey. Isolated flooding was observed across parts of Essex County, NJ as a result of this rainfall. Newark Airport received 2.79 inches of rain. John F. Kennedy Drive was closed in both directions due to flooding between Hoover Avenue and Belleville Avenue in Bloomfield. Watessing Avenue was closed due to flooding between Grove Street and Franklin Street in Bloomfield. NJ 21 was closed northbound at East 3rd Avenue due to flooding with all lanes detoured.
February 9, 2017	Winter Storm	N/A	N/A	Essex County	Low pressure developed along a cold front over the Middle Atlantic early Thursday, February 9th. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport. Trained spotters, CoCoRaHS observers, and the public reported 6 to 8 inches of snowfall.
March 14, 2017	Winter Storm	N/A	N/A	Essex County	Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March 14 bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. The storm cancelled numerous flights at Newark airport with some mass transit services suspended. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow. Trained spotters and the public reported 8 to 13 inches of snow and sleet.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
December 9, 2017	Winter Weather	N/A	N/A	Essex County	Low pressure along a slow moving cold front off the eastern seaboard brought locally heavy snow to portions of northeast New Jersey. A strong upper jet stream enhanced the snow across the Tri-State as the low pressure passed well offshore. Trained Spotters and the public reported 4 to 5 inches of snow.
January 4, 2018	Winter Storm	N/A	N/A	Essex County	The development of the blizzard/winter storm began along the southeast coast on Wednesday January 3, 2018. An amplifying upper level trough spawned the development of low pressure off the coast of Florida. The low pressure rapidly intensified on Wednesday night through Thursday January 4, 2018 as it moved north-northeast along the coast. The low passed just east of the benchmark Thursday afternoon. The central pressure when the storm developed was around 1004 millibars at 1 pm Wednesday. 24 hours later, the central pressure fell to around 950 mb, approximately a 54 millibar drop. The rapid intensification of the storm led to heavy snow, strong winds, and near-blizzard conditions across portions of Northeast New Jersey. Thousands of flights were cancelled at Newark Airport on January 4, 2018. Homes and businesses lost power and there were numerous accidents on area roadways. The public reported 6 inches of snow in West Caldwell. Winds gusts 30 to 40 mph at the Caldwell Airport during the afternoon and evening on January 4, 2018. The FAA Contract Observer at nearby Newark-Liberty Airport reported 8.4 inches of snowfall. Winds also gusted to 44 MPH at 4:38 PM at the airport.
February 17-18, 2018	Winter Weather	N/A	N/A	Essex County	A low pressure developed along a frontal boundary along the southeast coast on the evening of Saturday, February 17, 2018. This low gradually became better organized as it moved up the coast towards the benchmark early Sunday, February 18, 2018. This system brought heavy snow to northern portions of northeast New Jersey. CoCoRahs observers and nearby Newark Liberty Internal Airport reported 3 to 5 inches of snowfall.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
November 15, 2018	Winter Storm	N/A	N/A	Essex County	A wave of low pressure developed along the Middle Atlantic coast during Thursday November 15, 2018. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday November 16, 2018, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). The FAA contract observer at nearby Newark Airport reported 6.4 inches of snow. Trained spotters, social media, and the public reported 4 to 6 inches of snow. Impacts were widely felt across eastern Essex county with major disruption to the evening commute. Trees branches and limbs were downed due to the weight of the heavy wet snow. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.
March 3-4, 2019	Heavy Snow	N/A	N/A	Essex County	Low pressure developed across the southeast on Sunday March 3, 2019 and then tracked off the Middle Atlantic coast early on Monday March 4, 2019. The low moved just inside the 40N/70W benchmark and continued out to sea. The low brought a widespread snowfall to northeast New Jersey with the heaviest accumulations occurring across the interior. Much of the significant snow occurred overnight with improved conditions during the Monday morning commute. Trained spotters, CoCoRaHS, and the public reported 7 to 9 inches of snow.

Source: FEMA 2019; NCDC 2019; NWS 2014; SPC 2019; NHC 2019

Note: Not all sources have been identified or researched; therefore, the table may not include all events that have occurred in the County.

DR Disaster Declaration (FEMA)

FEMA Federal Emergency Management Agency

Mph miles per hour

N/A Not Applicable

Probability of Future Occurrences

Long-term coastal erosion is a continuous and dynamic process. It is anticipated that coastal erosion will continue due to the projected increase in sea level rise, storm frequency and intensity. A number of factors determine whether a community exhibits greater risk of long-term erosion or accretion:

- Exposure to high-energy storm waves;
- Sediment size and composition of eroding coastal landforms feeding adjacent beaches;
- Near-shore bathymetric variations that direct wave approach;
- Alongshore variations in wave energy and sediment transport rates;
- Relative sea-level rise; and
- Human interference with sediment supply (such as revetments, seawalls, and jetties) (Woods Hole Sea Grant 2003).

The long-term patterns of coastal erosion are difficult to detect because of substantial and rapid changes in coastlines in the short-term (that is, over days or weeks from storms and natural tidal processes). It is usually severe short-term erosion events, occurring either singly or cumulatively over a few years, that cause concern and lead to attempts to influence the natural processes. Analysis of both long- and short-term shoreline changes are required to determine which is more reflective of the potential future shoreline configuration (FEMA 1996).

The return period of an episodic erosion event is directly related to the return period of a coastal storm, hurricane or tropical storm. The one-percent annual chance erosion event can be determined using a predictive model that establishes the one-percent annual chance tide and water surface level, or surge elevation and the resulting wave heights. Storm wave heights, periods and directions have specific impacts on the dunes, currents, and other erosion processes. Analyses of coastal erosion impacts from the one-percent annual chance flood event are included in high-hazard zone determinations shown on NFIP maps. The impacts may vary for each reach of coastline.

A more significant measure of coastal erosion is the average annual erosion rate. Erosion rates can be used in land-use and hazard management to define areas in which development should be limited or where special construction measures should be used. The average annual erosion rate is based on analysis of historical shorelines derived from maps, charts, surveys, and aerial photography obtained over a period of record.

As discussed in next subsection, changes in atmospheric and oceanic temperature will impact the probability for future coastal storm events and sea level rise. Sea level rise takes place due to a combination of long term geological and climate related processes. Long term forecasts and recent data suggest the rate of sea level rise is likely to increase in the future (Kopp et al., 2016).

Based upon risk factors for and past occurrences, it is likely that coastal erosion events and sea level rise will continue to occur and impact New Jersey and Essex County. In addition, as temperatures increase (see climate change impacts below), the probability for future events will likely increase as well. It is estimated that Essex County will continue to experience direct and indirect impacts of coastal erosion on occasion.

In Section 4.4, the identified hazards of concern for Essex 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 Steering and Planning Committee, the probability of occurrence for coastal erosion in the County is considered ‘occasional’.

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. Coastal areas may be impacted by climate change in different ways.

Changes in global temperatures, hydrologic cycles, coverage of glaciers and ice sheets, and storm frequency and intensity are captured in long-term sea level records. Sea levels provide a key to understanding the impact of climate change (NOAA 2013). Sea level rise increases the risks coastal communities face from coastal hazards (floods, storm surges, and chronic erosion). It may also lead to the loss of important coastal habitats. Sea level along the New Jersey Coast has risen by more than 16 inches since 1911, double the global average (NOAA NCEI 2019). The historical rate of sea level rise along the New Jersey coast over the past 50 years was 0.12 to 0.16 inches per year (Miller and Kopp 2013).

Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. According to NASA, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion (NASA 1997).

4.3.1.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed or vulnerable to the identified hazard. Coastal erosion may impact public safety, property, infrastructure, environmental resources and local economies. There are no NJDEP-identified shoreline types in Essex County characterized as vulnerable to erosion. However, to estimate exposure to long-term coastal erosion the entire shoreline was analyzed.

Projected sea-level rise data (in one-foot increments) available from the NOAA Office of Coastal Management (https://coast.noaa.gov/slrdata/) was considered and used for this analysis. Please note these levels do not include additional storm surge due to a hurricane or Nor'easter. The current Flood Insurance Rate Maps (FIRMs) also do not include the effects of sea-level rise. Projected sea level rise inundation areas are considered areas of permanent loss of land and community assets. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess coastal erosion and sea level rise risk.

Figure 4.3.1-2. Estimated Coastal Erosion Hazard Area (CEHA)

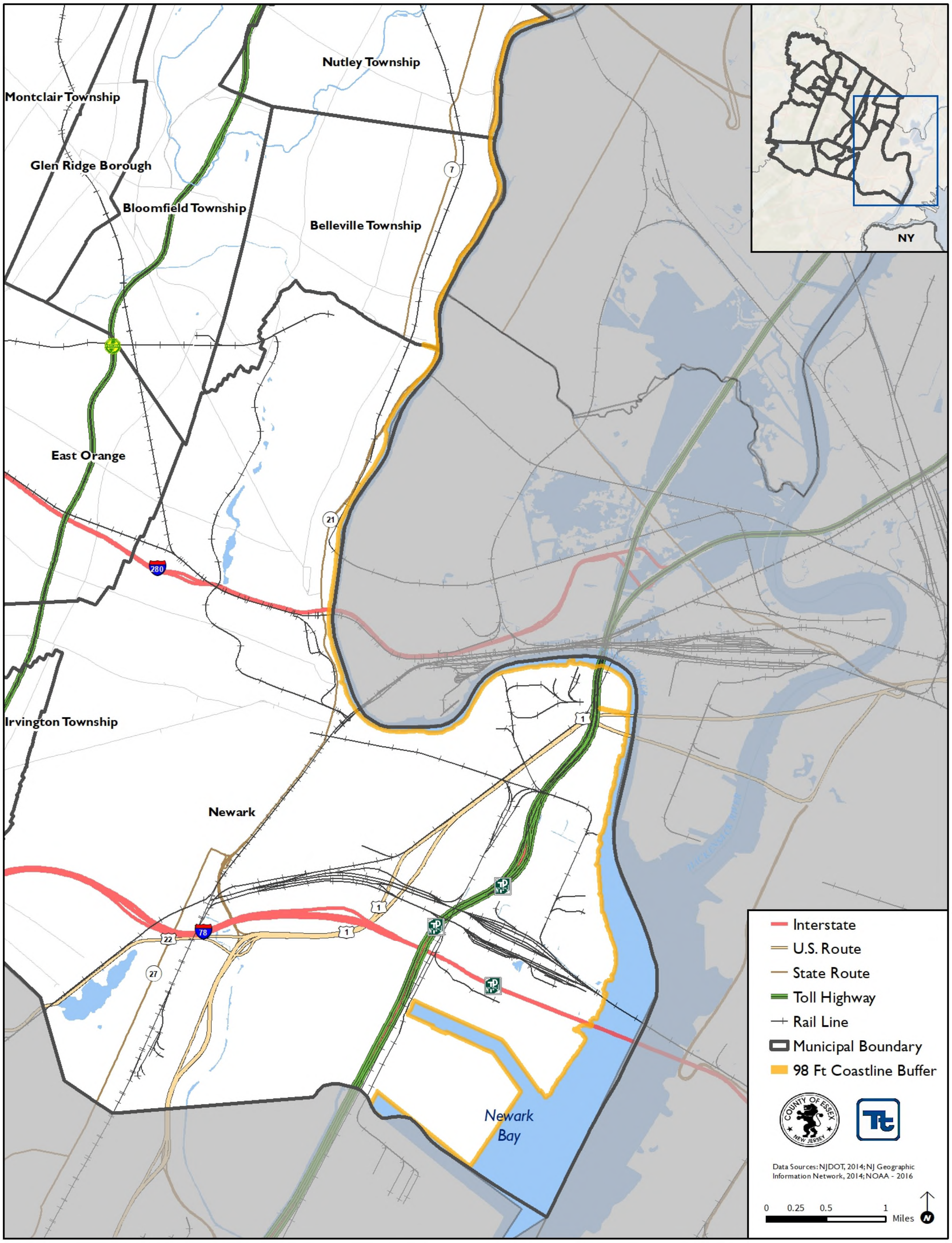
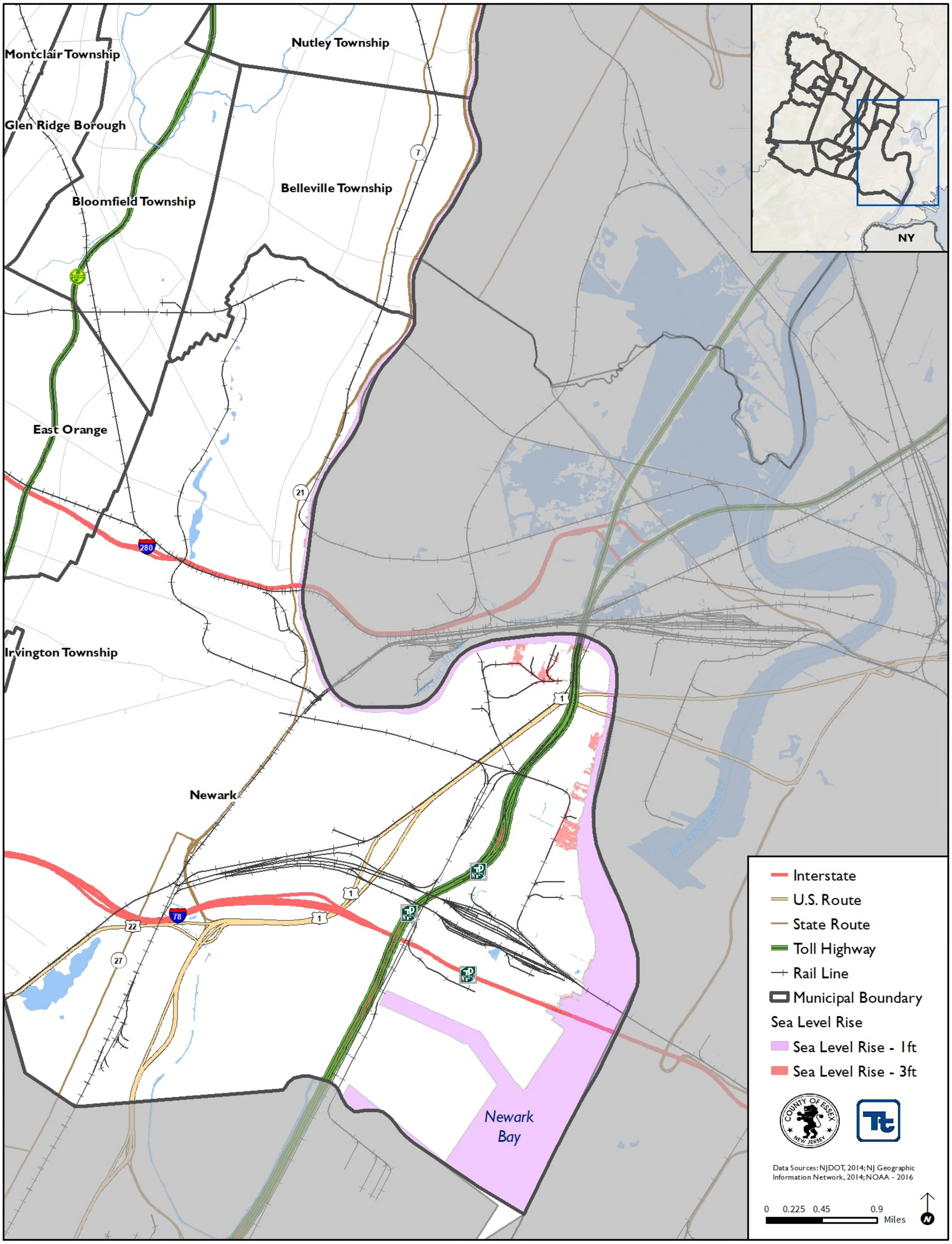


Figure 4.3.1-3. Sea Level Rise Scenarios for Essex County



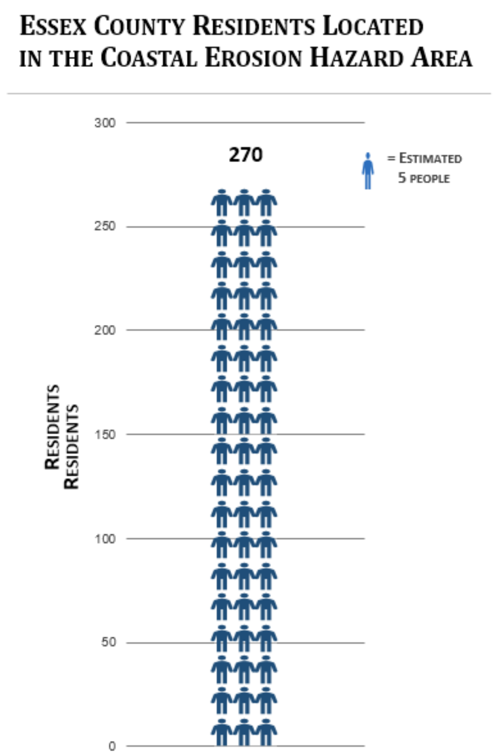
Impact on Life, Health and Safety

To estimate population exposed and vulnerable to the coastal erosion and sea level rise hazards, a spatial analysis was conducted using the 98-foot buffer along shoreline and the NOAA sea level rise inundation areas. The City of Newark is the only community in Essex County with populations located within each of the hazard areas. There are 270 people located in the coastal erosion hazard area, which accounts for less than 1% of the City's total population.

Houses and apartment buildings vulnerable to sea level rise may result in the loss of these structures. It is estimated that 28 City of Newark residents may be displaced as a result of +1-ft sea level rise. This increases to 251 displaced residents due to +3ft of sea level rise.

Socially vulnerable populations (e.g. the elderly and low-income populations) are particularly vulnerable to a hazard event. Of these 270 people located in the coastal erosion hazard area, 16 are over the age of 65 and 82 are below poverty level. Within the sea level rise +1 ft inundation area, 1 person is over the age of 65 and 4 people are below the poverty level; within the sea level rise +3 ft inundation area, 14 people are over the age of 65 and 60 people are below the poverty level.

Exhibit 4.3.1-1. Population Exposure



Impact on General Building Stock

Similar to the analysis on the County's population, the City of Newark is the only community with buildings located in the coastal erosion hazard area and sea level rise hazard areas. Projected sea level rise inundation areas are considered areas of permanent loss of land and community assets. The analysis indicates there are 42 buildings with a replacement coast value of $42 million located in the coastal erosion hazard area. Additionally, there 8 buildings with a replacement value of $19 million in the sea level rise +1 ft inundation area, which increases to 43 buildings with a replacement value of $68 million in the sea level rise + 3 ft inundation area. All these estimates account for less than 1% of the County's total building stock.

Impact on Critical Facilities

Coastal erosion and sea level rise can impact critical facilities. Coastal erosion can degrade the surrounding infrastructure and utility lines, depending on their location on the property. This could inhibit the facilities ability to respond during or after an emergency event. In the case of a single, severe event, the structural foundation of a facility can be compromised as well.

Regarding sea level rise, access to these facilities and infrastructure can be permanently inundated, as well as permanent inundation of the facilities themselves. There are five critical facilities, including three ports and two bridge in the City of Newark located within the coastal erosion hazard area and the sea level rise +1 ft inundation area. Within the sea level rise +3 ft inundation area, there is an oil facility that is also exposed. While the bridge elevations may be at a height greater than any sea level rise impacts, the access roads and ramps may vulnerable. Additionally, a severe coastal erosion event during a coastal storm could erode the riverbank and foundation of the bridge and could impact the structural integrity of the bridge.

Impact on Economy

Coastal erosion and sea level rise can also severely impact roads and infrastructure. As coastline evolution continues, evacuation and emergency routes need to be considered. Essex County includes significant westbound and northbound evacuation routes. Using the hurricane evacuation routes in the North Jersey Transportation Planning Authority (NJTPA) spatial dataset, routes used to direct traffic inland in case of a hurricane threat are located in the coastal erosion hazard area and sea level rise area. Evacuation routes exposed to Tier 1 and Tier 2 scenarios from the NJTPA climate resilience plan show impacts to New Jersey Route 23, U.S. and Interstate 80. Evacuation routes from the Homeland Infrastructure Foundation Level Data (HIFLD) show potential impacts to portions of the New Jersey Turnpike, U.S. Route 280 and 78. The City of Newark has the largest port facility in the State and as indicated in the exposure analysis could be exposed to sea level rise in the future.

Potential economic loss as a result of sea level rise is based on replacement cost value of structures based on the County Assessor's data. The total replacement cost value of structures located in the +1 and +3ft of sea level rise inundation areas are $18,754,730 and $68,375,036 respectively.

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

The County and participating municipalities intend to discourage development within vulnerable areas or to encourage higher regulatory standards on the local level. Any areas of growth could be affected by the identified hazards if located within identified hazard areas. Each municipality identified areas of recent development and proposed development in their community (refer to Section 3 – County Profile and Section 9 – Jurisdictional Annexes). Developments that could be located using an address or Parcel ID were geocoded and overlaid with the hazard area boundaries to determine vulnerability to coastal erosion and sea level rise. There are no recent and proposed development locations vulnerable to the coastal erosion and sea level rise hazard.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population change is not expected to have a direct effect on the overall vulnerability of the county's population over time. The coastal erosion and sea level rise hazard areas have a limited exposure along the eastern boundary of the County, while population growth will occur throughout the County. While some populations could see increased vulnerability due to impacted roadways and transportation routes traversing the hazard areas, the overall impact to the County's vulnerability will be low. Refer to Section 4.3.1, Population Trends in the County Profile, includes a discussion on population trends for the county.

Climate Change

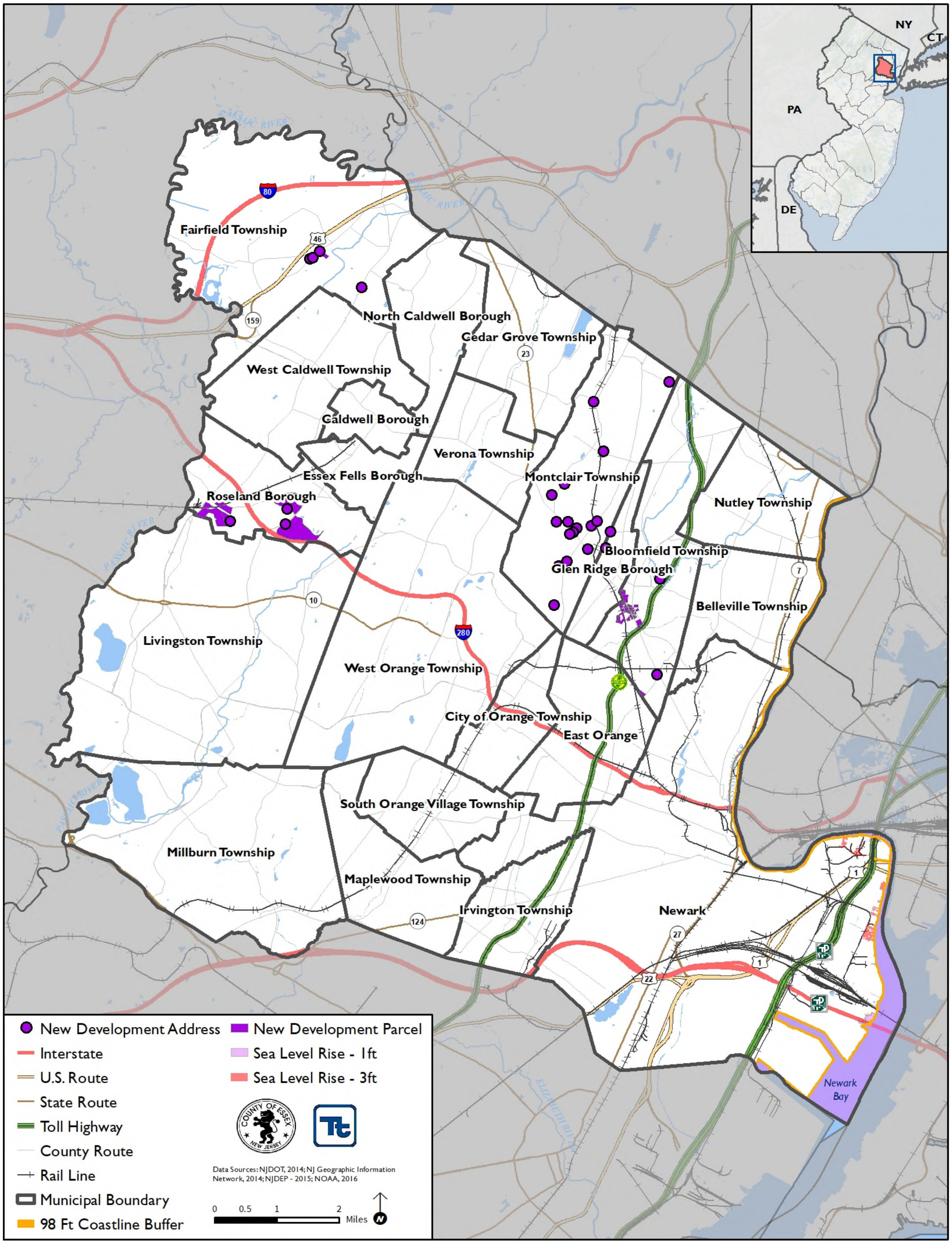
Impacts of climate change can lead to shoreline erosion, coastal flooding, and water pollution, affecting man-made coastal infrastructure and coastal ecosystems. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. Additionally, oceans are absorbing more carbon dioxide from the rising atmospheric concentrations of the gas, resulting in oceans becoming more acidic. This could have significant impacts on coastal and marine ecosystems (U.S. EPA 2013).

Coastal erosion is not generally considered an imminent threat to public safety when the changes are gradual over many years. However, drastic changes to the shoreline may occur as a result of a single storm event which can threaten public safety, buildings, and critical infrastructure. As previously stated, warmer temperatures may lead to an increase in frequency of storms, and an increase in the frequency and intensity of storms could increase the potential for severe coastal erosion events.

Change of Vulnerability Since 2015 HMP

The City of Newark and Townships of Belleville and Nutley continue to be vulnerable to the coastal erosion hazard and sea level rise. Several differences exist between the 2015 Plan and this update. For this plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the county's risk to the hazard areas. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. An updated hazard area was used as well; the 2016 sea-level rise spatial layer from NOAA was used. The original sea level rise data incorporated sea level rise into the floodplain, while this analysis looks at sea level rise only to be consistent with the 2019 NJSHMP. Due to changes in the data used, a direct comparison of vulnerability between the plans is difficult. The updated vulnerability assessment provides a more current exposure analysis for the county.

Figure 4.3.1-4. Potential New Development and Coastal Erosion Hazards and Coastal Risk Areas



4.3.2 Coastal Storms

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 coastal storms hazard in Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- New and updated figures from federal and state agencies are incorporated.
- Previous occurrences were updated with events that occurred between 2014 and 2019.

4.3.2.1 Profile

Hazard Description

For the purpose of this HMP update, the coastal storm hazard profile will include: hurricanes and tropical storms, Nor'Easters, and storm surge. Detailed information regarding these hazards in Essex County are discussed further in this section.

Hurricanes and Tropical Storm

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 (National Weather Service [NWS] 2013). 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 2013a).

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 1999).

The National Weather Service (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 (24 hours in the western north Pacific). 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 (24 hours for the western north Pacific) 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).

Nor'Easter

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 2013b). 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° 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)

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 (Storm Solutions 2013). 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.

Storm Surge

Storm surges inundate coastal floodplains through dune overwash, tidal elevation rise in inland bays and harbors, and backwater flooding through coastal river mouths. Strong winds can increase tide levels and water-surface elevations. Storm systems generate large waves that run up and flood coastal beaches. The combined effects create storm surges that affect the beach, dunes, and adjacent low-lying floodplains. Shallow, offshore depths can cause storm-driven waves and tides to pile up against the shoreline and inside bays.

Based on an area's topography, a storm surge may inundate only a small area (along sections of the northeast or southeast coasts) or storm surge may inundate coastal lands for a mile or more inland from the shoreline.

Location

All of Essex County, not just the coastal areas, is vulnerable to coastal storms, depending on the storm's track. The coastal areas are more susceptible to damage caused by the combination of both high winds and tidal surge. Inland areas, especially those in floodplains, are also at risk for flooding because of heavy rain and winds. The majority of damage following coastal storms often results from residual wind damage and inland flooding, as was demonstrated during recent tropical storms. Section 4.3.1 (Coastal Erosion and Sea Level Rise) and Section 4.3.6 (Flood) discuss Essex County's coastline and the flood hazard further. Refer to Section 9 (Jurisdictional

Annexes) for detailed maps that display the 1-percent annual chance event floodplains and Sea, Lake and Overland Surge from Hurricanes (SLOSH) inundation areas in each municipality.

New Jersey's coastal zone includes portions of eight counties and 126 municipalities. The coastal boundary of New Jersey encompasses the Coastal Area Facility Review Act (CAFRA) area and the New Jersey Meadowlands District. Figure 4.3.2-1 shows New Jersey and the highlighted coastal zone area. Essex County is not located in either the CAFRA zone or Meadowlands; however, the County does have areas influenced by coastal waters and storm surge. The coastal area includes coastal waters to the limit of tidal influence including Newark Bay and the Passaic River, and the tidal portions of their tributaries. (NJDEP 2014).

Essex County is located within the New York-New Jersey Harbor Estuary (Newark Bay). Located in the New York & New Jersey Harbor Estuary, Newark Bay is the center of the most urbanized and industrialized parts of the country. Newark Bay is approximately six miles long and one mile wide and is located at the confluence of the Passaic and Hackensack Rivers, between the shores of Newark and Elizabeth to the west, Jersey City and Bayonne to the east, and Staten Island to the south. Newark Bay is linked to Upper and Lower New York Bay by the Kill van Kull and the Arthur Kill. Port Newark is located on the western shore of Newark Bay (Our Newark Bay 2014).

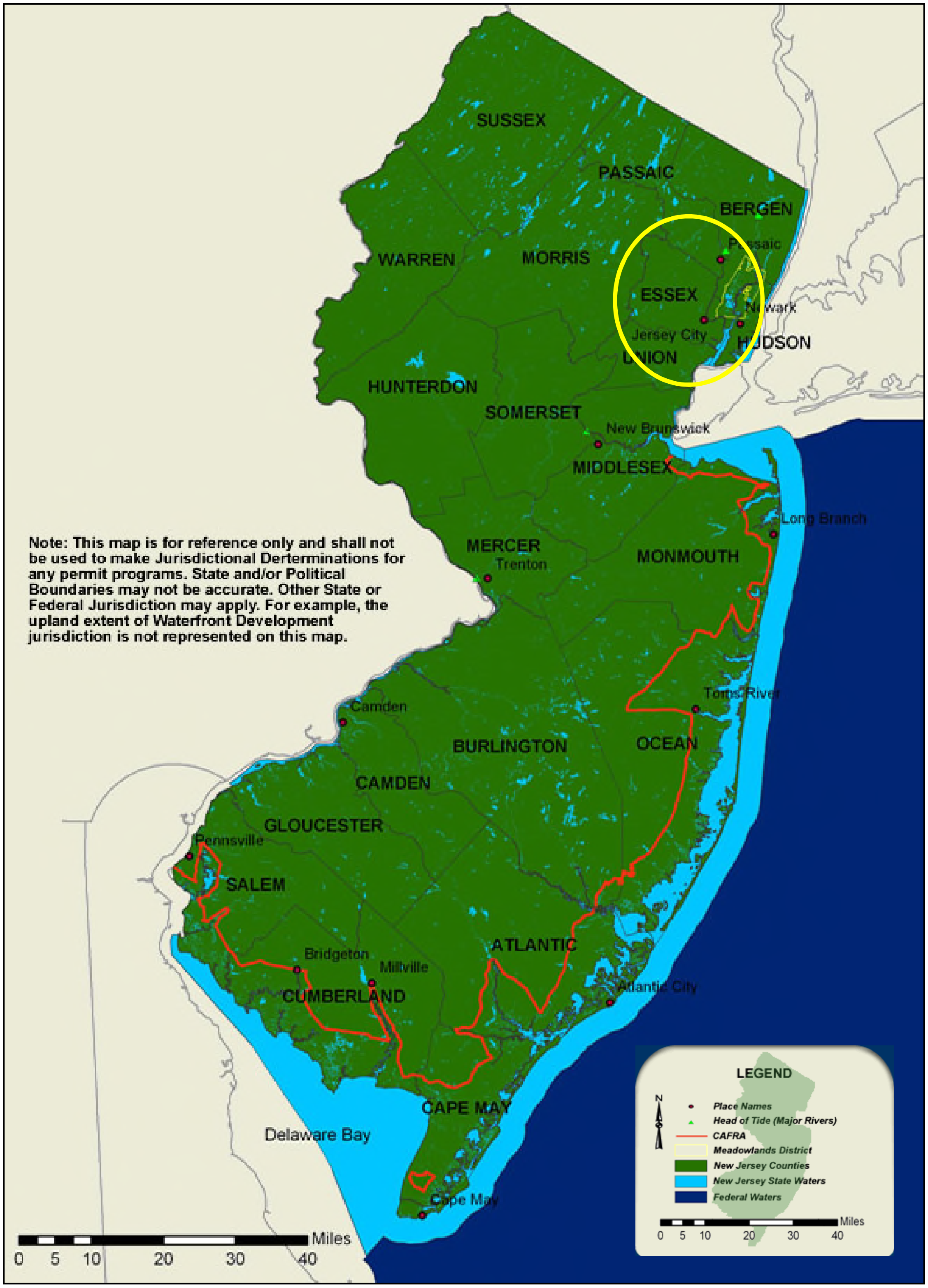
Storm Surge

Typically, storm surge is estimated by subtracting the regular/astrological tide level from the observed storm tide. Typical storm surge heights range from several feet to more than 25 feet. The exact height of the storm surge and which coastal areas will be flooded depends on many factors: strength, intensity, and speed of the hurricane or storm; the direction it is moving relative to the shoreline; how rapidly the sea floor is sloping along the shore; the shape of the shoreline; and the astronomical tide. Storm surge is the most damaging when it occurs along a shallow sloped shoreline, during high tide, in a highly populated, and developed area with little or no natural buffers (for example, barrier islands, coral reefs, and coastal vegetation).

The most common reference to a return period for storm surges has been the elevation of the coastal flood having a 1% chance of being equaled or exceeded in any given year, also known as the 100-year flood. Detailed hydraulic analyses include establishing the relationship of tide levels with wave heights and wave run-up. The storm surge inundation limits for the 1% annual chance coastal flood event are a function of the combined influence of the water surface elevation rise and accompanying wave heights and wave run-up along the coastline.

The coastal areas are more susceptible to damage caused by the combination of both high winds and tidal surge. Inland areas, especially those in floodplains, are also at risk for flooding because of heavy rain and winds. The majority of damage following hurricanes and tropical storms often results from residual wind damage and inland flooding, as was demonstrated during recent tropical storms.

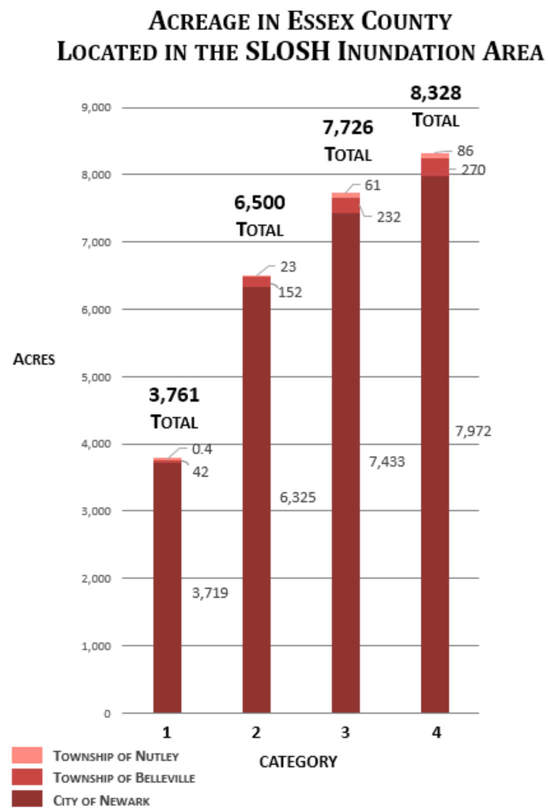
Figure 4.3.2-1. New Jersey Coastal Zone Area



Source: New Jersey Department of Environmental Protection (NJDEP) 2007
The yellow circle highlights the location of Essex County.

As noted, inundation from storm surge has devastating impacts on the State's coastal communities. The U.S. Army Corps of Engineers (USACE), in cooperation with FEMA, initially prepared SLOSH inundation maps. SLOSH maps represent potential flooding from worst-case combinations of hurricane direction, forward speed, landfall point, and high astronomical tide. It does not include riverine flooding caused by hurricane surge or inland freshwater flooding. The mapping was developed for the coastal communities in New Jersey using the computer model to forecast surges that occur from wind and pressure forces of hurricanes coastline topography. In New Jersey, hurricane category is the predominant factor in worst-case hurricane surges. The resulting inundation areas are grouped into Category 1 and 2 (dangerous), Category 3 (devastating), and Category 4 (catastrophic) classifications. The hurricane category refers to the Saffir/Simpson Hurricane Intensity Scale, summarized below.

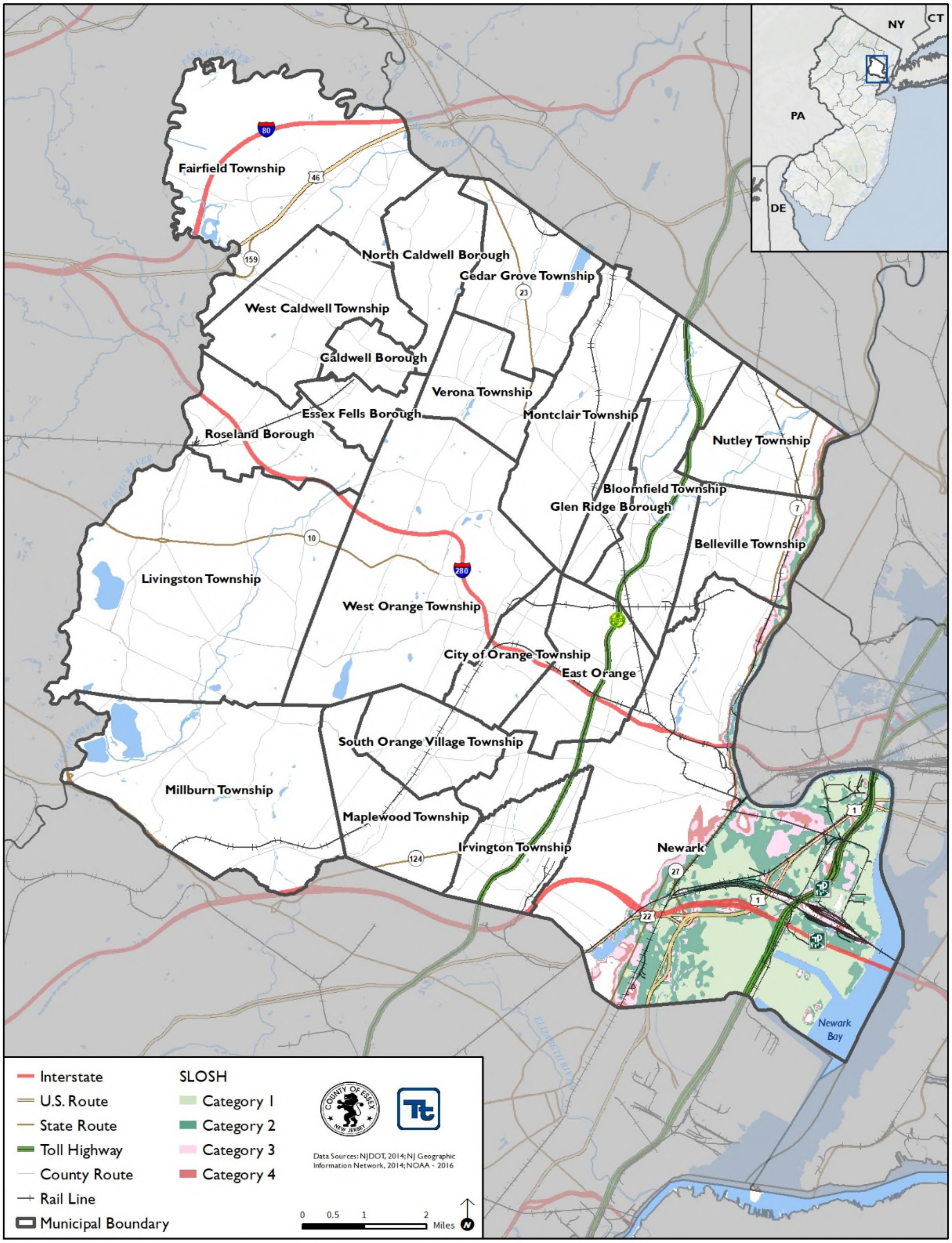
Exhibit 4.3.2-1. Acreage in SLOSH



Source: NOAA National Hurricane Center, 2016

FEMA Region IV Risk Analysis Team developed storm surge inundation grids for the State in a spatial format from the maximum of maximums outputs from the SLOSH model. These represent the worst-case storm surge scenarios for each hurricane category (1 through 4). To assess the Planning Area's exposure to the hurricane/tropical surge, a spatial analysis was conducted using the SLOSH model. The SLOSH boundaries do not account for any inland flash flooding. Exhibit 4.3.2-1 shows the acreage of land in the SLOSH boundaries for the Township of Nutley, Township of Belleville and City of Newark. Figure 4.3.2-2 below illustrates these SLOSH zones.

Figure 4.3.2-2. FEMA Region IV SLOSH Model (Categories 1 through 4)



Extent

Hurricane and Tropical Storm

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 4.3.2-1 presents this scale, which is used to estimate the potential property damage and flooding expected when a hurricane makes landfall.

Table 4.3.2-1. The Saffir-Simpson Scale

Category	Wind Speed (mph)	Expected Damage
1	74-95 mph	Very dangerous winds will produce some damage: Homes with well-constructed frames could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap, and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110 mph	Extremely dangerous winds will cause extensive damage: Homes with well-constructed frames could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3 (major)	111-129 mph	Devastating damage will occur: Homes with well-built frames may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4 (major)	130-156 mph	Catastrophic damage will occur: Homes with well-built frames can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted, and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5 (major)	>157 mph	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Source: NOAA 2013b
Notes: mph = Miles per hour
> = Greater than

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (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 4.3.2-3 and Figure 4.3.2-4 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 Hazards U.S. Multi-Hazard (HAZUS-MH) model runs. The estimated hurricane track used for the 100- and 500-year event is also shown. The maximum 3-second gust wind speeds for Essex County range from Tropical Storm to Category 1 hurricane speeds for the 100-year MRP event. The maximum 3-second gust wind speeds for Essex County range from Category 1 to Category 2 hurricane speeds for the 500-year MRP event. The associated impacts and losses from these 100-year and 500-year MRP hurricane event model runs are reported in the Vulnerability Assessment.

Figure 4.3.2-3. Wind Speeds for the 100-Year Mean Return Period Event

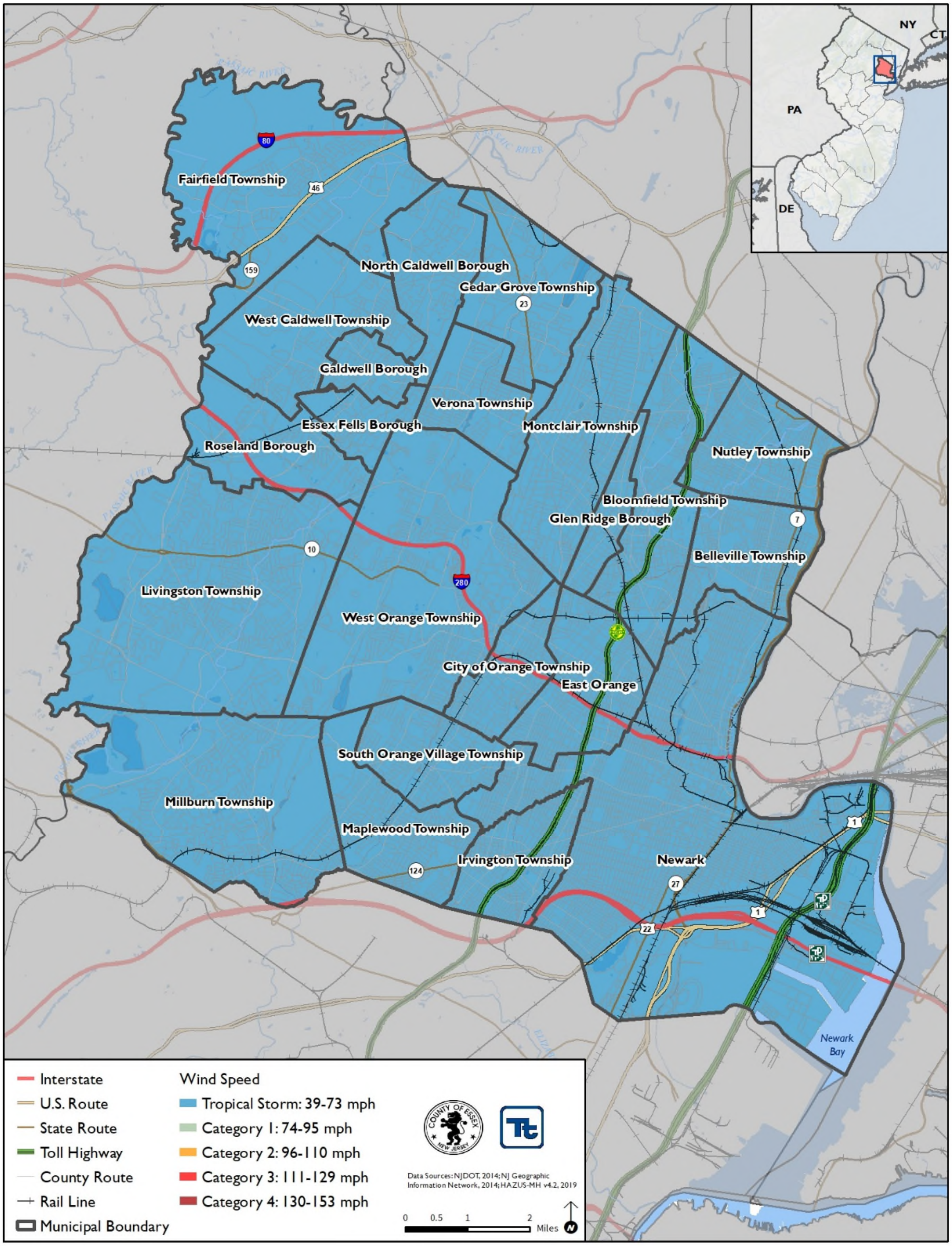
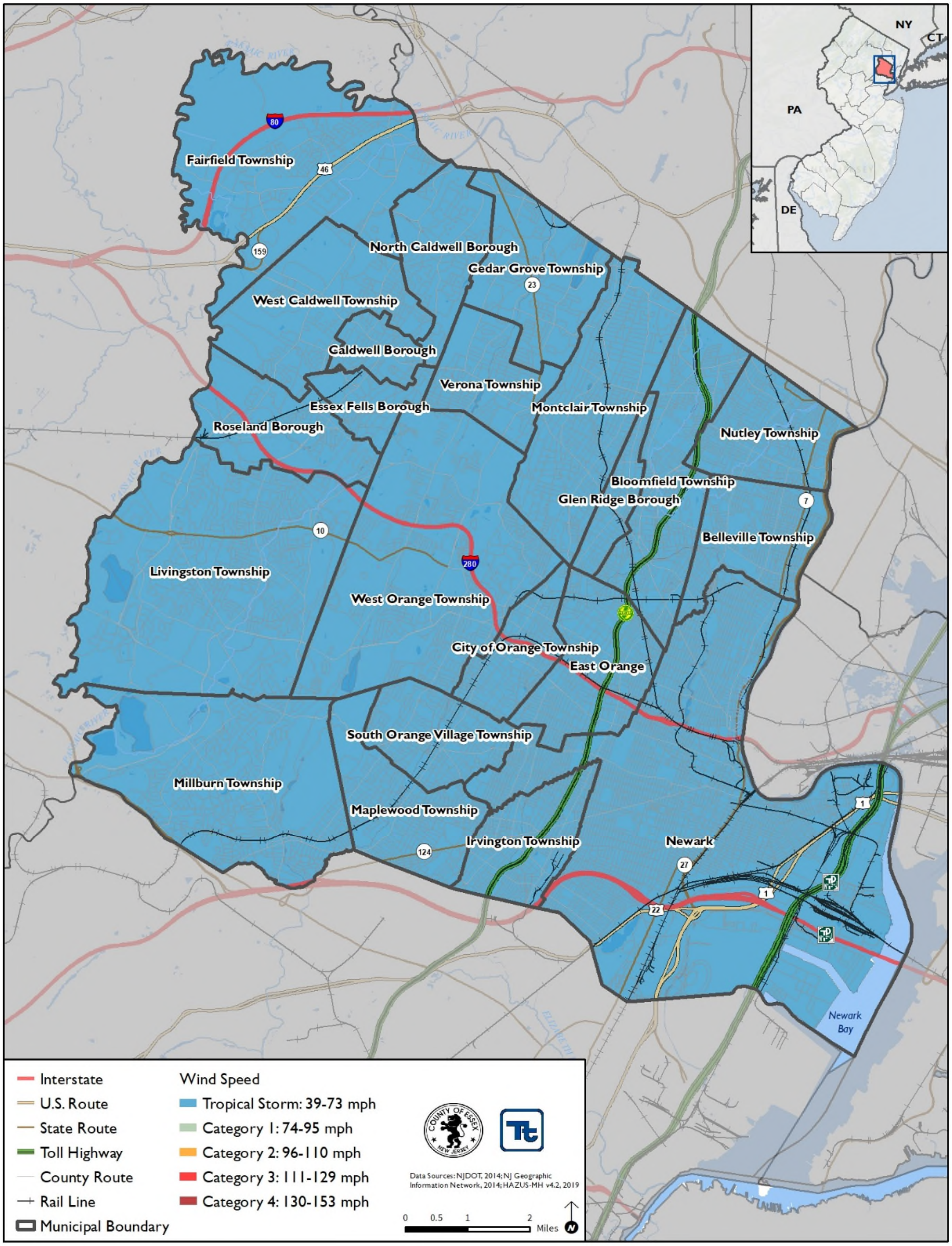


Figure 4.3.2-4. Wind Speeds for the 500-Year Mean Return Period Event



Nor'Easter

The severity of a 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, time of occurrence during the day (e.g., weekday versus weekend), and time of season. 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 U.S. 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 4.3.2-2 presents the five categories.

Table 4.3.2-2. 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
RSI Regional Snowfall Index

Nor'Easters have the potential to impact society to a greater extent than hurricanes and tornadoes. These storms often have a diameter three to four times larger than a hurricane and therefore, impact much larger areas. More homes and properties become susceptible to damage as the size and strength of a Nor'Easter intensifies (Storm Solution, 2013).

Storm Surge

Typically, storm surge is estimated by subtracting the regular/astrological tide level from the observed storm tide. Typical storm surge heights range from several feet to more than 25 feet. The exact height of the storm surge and which coastal areas will be flooded depends on many factors: strength, intensity, and speed of the hurricane or storm; the direction it is moving relative to the shoreline; how rapidly the sea floor is sloping along the shore; the shape of the shoreline; and the astronomical tide. Storm surge is the most damaging when it occurs along a shallow sloped shoreline, during high tide, in a highly populated, and developed area with little or no natural buffers (for example, barrier islands, coral reefs, and coastal vegetation).

The most common reference to a return period for storm surges has been the elevation of the coastal flood having a one-percent chance of being equaled or exceeded in any given year, also known as the 100-year flood. Detailed hydraulic analyses include establishing the relationship of tide levels with wave heights and wave run-up. The storm surge inundation limits for the one-percent annual chance coastal flood event are a function of the combined influence of the water surface elevation rise and accompanying wave heights and wave run-up along the coastline.

Previous Occurrences and Losses

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 2017 (latest date available from data source). Between 1842 and 2017, 32 tropical cyclones tracked within 65 nautical miles of Essex County. From 2012 to 2017, no tropical cyclones tracked within 65 nautical miles.

Between 1954 and 2019, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for 37 coastal storm-related events, classified as one or a combination of the following disaster types: hurricane, tropical storm, severe storm, flooding, Nor'Easter, tropical depression, coastal storm, high tides, and heavy rain. Of those events, Essex County has been included in eight coastal storm-related declarations (EM and DR) (FEMA 2019).

Coastal storm events that have impacted Essex County between 2014 and 2019 are identified in Appendix E. For events prior to 2015, refer to Appendix E (Risk Assessment Supplement). Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Table 4.3.2-3. Coastal Storm Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
November 2, 2014	Strong Wind	N/A	N/A	Eastern Essex County	A strong low pressure system passed south then east of Long Island. At Newark International Airport, a measured wind of 32 mph was reported at 12:40 pm.
December 9, 2014	Flood	N/A	N/A	East Newark	A coastal storm passed just south and east of the area causing strong winds and heavy rain with isolated flooding in portions of Northeast New Jersey. Passaic Ave. was closed between Central Ave. and Johnston Ave. in East Newark due to flooding.
January 24, 2015	Winter Weather	N/A	N/A	Eastern Essex County	Low pressure moved out of the northern Gulf of Mexico on the morning of the 23rd, to the Mid Atlantic coast on the morning of the 24th, then rapidly intensified on its way northeast to the Canadian Maritimes the following day. This low brought heavy snow to parts of northeast New Jersey on the 24th. Trained spotters measured an average snowfall of 5 inches. The public measured snowfall of 6 inches in Cedar Grove. A trained spotter measured snowfall of 5.6 inches in Bloomfield. Newark Airport measured 5.1 inches of snow.
January 26, 2015	Winter Storm	N/A	N/A	Eastern Essex County	A potent Alberta Clipper low moved from southwestern Canada on January 24th to the Plains states and Ohio Valley on the 25th. The low then redeveloped off the Mid Atlantic coast on the 26th and rapidly intensified into a strong nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. Newark Liberty Airport reported snowfall of 6.5 inches, and north winds gusted up to 33 mph, with blowing and drifting of snow.
January 22-23, 2016	Winter Storm, Blizzard	DR-4264	Yes	Essex County	Low pressure moving across the deep South on Thursday January 21st and Friday January 22nd intensified and moved off the Mid Atlantic coast on Saturday January 23rd, bringing heavy snow and strong winds to northeast New Jersey, and blizzard conditions to the urban corridor and some nearby areas. Governor Chris Christie declared a state of emergency for New Jersey on Friday January 22nd. New Jersey Transit stopped running trains, buses and light rail at 2 AM Saturday January 23rd. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday. Travel in and out of airports lagged through Monday January 25th as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
					airports were cancelled, and Teterboro Airport were shuttered due to whiteout conditions. At Newark Airport, the storm total snowfall was 24.5 inches, where winds gusted to 39 mph. Newark Airport ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph through the day and into the early evening on Saturday January 23rd.
February 5, 2016	Winter Weather	N/A	N/A	Western Essex County	Low pressure developing along a cold front moving through the region on Thursday February 4th moved off the southern Mid Atlantic coast on Friday February 5th, bringing locally heavy snow to parts of interior Northeast New Jersey on the fifth. Trained spotters reported a widespread 4 to 5 inch snowfall, with locally up to 6 inches in North Caldwell.
November 15, 2016	Flood	N/A	N/A	Bloomfield, Silver Lake	Low pressure moving north along the east coast of the United States resulted in a widespread 1-3 inch rainfall event across northeast New Jersey. Isolated flooding was observed across parts of Essex County, NJ as a result of this rainfall. Newark Airport received 2.79 inches of rain. John F. Kennedy Drive was closed in both directions due to flooding between Hoover Avenue and Belleville Avenue in Bloomfield. Watessing Avenue was closed due to flooding between Grove Street and Franklin Street in Bloomfield. NJ 21 was closed northbound at East 3rd Avenue due to flooding with all lanes detoured.
February 9, 2017	Winter Storm	N/A	N/A	Essex County	Low pressure developed along a cold front over the Middle Atlantic early Thursday, February 9th. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport. Trained spotters, CoCoRaHS observers, and the public reported 6 to 8 inches of snowfall.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
March 14, 2017	Winter Storm	N/A	N/A	Essex County	Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March 14 bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. The storm cancelled numerous flights at Newark airport with some mass transit services suspended. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow. Trained spotters and the public reported 8 to 13 inches of snow and sleet.
December 9, 2017	Winter Weather	N/A	N/A	Essex County	Low pressure along a slow moving cold front off the eastern seaboard brought locally heavy snow to portions of northeast New Jersey. A strong upper jet stream enhanced the snow across the Tri-State as the low pressure passed well offshore. Trained Spotters and the public reported 4 to 5 inches of snow.
January 4, 2018	Winter Storm	N/A	N/A	Essex County	The development of the blizzard/winter storm began along the southeast coast on Wednesday January 3, 2018. An amplifying upper level trough spawned the development of low pressure off the coast of Florida. The low pressure rapidly intensified on Wednesday night through Thursday January 4, 2018 as it moved north-northeast along the coast. The low passed just east of the benchmark Thursday afternoon. The central pressure when the storm developed was around 1004 millibars at 1 pm Wednesday. 24 hours later, the central pressure fell to around 950 mb, approximately a 54 millibar drop. The rapid intensification of the storm led to heavy snow, strong winds, and near-blizzard conditions across portions of Northeast New Jersey. Thousands of flights were cancelled at Newark Airport on January 4, 2018. Homes and businesses lost power and there were numerous accidents on area roadways. The public reported 6 inches of snow in West Caldwell. Winds gusts 30 to 40 mph at the Caldwell Airport during the afternoon and evening on January 4, 2018. The FAA Contract Observer at nearby Newark-Liberty Airport reported 8.4 inches of snowfall. Winds also gusted to 44 MPH at 4:38 PM at the airport.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
February 17-18, 2018	Winter Weather	N/A	N/A	Essex County	A low pressure developed along a frontal boundary along the southeast coast on the evening of Saturday, February 17, 2018. This low gradually became better organized as it moved up the coast towards the benchmark early Sunday, February 18, 2018. This system brought heavy snow to northern portions of northeast New Jersey. CoCoRahs observers and nearby Newark Liberty Internal Airport reported 3 to 5 inches of snowfall.
November 15, 2018	Winter Storm	N/A	N/A	Essex County	A wave of low pressure developed along the Middle Atlantic coast during Thursday November 15, 2018. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday November 16, 2018, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). The FAA contract observer at nearby Newark Airport reported 6.4 inches of snow. Trained spotters, social media, and the public reported 4 to 6 inches of snow. Impacts were widely felt across eastern Essex county with major disruption to the evening commute. Trees branches and limbs were downed due to the weight of the heavy wet snow. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
March 3-4, 2019	Heavy Snow	N/A	N/A	Essex County	Low pressure developed across the southeast on Sunday March 3, 2019 and then tracked off the Middle Atlantic coast early on Monday March 4, 2019. The low moved just inside the 40N/70W benchmark and continued out to sea. The low brought a widespread snowfall to northeast New Jersey with the heaviest accumulations occurring across the interior. Much of the significant snow occurred overnight with improved conditions during the Monday morning commute. Trained spotters, CoCoRaHS, and the public reported 7 to 9 inches of snow.

Source: FEMA 2019; NCDC 2019; NWS 2014; SPC 2019; NHC 2019
DR Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
N/A Not Applicable

With coastal storm documentation for New Jersey and Essex County being so extensive, not all sources have been identified or researched; therefore, this table may not include all events that have occurred in or impacted the County.

Probability of Future Occurrences

It is estimated that Essex County will continue to experience direct and indirect impacts of coastal storms annually that may induce secondary hazards such as flooding, extreme wind, coastal erosion, storm surge in coastal areas, 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 Essex 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 coastal storm hazard in the County is considered 'occasional'.

The following provides probability of each type of coastal storm discussed in this section.

Hurricane and Tropical Storm

Hurricane return periods are the frequency at which a certain intensity of hurricane can be expected within a given distance of a given location. According to the NHC, the return period for Essex County 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) (NHC 2014).

Nor'Easter

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).

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. Coastal areas may be impacted by climate change in different ways. Coastal areas are sensitive to sea-level rise, changes in the frequency and intensity of storms, increase in precipitation, and warmer ocean temperatures. According to NASA, warmer temperatures may lead to an increase in frequency of storms, thus leading to more weather events that cause coastal erosion (NASA 1997).

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4 °F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Northern and southern New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over 5″ (12%) greater than the average from 1895-1970. Southern New Jersey became

2″ (5%) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5% by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC2] 2009).

Precipitation measurements indicate 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. Southern New Jersey became two inches (5%) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5% by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (NPCC2 2009).

Some climatologists predict 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. Future climate change has been predicted 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.

Higher sea levels will increase the starting level for flooding from coastal storms and, therefore, smaller flooding events in the future will be able to reach the same flooding heights as present day storms. Sea-level rise in New Jersey has resulted in an increase in sea level of roughly 16 inches in the past century. The rate of sea-level rise is anticipated to increase as time goes on, with the rate of increase being tied to the rate of greenhouse gas emissions and the corresponding increase in global temperatures (Rutgers 2016). As sea levels continue to rise, an increase in the frequency and severity of coastal flooding events from coastal storms is expected. Section 4.3.1 (Coastal Erosion and Sea Level Rise) contains a discussion of the State's efforts to address sea level rise.

4.3.2.2 Vulnerability Assessment

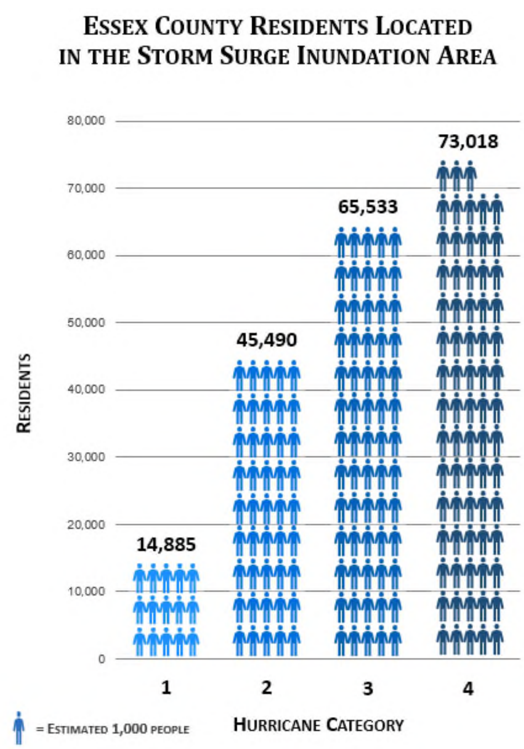
Wind-related vulnerability data was generated using a HAZUS-MH analysis for the coastal storms hazard. A probabilistic assessment was conducted for the 100- and 500-year MRPs through a Level 2 analysis in HAZUS-MH v4.2 to analyze the hazard and provide a range of loss estimates. Storm surge impacts were assessed using SLOSH data from NOAA's National Hurricane Center. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess coastal storm risk.

Impact on Life, Health and Safety

The impact of a coastal storm 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. For the purposes of this HMP, the entire population of Essex County (800,401 people) is exposed to coastal storm events (2013-2017 American Community Survey 5-year Estimate). Residents may be displaced or require temporary to long-term sheltering due to coastal storm events. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Please refer to Section 3 (County Profile) for the total Essex County population vulnerable to this hazard.

The loss associated with coastal storms can vary across the County; secondary flooding associated with the torrential downpours during hurricanes/tropical storms is also a primary concern in the County (see flooding discussion in Section 4.3.6 Flood). The estimated population living in the Category 1 through 4 SLOSH inundation zones is summarized in Exhibit 4.3.2-2 for the County and Table 4.3.2-4 by municipality. For the Category 1 through Category 4 inundation areas, the City of Newark has the greatest total exposure with 14,793 people, 44,505 people, 63,077 people, and 69,865 people located in each area, respectively.

Exhibit 4.3.2-2. Population Exposure



Source: NOAA National Hurricane Center, 2016; American Community Survey 2013-2017

Table 4.3.2-4. Estimated Population in the Hurricane SLOSH Inundation Zones

Municipality	Total Population	Estimated Population Exposed							
		Category 1 SLOSH	% of Total	Category 2 SLOSH	% of Total	Category 3 SLOSH	% of Total	Category 4 SLOSH	% of Total
Township of Belleville	36,383	92	0.3%	951	2.6%	2,229	6.1%	2,595	7.1%
Township of Bloomfield	48,892	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Caldwell	8,032	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Cedar Grove	12,638	0	0.0%	0	0.0%	0	0.0%	0	0.0%
City of East Orange	65,151	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Essex Fells	2,095	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Fairfield	7,671	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Glen Ridge	7,668	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Irvington	54,715	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Livingston	29,955	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Maplewood	24,706	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Millburn	20,387	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Montclair	38,572	0	0.0%	0	0.0%	0	0.0%	0	0.0%
City of Newark	282,803	14,793	5.2%	44,505	15.7%	63,077	22.3%	69,865	24.7%
Borough of North Caldwell	6,637	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Nutley	28,829	0	0.0%	35	<1%	227	<1%	558	1.9%
City of Orange Township	30,731	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Roseland	5,907	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of South Orange Village	16,503	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Verona	13,585	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of West Caldwell	10,932	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of West Orange	47,609	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Essex County (Total)	**800,401**	**14,885**	**1.9%**	**45,490**	**5.7%**	**65,533**	**8.2%**	**73,018**	**9.1%**

Sources: American Community Survey 5-year Estimate (2013 – 2017), 2017; NOAA, 2016
SLOSH = Sea, Lake and Overland Surge from Hurricanes

Socially vulnerable and economically disadvantaged populations are most susceptible to natural hazard events, 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. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. They may require extra time or outside assistance during evacuations and are more likely to seek or need medical attention which may not be available due to isolation during a storm event. Table 4.3.2-5 summarizes the estimated socially vulnerable population living in each SLOSH zone.

Table 4.3.2-5. Estimated Socially Vulnerable Populations Living in the Hurricane SLOSH Inundation Zones

SLOSH Inundation Area	Population Over 65 Years	Population Below the Poverty Level
Category 1	852	2,957
Category 2	3,061	8,871
Category 3	5,105	13,530
Category 4	5,999	15,897

Sources: American Community Survey 5-year Estimate (2013 – 2017), 2017; NOAA, 2016
SLOSH = Sea, Lake and Overland Surge from Hurricanes

Residents may be displaced or require temporary to long-term sheltering. HAZUS-MH v4.2 estimates there will be 0 displaced households and 0 people that may require temporary shelter due to a 100-year MRP event. For a 500-year MRP event, HAZUS-MH v4.2 estimates 2 households will be displaced, and 0 people will require short-term sheltering. Please note these estimates are based on wind speed only and do not account for sheltering needs associated with flooding and storm surge that may accompany coastal storm events.

Impact on General Building Stock

Wind-Only Impacts

Damage to buildings is dependent upon several factors, including wind speed, storm duration, and path of the storm track. Building construction also plays a major role in the extent of damage resulting from a coastal storm. 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 U.S. Census Bureau defines manufactured homes as “movable dwellings, 8 feet or wider and 40 feet or longer, designed to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (U.S. Census, 2010).” They can include multi-wides and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their light-weight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage. According to the 2018 MODIV tax assessor data from NJOIT, there are no manufactured homes in the County.

The entire County’s general building stock is assumed to be exposed to the coastal storm hazard (greater than $73 billion in structure cost only). Expected building damage was estimated by HAZUS-MH v4.2 and includes buildings damaged at the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction. Table 4.3.2-6 summarizes the definition of the damage categories.

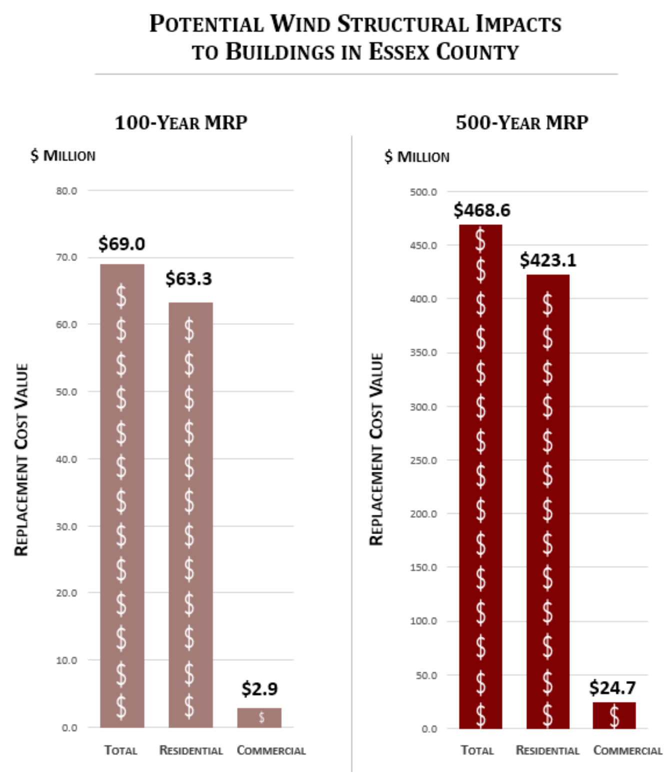
Table 4.3.2-6. Description of Damage Categories

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 over, 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

Exhibit 4.3.2-3 and Table 4.3.2-7 summarizes the building value (structure only) damage estimated for the 100- and 500-year MRP hurricane wind-only events. Damage estimates are reported for the County's probabilistic HAZUS-MH model scenarios. The data shown indicates total losses associated with wind damage to building structure.

Exhibit 4.3.2-3. Estimated Wind Impacts to Buildings



Source: NOAA National Hurricane Center, 2016; American Community Survey 2013-2017

Table 4.3.2-7. Estimated Building Value (Structure Only) Damaged by the 100-Year and 500-Year MRP Hurricane-Related Winds

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*		
		Annualized Loss	100-Year Event	500-Year Event
Township of Belleville	$2,698,371,020	$192,556	$3,381,110	$16,934,187
Township of Bloomfield	$3,668,749,043	$250,835	$4,637,793	$24,834,720
Borough of Caldwell	$711,283,402	$31,871	$585,788	$4,486,911
Township of Cedar Grove	$1,812,062,362	$68,407	$1,473,359	$7,912,578
City of East Orange	$3,661,597,262	$332,458	$4,641,046	$36,595,336
Borough of Essex Fells	$337,961,118	$10,987	$264,906	$1,488,965
Township of Fairfield	$3,280,911,340	$75,695	$1,746,773	$9,904,882
Borough of Glen Ridge	$694,958,216	$34,772	$691,490	$3,581,584
Township of Irvington	$3,187,766,948	$263,843	$3,446,736	$29,273,808
Township of Livingston	$4,683,896,484	$182,263	$3,683,983	$25,466,370
Township of Maplewood	$2,187,933,750	$116,936	$1,875,272	$13,531,920
Township of Millburn	$3,227,413,370	$133,899	$2,278,119	$18,249,309
Township of Montclair	$3,592,077,078	$202,280	$3,966,255	$22,012,264
City of Newark	$22,631,425,110	$1,767,308	$21,018,601	$159,024,073
Borough of North Caldwell	$1,092,780,064	$35,612	$867,292	$4,615,008

Municipality	Total Replacement Cost Value (Structure Only)	Estimated Total Damages*		
		Annualized Loss	100-Year Event	500-Year Event
Township of Nutley	$2,394,461,023	$162,643	$3,173,692	$13,964,506
City of Orange Township	$2,049,714,805	$132,538	$1,988,910	$15,294,256
Borough of Roseland	$1,141,841,136	$39,482	$826,293	$5,555,768
Township of South Orange Village	$1,776,332,135	$98,559	$1,739,095	$11,519,412
Township of Verona	$1,371,207,640	$61,116	$1,223,554	$7,440,808
Township of West Caldwell	$2,040,415,478	$62,526	$1,450,364	$8,469,070
Township of West Orange	$5,124,878,158	$232,334	$4,063,879	$28,409,745
Essex County (Total)	**$73,368,036,940**	**$4,488,919**	**$69,024,310**	**$468,565,482**

*Source: HAZUS-MH v4.2 *Total Damages is sum of damages for all occupancy classes based on improvement value.*

The total estimated damage to buildings (structure only) for all occupancy types across Essex County is $69 million for the 100-year MRP wind-only event, and $469 million for the 500-year MRP wind-only event. The majority of these losses are to the residential building category. Refer to Figure 4.3.2-5 and Figure 4.3.2-6 which illustrate the density of estimated building loss across Essex County for these two events.

Storm Surge Hurricane Impacts

To estimate potential building exposure to storm surge, the SLOSH inundation zones were used. The estimated total number of buildings and replacement cost value are located in Categories 1 through 4 SLOSH inundation zones are summarized in Exhibit 4.3.2-4 and 4.3.2-5 for the County. Table 4.3.2-8 and Table 4.3.2-9 summarize the building exposure by municipality.

Exhibit 4.3.2-4. Number of Buildings Exposed to SLOSH

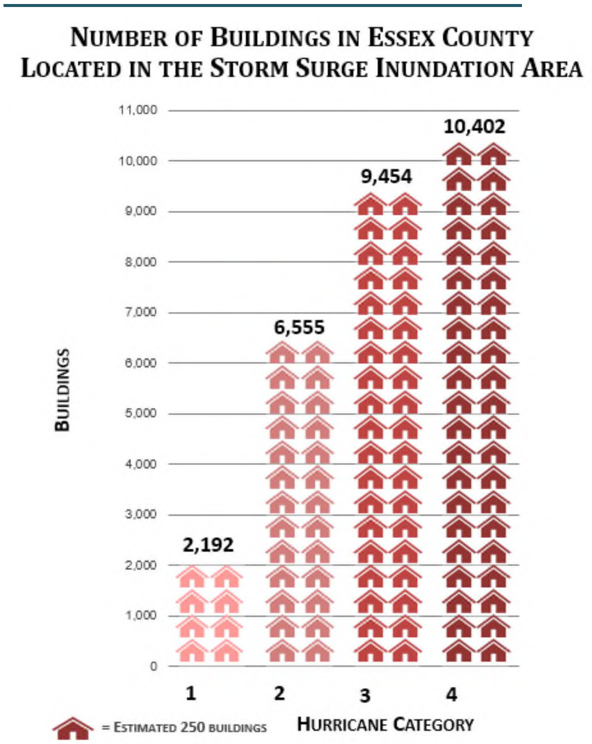
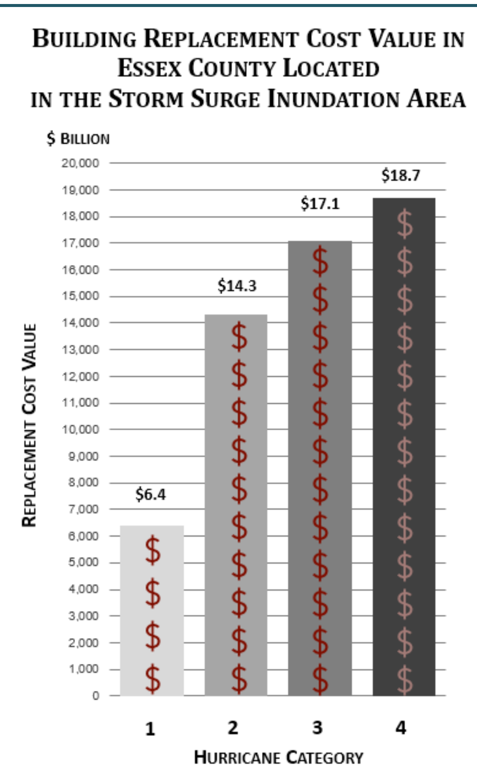


Exhibit 4.3.2-5. Building RCV Exposed to SLOSH



Source: NOAA National Hurricane Center, 2016; American Community Survey 2013-2017

Figure 4.3.2-5. Density of Losses for Structures (All Occupancies) for the County 100-Year MRP Hurricane (Wind-Only) Event

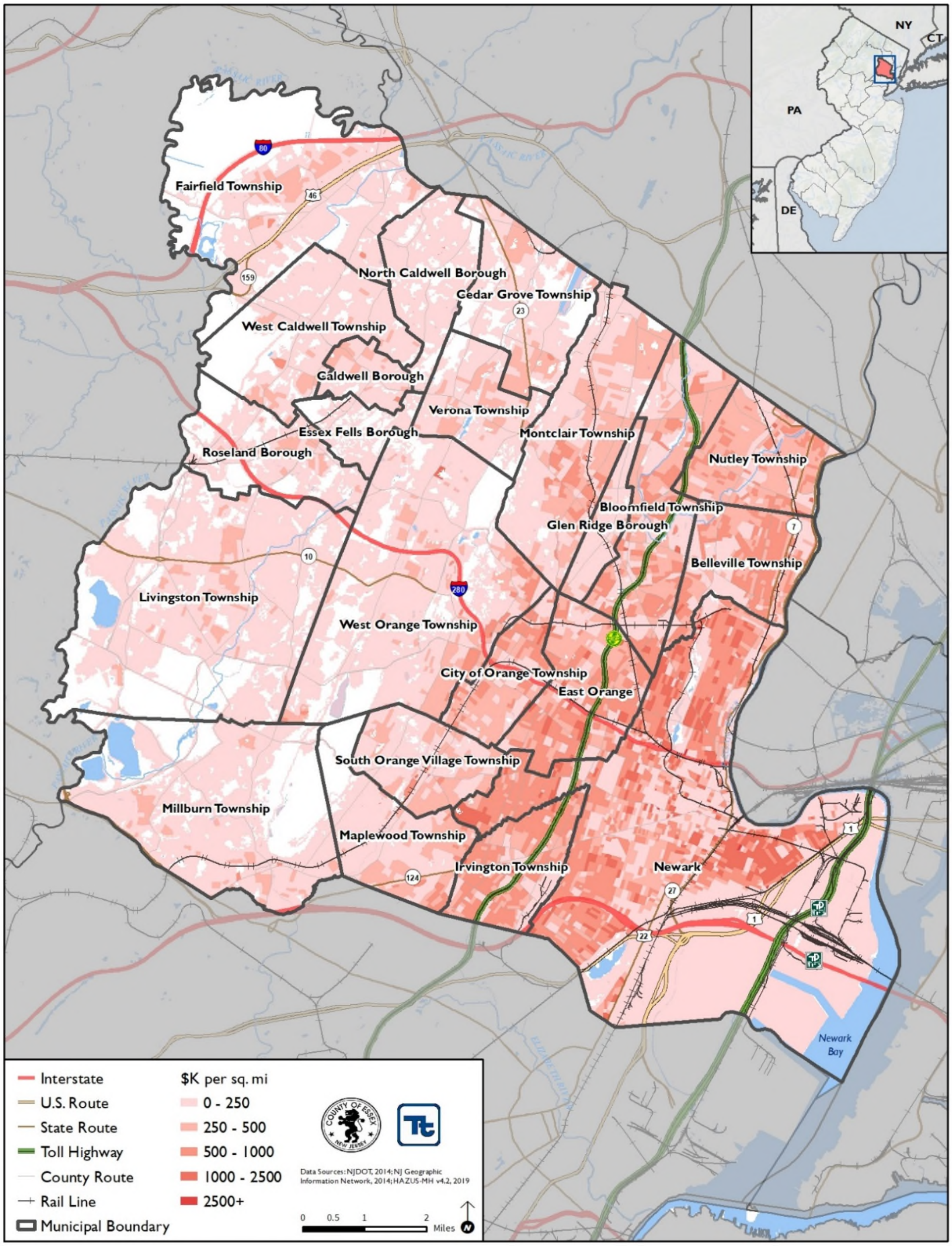


Figure 4.3.2-6. Density of Losses for Structures (All Occupancies) for the County 500-Year MRP Hurricane (Wind-Only) Event

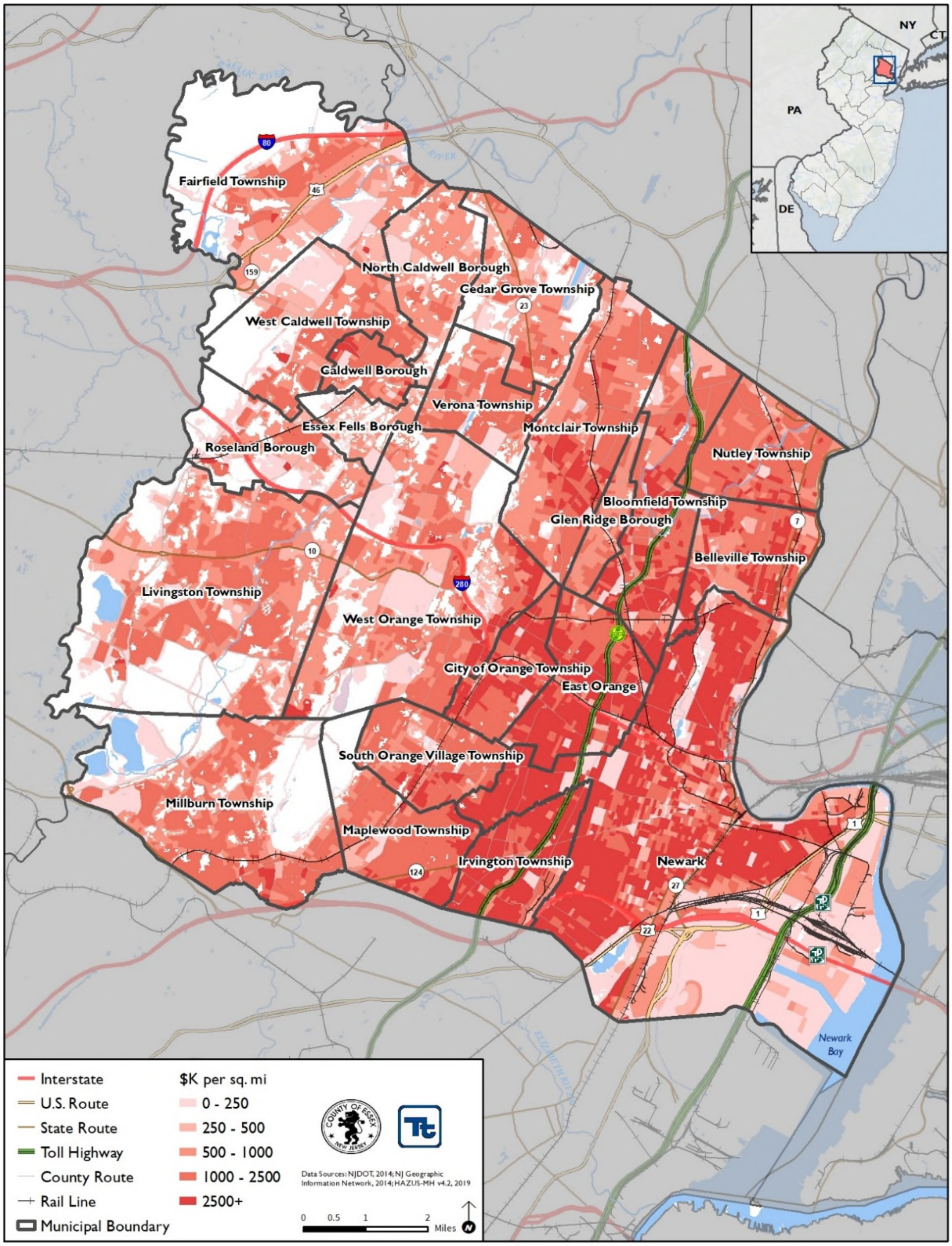


Table 4.3.2-8. Estimated Replacement Cost Value Located in the SLOSH Inundation Zones

Municipality	Total Replacement Cost Value	Replacement Cost Value in Hazard Area							
		Cat 1 Exposure	% of Total	Cat 2 Exposure	% of Total	Cat 3 Exposure	% of Total	Cat 4 Exposure	% of Total
Township of Belleville	$4,483,250,138	$75,680,812	1.7%	$346,316,511	7.7%	$554,972,044	12.4%	$740,479,251	16.5%
Township of Bloomfield	$6,021,089,887	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Borough of Caldwell	$1,183,204,981	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Cedar Grove	$3,008,045,785	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
City of East Orange	$6,090,766,912	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Borough of Essex Fells	$527,629,662	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Fairfield	$6,082,819,367	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Borough of Glen Ridge	$1,095,474,263	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Irvington	$5,384,838,816	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Livingston	$7,691,376,811	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Maplewood	$3,575,395,600	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Millburn	$5,241,567,136	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Montclair	$5,845,976,130	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
City of Newark	$40,970,549,425	$6,286,023,015	15.3%	$13,906,600,972	33.9%	$16,491,364,934	40.3%	$17,812,372,022	43.5%
Borough of North Caldwell	$1,727,767,442	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Nutley	$3,841,553,722	$0	0.0%	$6,804,317	<1%	$81,732,851	2.1%	$126,191,637	3.3%
City of Orange Township	$3,520,865,708	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Borough of Roseland	$1,955,487,279	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of South Orange Village	$2,877,374,186	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Verona	$2,213,338,613	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of West Caldwell	$3,533,044,820	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of West Orange	$8,358,783,858	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Essex County	**$125,230,200,542**	**$6,361,703,826**	**5.1%**	**$14,259,721,800**	**11.4%**	**$17,128,069,829**	**13.7%**	**$18,679,042,911**	**14.9%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NOAA, 2016

Table 4.3.2-9. Estimated Number of Buildings Located in the SLOSH Inundation Zones

Municipality	Total # Buildings	Number of Buildings in Hazard Area							
		Cat 1 Exposure	% of Total	Cat 2 Exposure	% of Total	Cat 3 Exposure	% of Total	Cat 4 Exposure	% of Total
Township of Belleville	7,910	19	0.2%	197	2.5%	462	5.8%	533	6.7%
Township of Bloomfield	11,720	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Caldwell	1,738	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Cedar Grove	3,944	0	0.0%	0	0.0%	0	0.0%	0	0.0%
City of East Orange	7,908	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Essex Fells	766	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Fairfield	3,121	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Glen Ridge	2,256	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Irvington	7,934	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Livingston	9,795	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Maplewood	6,738	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Millburn	6,437	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Montclair	9,436	0	0.0%	0	0.0%	0	0.0%	0	0.0%
City of Newark	43,085	2,173	5.0%	6,352	14.7%	8,953	20.8%	9,773	22.7%
Borough of North Caldwell	2,095	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Nutley	7,945	0	0.0%	6	<1%	39	<1%	96	1.2%
City of Orange Township	3,890	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Borough of Roseland	1,794	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of South Orange Village	4,188	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Verona	4,113	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of West Caldwell	3,730	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of West Orange	11,845	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Essex County	**162,388**	**2,192**	**1.3%**	**6,555**	**4.0%**	**9,454**	**5.8%**	**10,402**	**6.4%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NOAA, 2016
Cat = Category

Impact on Land Uses

A spatial analysis was completed to assess the exposure of the residential and non-residential land uses within the County to storm surge. To estimate the land use located in the Category 1 through Category 4 storm surge inundation zones, the SLOSH boundaries were overlaid upon the general building stock and 2018 parcel layer in GIS and used to calculate the estimated the number of structures and area of parcels located in each hazard area.

Neighborhoods within the Ironbound section of the City of Newark comprise the majority of the residential land uses and structures exposed to SLOSH. Approximately 2-percent of the total residential land use acreage and 3-percent of the residential properties are located in the Category 1 storm inundation extent. However, approximately 14-percent of the total residential land use area and 19-percent of the residential properties are located in the Category 4 storm inundation extent.

The spatial analysis also shows a substantial number of the non-residential properties are exposed to storm surge as well. The City of Newark's large area of industrial and commercial land uses adjacent to the Passaic River and the Newark Bay account for the majority of the area exposed to this hazard. A substantial amount of the area is associated with Newark International Airport and the Port of Newark. Approximately 34-percent of the total non-residential land use acreage and 13-percent of the non-residential properties are located in the Category 1 storm inundation extent. However, approximately 64-percent of the total non-residential land use area and 37-percent of the non-residential properties are located in the Category 4 storm inundation extent. It is clear that the Newark's Ironbound section and the commercial and industrialized sections of the East Ward are highly exposed to storm surge.

Figure 4.3.2-7. Residential Properties Exposed to Category 1 through 4 SLOSH Areas

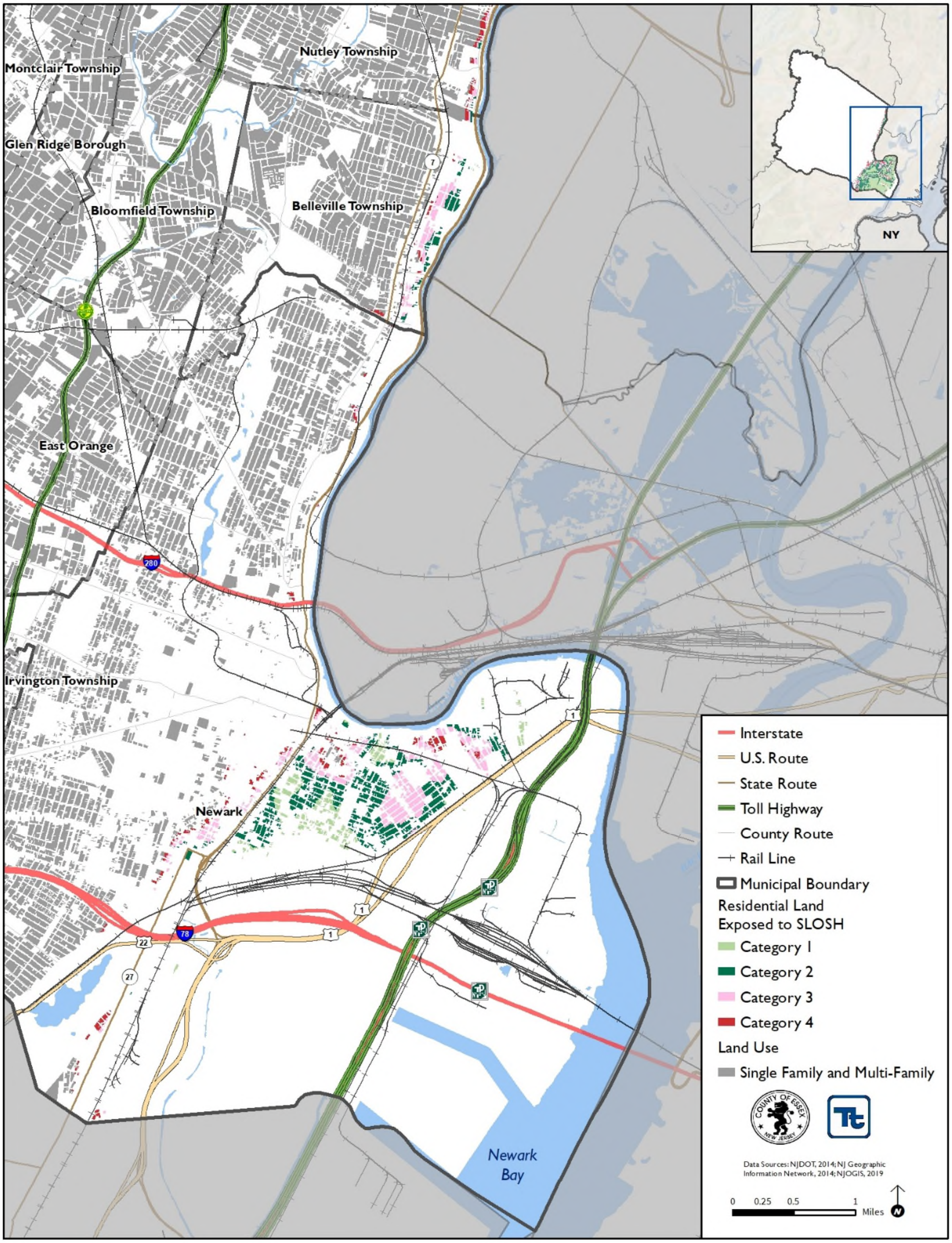


Table 4.3.2-10. Residential Land Use Exposure to SLOSH

Municipality	Total Residential Land Use Area (acres)	Total Number of Residential Properties	Number of Residential Properties in Category 1	% of Total	Residential Land Use Area Category 1 (acre s)	% of Total	Number of Residential Properties Category 2	% of Total	Residential Land Use Area in Category 2 (acres)	% of Total Residential Land Use Area	Number of Residential Properties Category 3	% of Total	Residential Land Use Area in Category 3 (acres)	% of Total Residential Land Use Area	Number of Residential Properties Category 4	% of Total	Residential Land Use Area in Category 4 (acres)	% of Total Residential Land Use Area
Township of Belleville	908	7,279	4	0.1%	0	0.1%	148	2.0%	19	2.1%	371	5.1%	46	5.1%	410	5.6%	52	5.7%
City of Newark	2,523	33,549	945	2.8%	56	2.2%	3,838	11.4%	211	8.4%	5,792	17.3%	323	12.8%	6,296	18.8%	359	14.2%
Township of Nutley	1,152	7,431	0	0.0%	0	0.0%	5	0.1%	1	0.1%	29	0.4%	7	0.6%	83	1.1%	16	1.4%
Total	**4,583**	**48,259**	**949**	**2.0%**	**56**	**1.2%**	**3,991**	**8.3%**	**232**	**5.1%**	**6,192**	**12.8%**	**376**	**8.2%**	**6,789**	**14.1%**	**427**	**9.3%**

Source: NJOIT, 2018; Microsoft, 2018; Open Street Map, 2019; NOAA 2016

Figure 4.3.2-8. Non-Residential Properties Exposed to Category 1 through 4 SLOSH Areas

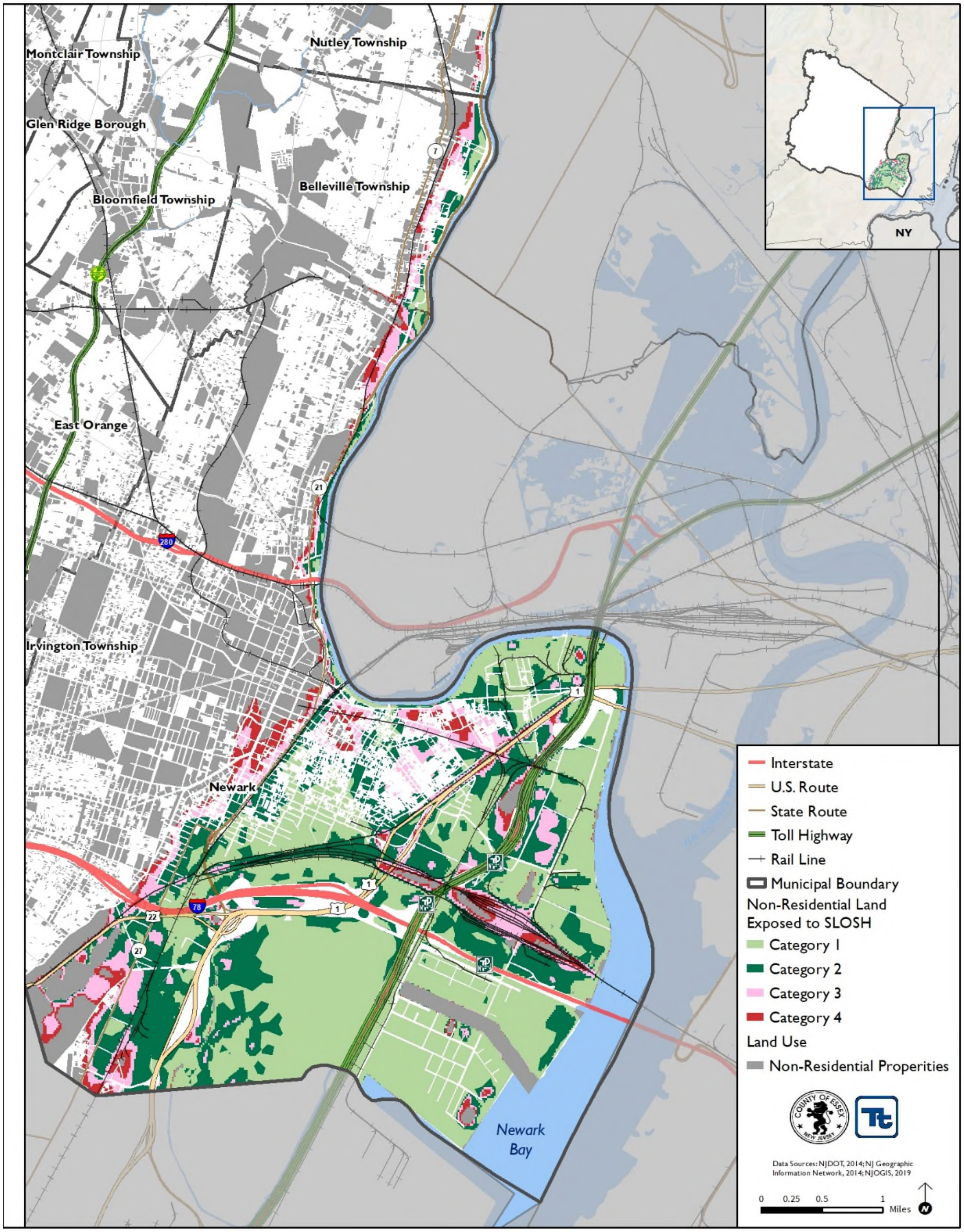


Table 4.3.2-11. Non-Residential Land Use Exposure to SLOSH

Municipality	Total Non-Residential Land Use Area (acres)	Total Number of Non- Residential Properties	Number of Non-Residential Properties in Category 1	% of Total	Non-Residential Land Use Area Category 1 (acres)	% of Total	Number of Non- Residential Properties Category 2	% of Total	Non-Residential Land Use Area in Category 2 (acres)	% of Total Non-Residential Land Use Area	Number of Non-Residential Properties Category 3	% of Total	Non-Residential Land Use Area in Category 3 (acres)	% of Total Non-Residential Land Use Area	Number of Non-Residential Properties Category 4	% of Total	Non-Residential Land Use Area in Category 4 (acres)	% of Total
Township of Belleville	766	631	15	2.4%	25	3.3%	49	7.8%	69	9.0%	91	14.4%	104	13.6%	123	19.5%	129	16.9%
City of Newark	9,594	9,536	1,228	12.9%	3,233	33.7%	2,515	26.4%	5,085	53.0%	3,162	33.2%	5,768	60.1%	3,477	36.5%	6,105	63.6%
Township of Nutley	559	514	0	0.0%	0	0.0%	1	0.2%	4	0.7%	10	1.9%	22	3.9%	13	2.5%	32	5.7%
Total	**10,919**	**10,681**	**1,243**	**11.6%**	**3,258**	**29.8%**	**2,565**	**24.0%**	**5,158**	**47.2%**	**3,263**	**30.5%**	**5,894**	**54.0%**	**3,613**	**33.8%**	**6,266**	**57.4%**

Source: NJOIT, 2018; Microsoft, 2018; Open Street Map, 2019; NOAA 2016

Impact on Critical Facilities

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 the young and elderly, who are particularly vulnerable to temperature-related health impacts. Loss of power can impact other public utilities, including potable water and wastewater treatment and communications. In addition to public water services, property owners with private wells may not have access to potable water either until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effective respond to an event and maintain the safety of its citizens.

HAZUS-MH v4.2 estimates the probability that critical facilities (i.e., medical facilities, fire/EMS, police, EOC, schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP wind-only events. Additionally, HAZUS-MH v4.2 estimates the loss of use for each facility in number of days. HAZUS-MH v4.2 estimates that critical facilities in Essex County will experience minor damage, and continuity of operations at these facilities will not be interrupted (loss of use is estimated to be zero days) as a result of a 100-year MRP event. Table 4.3.2-13 summarizes the estimated impacts to critical facilities as a result of the 500-year MRP event.

At this time, HAZUS-MH v4.2 does not estimate losses to transportation lifelines and utilities as part of the hurricane model. Transportation lifelines are not considered particularly vulnerable to the wind hazard; they are more vulnerable to cascading effects such as flooding, falling debris etc. Impacts to transportation lifelines affect both short-term (e.g., evacuation activities) and long-term (e.g., day-to-day commuting) transportation needs.

The critical facilities and utilities located in the Category 1 through 4 inundation zones are summarized in Table 4.3.2-12 by municipality. Oil facilities have the greatest number exposed to the Category 1 inundation zone, while schools have the greatest number exposed to the Category 2 through Category 4 inundation zones.

Table 4.3.2-12. Number of Critical Facilities Located in the SLOSH Inundation Zones

Municipality		Facility Types																			
	Airport	Bus	Chemical Storage	Commercial	Correctional Institution	Electric Power	Electric Substation	EMS	Fire	Government	Hospital	Light Rail	Newark Housing Authority	Oil Facility	Police	Port	Safety	School	Shelter	Train Station	Transportation	Wastewater Treatment Plant
Category 1																						
Township of Belleville	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
City of Newark	1	1	2	0	1	3	0	0	1	1	0	0	1	4	2	2	0	0	0	0	0	2
Essex County	**1**	**1**	**2**	**0**	**1**	**3**	**0**	**0**	**1**	**1**	**0**	**0**	**1**	**4**	**2**	**2**	**0**	**0**	**0**	**0**	**1**	**2**
Category 2																						
Township of Belleville	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0
City of Newark	1	2	3	0	2	3	0	1	3	1	0	1	3	4	3	2	0	6	0	1	0	2
Essex County	**1**	**2**	**3**	**1**	**2**	**3**	**0**	**1**	**3**	**1**	**0**	**1**	**3**	**4**	**3**	**2**	**0**	**8**	**0**	**1**	**1**	**2**
Category 3																						
Township of Belleville	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0
City of Newark	1	3	3	0	2	4	0	1	5	2	1	1	3	4	4	2	0	10	0	2	0	2
Township of Nutley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Essex County	**1**	**3**	**3**	**1**	**2**	**4**	**0**	**1**	**5**	**3**	**1**	**1**	**3**	**4**	**4**	**2**	**1**	**12**	**1**	**2**	**1**	**2**
Category 4																						
Township of Belleville	0	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	0	2	0	0	1	0
City of Newark	1	3	3	0	2	5	0	1	6	2	1	2	4	4	6	1	0	16	0	2	0	2
Township of Nutley	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
Essex County	**1**	**3**	**3**	**1**	**2**	**5**	**1**	**1**	**6**	**3**	**1**	**2**	**4**	**4**	**6**	**1**	**1**	**18**	**1**	**2**	**1**	**2**

Source: Essex County, 2019; NOAA, 2016

*Notes: *Only municipalities within the SLOSH inundation zones are tabulated*

Table 4.3.2-13. Estimated Impacts to Critical Facilities for the 500-Year Mean Return Period Hurricane-Related Winds

Facility Type	500-Year Event				
	Loss of Days	Percent-Probability of Sustaining Damage			
		Minor	Moderate	Severe	Complete
EOC	0	2-4	<1	0	0
Medical	0	1-3	<1	0	0
Police	0	2-4	<1	0	0
Fire	0	1-2	<1	0	0
Schools	0	1-4	0-1	0	0

Source: HAZUS-MH v4.2

Impact on Economy

Coastal storms also impact the economy, including: 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. 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.

For the 100-year MRP wind event, HAZUS-MH v4.2 estimates approximately $597,000 in business interruption costs (income loss, relocation costs, rental costs and lost wages) and no estimated inventory losses. For the 500-year MRP wind only event, HAZUS-MH v4.2 estimates approximately $31 million in business interruption losses for the County, which includes loss of income, relocation costs, rental costs and lost wages, in addition to approximately $340,000 in inventory losses.

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.

Debris management can be costly and may also impact the local economy. HAZUS-MH estimates the amount of building and tree debris that may be produced a result of the 100- and 500-year MRP wind events. Because the estimated debris production does not include flooding, this is likely a conservative estimate and may be higher if multiple impacts occur. According to the HAZUS-MH Hurricane User Manual, estimates of weight and volume of eligible tree debris consist of downed trees that would likely be collected and disposed at public expense. Refer to the User Manual for additional details regarding these estimates. Table 4.3.2-14 summarizes debris production estimates for the 100- and 500-year MRP wind events.

Table 4.3.2-14. Debris Production for 100- and 500-Year Mean Return Period Hurricane-Related Winds

Mean Return Period	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
100-year MRP	6,429	0	4,840	35,778

Mean Return Period	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
500-year MRP	61,162	0	33,311	224,498

Source: HAZUS-MH v4.2

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

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 the hurricane and tropical storm hazard because the entire Planning Area is exposed and vulnerable to the wind and storm surge hazards associated with these events. However, due to increased standards and codes, new development may be less vulnerable to the coastal storm hazard compared with the aging building stock in the county.

Each municipality identified areas of recent development and proposed development in their community. Based on the information provided from municipalities, there are no recent and proposed developments within Category 1 through 4 SLOSH boundaries. Refer to Section 3 (County Profile), and Volume II Section 9 for potential new development and storm surge inundation areas in Essex County. Refer to Figure 4.3.2-2 for a map of proposed new development and the Category 1 through Category 4 SLOSH inundation areas of Essex County.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time. Those moving to from areas of lower vulnerability to higher will increase their vulnerability, though not in a dramatic fashion. An increase in population can lead to an increase in commuters traveling throughout and outside the County. Commuters utilizing the major transportation corridors, including the NJ Turnpike, I-78, NJ-21, or US-1&9, would be impacted during and after a coastal storm as portions of these roadways are impacted by storm surge inundation from Category 1 to Category 4 events. Refer to Section 3 (County Profile) for a discussion on population trends.

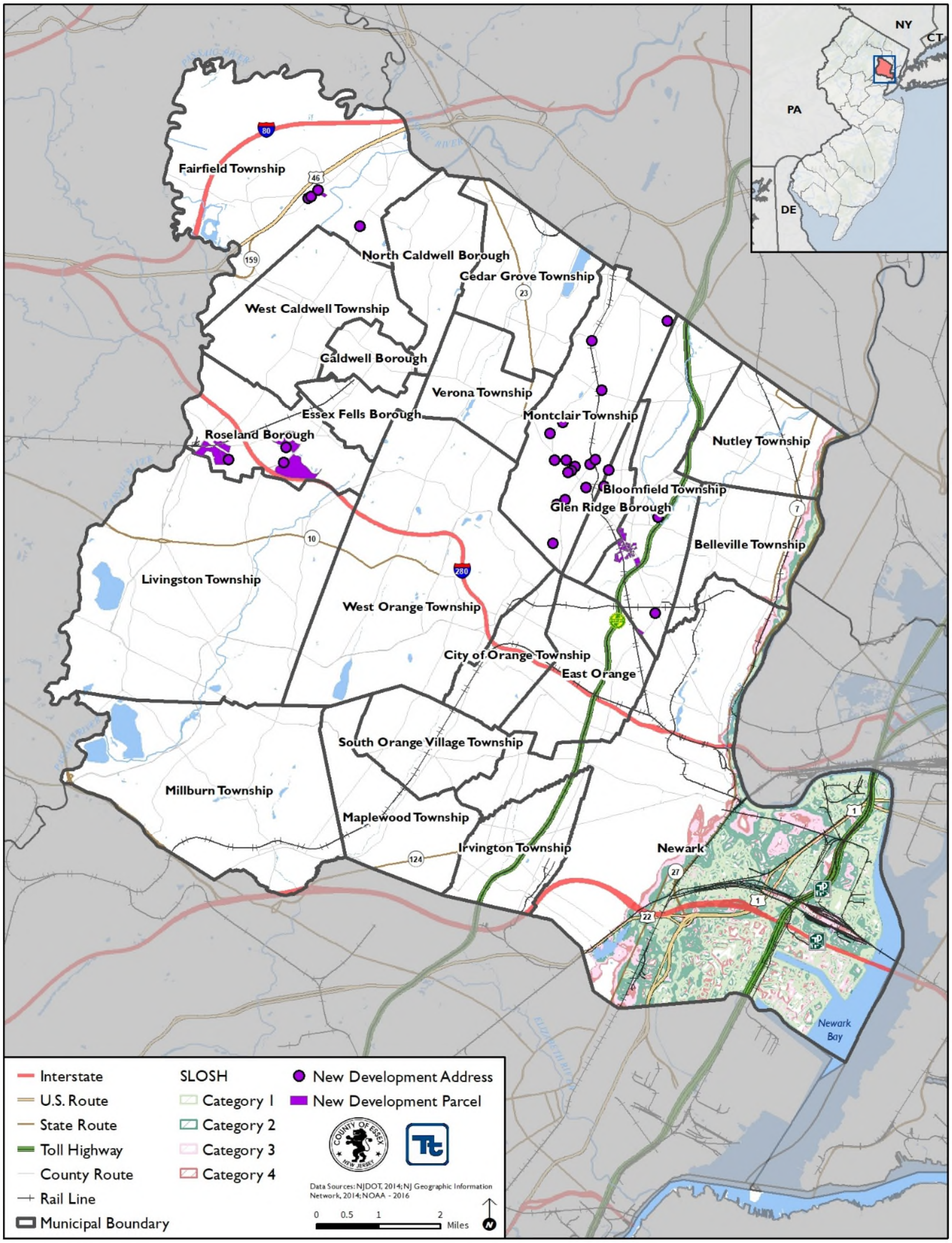
Climate Change

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 impacts Countywide and storm surge impacts along the Passaic River between the City of Newark and Township of Nutley. In the remainder of the County, communities will experience an increase in rainfall due to the more frequent, and severe coastal storms. Section 4.3.6 (Flood) provides a discussion related to the impact of climate change due to increases in rainfall. In addition to the impacts of increasing temperatures and precipitation, sea level rise will increase the County's vulnerability to coastal storms. Increases in mean sea level will lead to subsequent increases in storm surge inundation depths.

Change of Vulnerability Since 2015 HMP

The entire County continues to be vulnerable to the coastal storm hazard. Several differences exist between the 2015 HMP and this update. For this plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the county's risk to the hazard areas. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. Updated hazard areas were used as well; since the 2015 HMP, NOAA has released updated storm surge inundation boundaries for the United States. This updated data was used for the exposure analysis. Due to changes in the data used, a direct comparison of the change in vulnerability is difficult. However, in comparing the hazard areas between the original storm surge data and the 2016 NOAA data, the extents are similar and an increase in vulnerability would be due to increases in population and changes in development throughout the impacted areas. The updated vulnerability assessment provides a more current exposure analysis for the County.

Figure 4.3.2-9. Potential New Development in Essex County and SLOSH



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 Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2014 and 2019.
- Information from the New Jersey Water Supply Plan 2017-2022 has been integrated.

4.3.3.1 Profile

Hazard Description

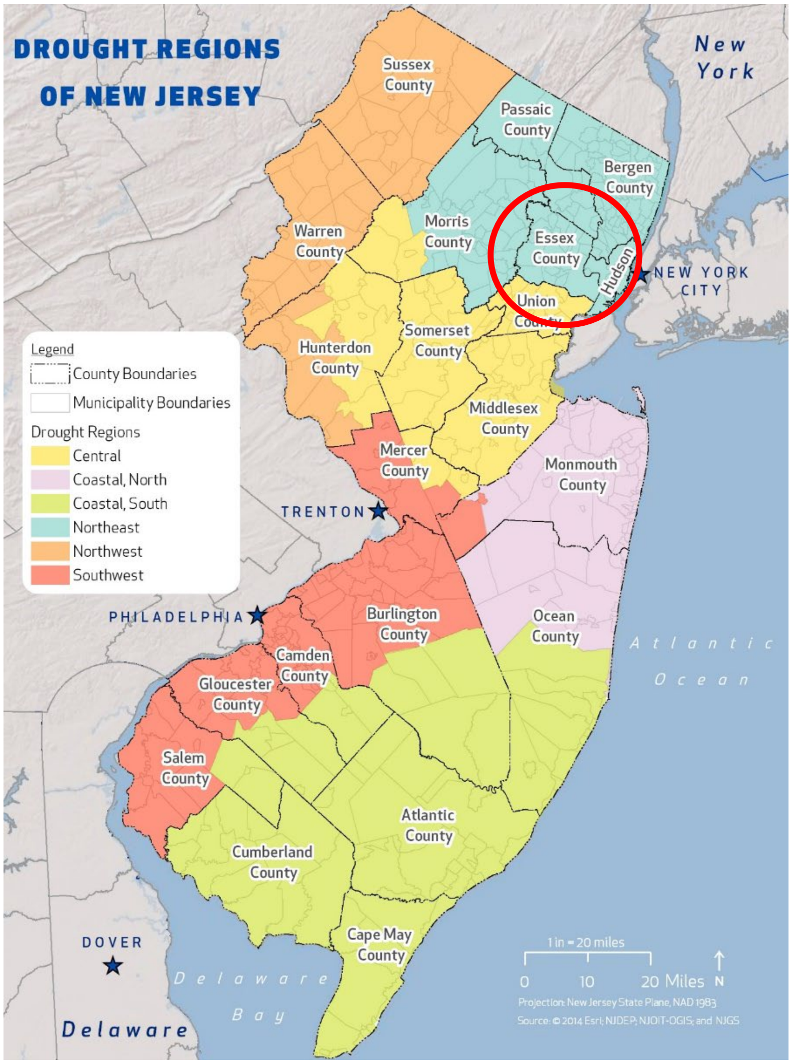
Drought is a period characterized by long durations of below normal precipitation. Drought conditions occur in virtually all climatic zones, yet characteristics of drought vary significantly from one region to another, relative to normal precipitation within respective regions. Drought can affect agriculture, 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 (NOAA, 2012). Essex County is located in the Northern Climate Division.

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). 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 shows the drought regions of New Jersey. Essex County is located in the Northeast Drought Region.

Figure 4.3.3-1. Drought Regions of New Jersey

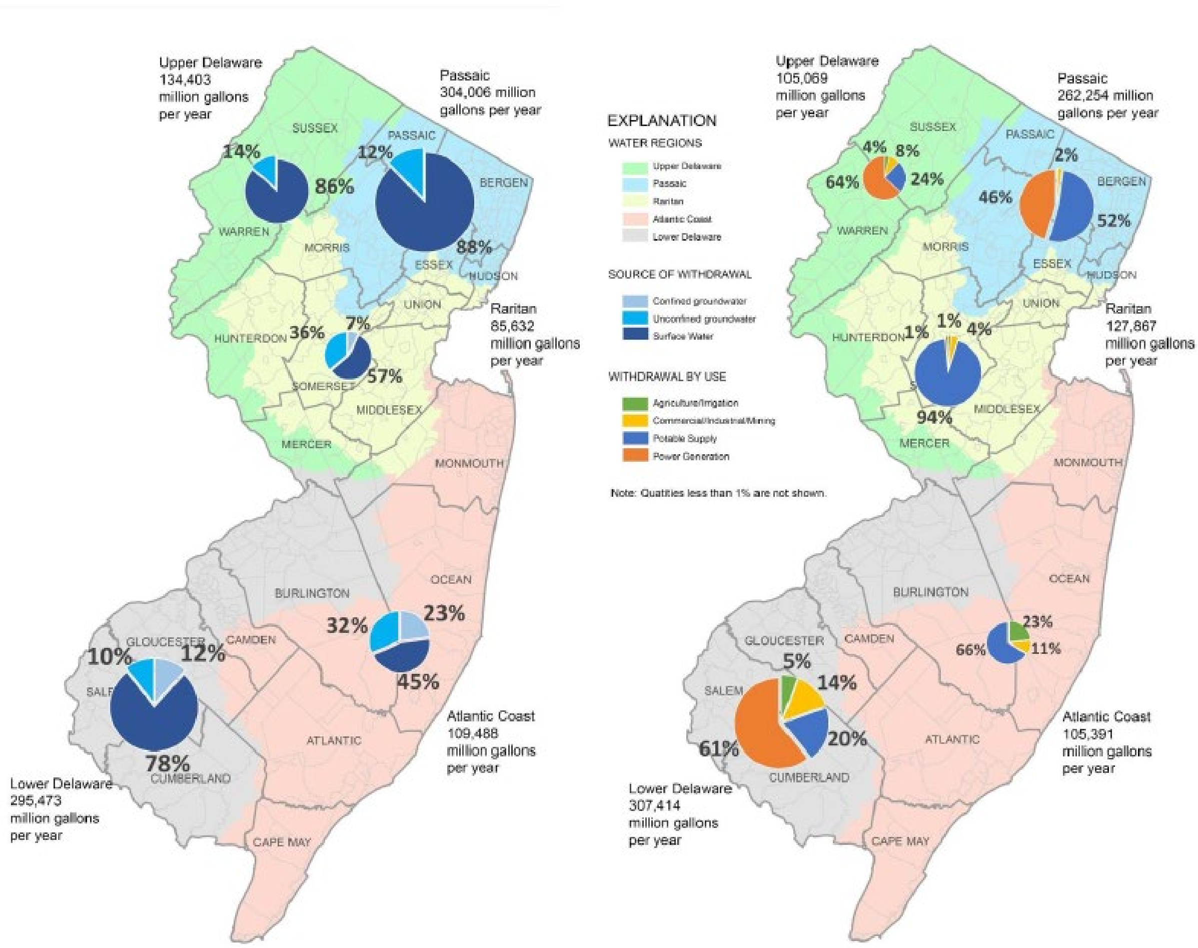


Source: NJOEM (State HMP) 2019
Note: The red circle indicates the location of Essex County. The County is located in the Northeast Region of New Jersey

There are five water regions across the State (compiled from HUCH11 Watershed Management Areas). Essex County is located in the Passaic and Raritan water regions; refer to Figure 4.3.3-2. The County's water supply sources are from unconfined groundwater and surface water sources. In terms of annual water withdrawal by sector, the majority is for potable water supply, followed by power generation, then commercial/industrial/mining. 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).

According to the Water Resources Baseline Topic Report, the City of Newark may approach or exceed the capacity of their reservoirs and more detailed evaluations are needed. In addition, the Central Passaic Buried Valley Aquifers that serve eastern Morris and western Essex Counties have been constrained and municipalities with significant growth may be affected (Together North Jersey 2013).

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



Source: NJDEP 2017

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 4.3.3-1 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 4.3.3-1 (National Drought Mitigation Center [NDMC] 2013).

Table 4.3.3-1. Palmer Drought Category Descriptions

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

Between 1954 and 2014, the State of New Jersey experienced two FEMA declared drought-related disasters (DR) or emergencies (EM) classified as a water shortage; DR-205 in 1965 and EM-3083 in 1980 were both declared. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Essex County was included in both declarations (FEMA 2019); refer to Table 4.3.3-2. Drought events that have impacted Essex County between 2014 and 2019 are identified in Table 4.3.3-3. For events prior to 2014, refer to Appendix E (Risk Assessment Supplement). Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality.

Table 4.3.3-2. FEMA Declarations Related to Drought

Declaration	Event Date	Declaration Date	Event Description
DR-205	August 18, 1965	August 8, 1967	Drought: Water Shortage
EM-3083	October 19, 1980	May 21, 1983	Drought: Water Shortage

Source: FEMA 2019

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 2016, Essex County was included in declaration S4071 for the combined effects of freeze, excessive heat, and drought with no losses reported.

Table 4.3.3-3. Drought Incidents in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
September 9-December 1, 2014	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Essex County from September 9 - December 1, 2014.
May 5-June 23 2015	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Essex County from May 5 - May 25, D1 or "moderate drought" status from May 26 - June 1, and D0 or "abnormally dry" status from June 2 - June 23, 2015.
August 11, 2015-January 25, 2016	Drought	N/A	N/A	According to the U.S. Drought Monitor, conditions held at a D0 or "abnormally dry" status across Essex County from August 11 – August 31, 2015 and D1 or "moderate drought" status from September 1, 2015 – January 25, 2016.
April 19, 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 Essex County from April 19 - June 13, 2016, D1 or "moderate drought" status from June 14 - October 24, 2016, D2 or "severe drought" status from October 25, 2016 – January 23, 2017, D1 or "moderate drought" status from January 24 – March 20, 2017, and D0 or "abnormally dry" status from March 21 - April 10, 2017. In October of 2016, a CoCoRaHS reporter noted that lawns were stressed with numerous brown areas and slow growth, soils in surrounding fields and farms were dry and dusty, leaves were starting to change color and drop early, structures could be seen at the bottom of local reservoirs, forest fire and a drought watch was in effect for the county. A spokesman for the Department of Environmental Protection recommended that the public conserve water. Agricultural disaster S4071 was declared for the combined effects of freeze, excessive heat, and drought.
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 Essex County from October 3-30, 2017. Fall leaves were reported to be dropping early without changing color.
December 5, 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 Essex County from December 5, 2017 – February 12, 2018. Drinking water reservoirs were reported to be low.

Source: NOAA NCEI 2019. USDA 2019, NDMC 2019

Probability of Future Occurrences

Based on the historical occurrences for drought, Essex County can anticipate a range of drought from abnormally dry to severe, or D0 to D2, based on the Palmer Drought Category. 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 Essex 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 (Hazard Ranking), the identified hazards of concern for Essex 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 Steering Committee and Planning Committee, the probability of occurrence for drought in the County is considered 'occasional' .

Climate Change Impacts

The climate of New Jersey is already changing and will continue to change over the course of this century. From 1900 to 2014 annual average temperatures in New Jersey have increased approximately 3°F (NOAA NCEI, 2017). In terms of winter temperatures, the northeast region has seen an increase in the average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F, and by 2080 projections show an increase of 4°F to 7.5°F (Sustainable Jersey Climate Change Adaptation Task Force 2015). With an overall increase in temperature, drought conditions may become more frequent.

The future drought potential that New Jersey is modeled to experience indicates the State will experience more frequent but not necessarily more severe droughts. While all droughts impose some level of stress on water supplies, some will have long-term effects. If the projected more frequent droughts are spaced out over time, then New Jersey's water supply systems should be capable of recovering between droughts. However, more frequent droughts raise the potential for sequential droughts that do not allow for recovery of reservoir levels or aquifer storage, resulting in a scenario where moderate droughts could have aggregate results that severely test our water supply capabilities (NJ Climate Adaptation Alliance, 2016).

As temperatures rise, people and animals will need more water to maintain their health and to thrive. Many economic activities, such as hydropower, raising livestock, and growing foods, will also require water. The amount of water available for these activities may be reduced as temperatures rise and if competition for water resources increases. As shown in the paragraph above, these trends will certainly affect the probability and frequency of dryer conditions that could lead to drought events in Essex County.

4.3.3.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

The entire population of Essex County is exposed to drought events (population of 800,401 people, according to the 2013-2017 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).

Essex County is supplied by both surface water and groundwater as shown on Figure 4.3.3-2. Surface water supplies are affected more quickly during droughts than groundwater sources; however, groundwater supplies generally take longer to recover. Table 4.3.3-4 summarizes the surface water drinking water suppliers for Essex County.

Table 4.3.3-4. Surface Water Source Drinking Water Suppliers in Essex County

Name	Population Served	Source Type
Belleville Water Dept	35,129	Surface Water Purchased
Bloomfield Water Department	47,315	Surface Water Purchased
Caldwell Water Dept	7,822	Surface Water Purchased
Cedar Grove Water Dept	12,900	Surface Water Purchased
East Orange Water Commission	75,000	Surface Water Purchased
Essex Fells Water Dept	2,200	Surface Water Purchased
Essex Fells Water Hilltop System	354	Surface Water Purchased
Fairfield Water Dept	7,400	Surface Water Purchased
Glen Ridge Water Dept	7,681	Surface Water Purchased
Livingston Twp Division of Water	27,391	Surface Water Purchased
Montclair Water Bureau	37,669	Surface Water Purchased
Newark Water Department	290,139	Surface Water
NJ American Water - Short Hills	217,230	Surface Water
North Caldwell - Hilltop	208	Surface Water Purchased
North Caldwell Water Dep	6,000	Surface Water Purchased
Nutley Water Dept	29,500	Surface Water Purchased
Orange Water Dept	30,134	Surface Water Purchased
Roseland Water Dept	5,300	Surface Water Purchased
South Orange Water Department	16,964	Surface Water Purchased
Verona Water Department	13,641	Surface Water Purchased
West Caldwell Water Department	10,759	Surface Water Purchased

Source: U.S. EPA 2019

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). Therefore, all assets in and adjacent to, the WUI zone, including population, structures, critical facilities, lifelines, and businesses are considered vulnerable to wildfire. Refer Section 4.3.10 for the Wildfire risk assessment.

Impact on Critical Facilities

As mentioned, drought events generally do not impact buildings; however, droughts have the potential to impact agriculture-related facilities and critical facilities that are associated with potable water supplies. Critical facilities in and adjacent to the wildfire hazard areas are considered vulnerable to wildfire.

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. Increased demand for water and electricity can 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.

Based on information from the 2017 Census of Agriculture, 22 farms were present in Essex County, encompassing 191 acres of total farmland. The average farm size was 9 acres. The total market value of agricultural products from Essex County farms was withheld to avoid disclosing data for individual farms. The 2017 Census indicated that 11 farm operators reported farming as their primary occupation (USDA 2017). Table 4.3.3-5 lists the acreage of agricultural land exposed to the drought hazard.

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

Number of Farms	Land in Farms (acres)	Total Cropland (acres)	Harvested Cropland (acres)	Total Cropland Used Only for Pasture/Grazing (acres)
22	191	60	48	12

Source: USDA 2017

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 Essex County. The New Jersey Water Supply Plan indicates seasonal outdoor water use is rising 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 population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). NJDEP assessed future water needs for public water systems factoring in future projected population growth for each municipality. The analysis suggests an additional 32 million gallons per day (mgd) (over 2015 rates) will be needed by 2020 to meet the anticipated growth in potable demand, 68 mgd by 2025, 103 mgd by 2030, 134 mgd by 2035, and 164 mgd by 2040 (NJDEP 2017).

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 2015 HMP

Overall, the entire County remains vulnerable to droughts. Statewide total water withdrawals, excluding power generation, have decreased from 1990 to 2015 due to reduced demands in the commercial/industrial/mining sectors. However, potable water withdrawal and demand continues to increase as population increases (NJDEP 2017). In terms of the agricultural industry, from 2007 to 2017, there was a 69% increase in number of farms (13 farms to 22 farms), and a 4% increase in land in farms (184 acres to 184 acres) in Essex County. This may suggest an increase in water withdrawals, typically with peaks in the summer months, for traditional agricultural uses like irrigation of crops, plants and animals as well as other horticultural uses.

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 Essex County.

2019 HMP Update Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2015 and 2019.
- The New Jersey Geologic and Water Survey (NJGWS) updated liquefaction data has been integrated into the vulnerability assessment.
- Updated HAZUS-MH probabilistic modeling was conducted using updated inventory data.

4.3.4.1 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 Essex 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 4.5.7 (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 Essex 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

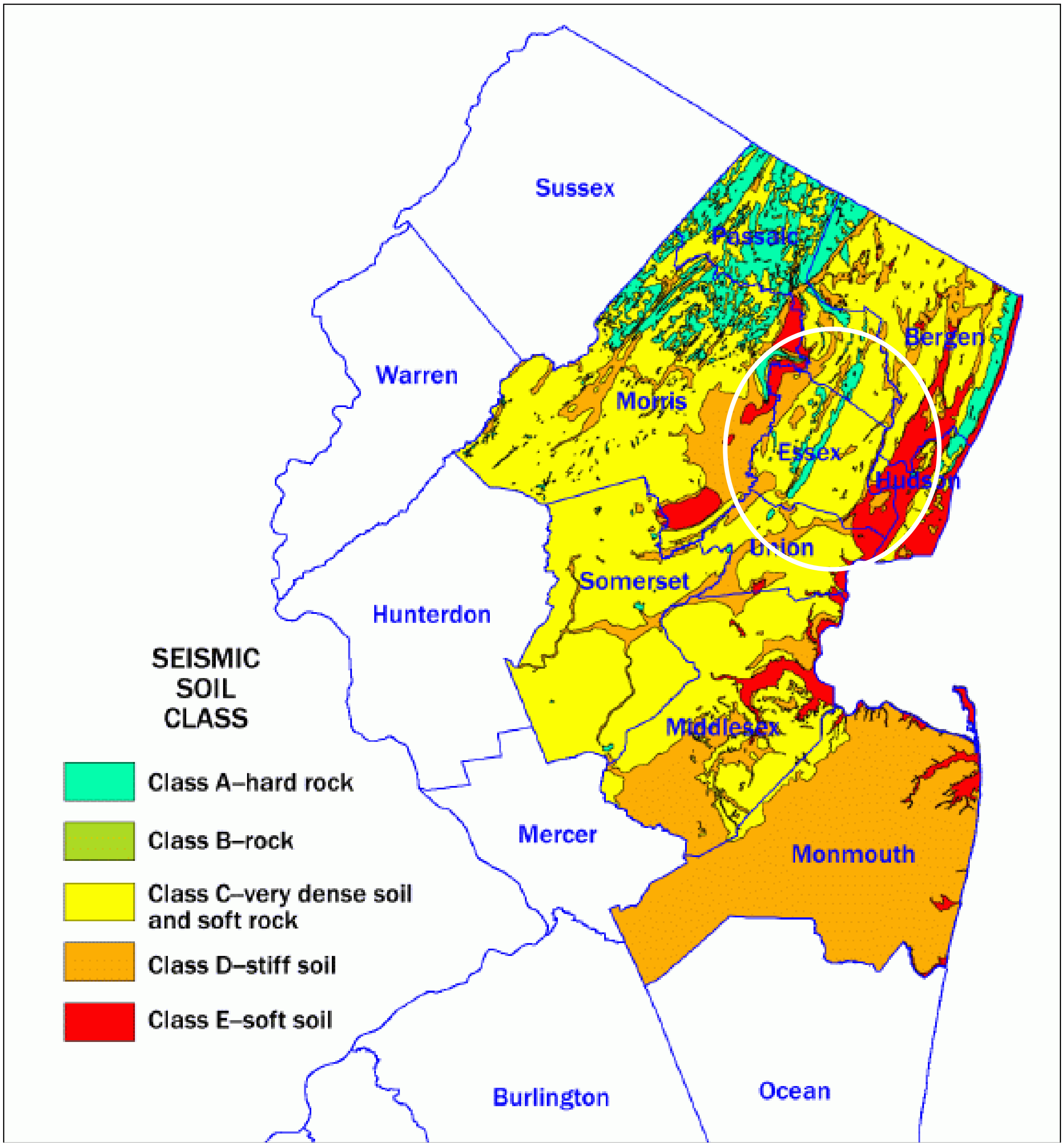
Soil Classification	Description
A	Hard Rock
B	Rock
C	Very dense soil and soft rock
D	Stiff soils
E	Soft soils

Source: FEMA 2013

Earthquakes are most likely to occur in the northern parts of New Jersey, where significant faults are concentrated; however, low-magnitude events can and do occur in many other areas of the State. Figure 4.3.4-1 illustrates the NEHRP soils located in the northeast quadrant the State. The data was available from the New Jersey Geologic and Water Survey. The available NEHRP soils information is incorporated into the HAZUS-

MH earthquake model for the risk assessment (discussed in further detail later in this section). According to this figure, Essex County is predominately underlain by Class C soils, with bands of Class A in the central portion of the County and areas of Class D in the western and southwestern areas.

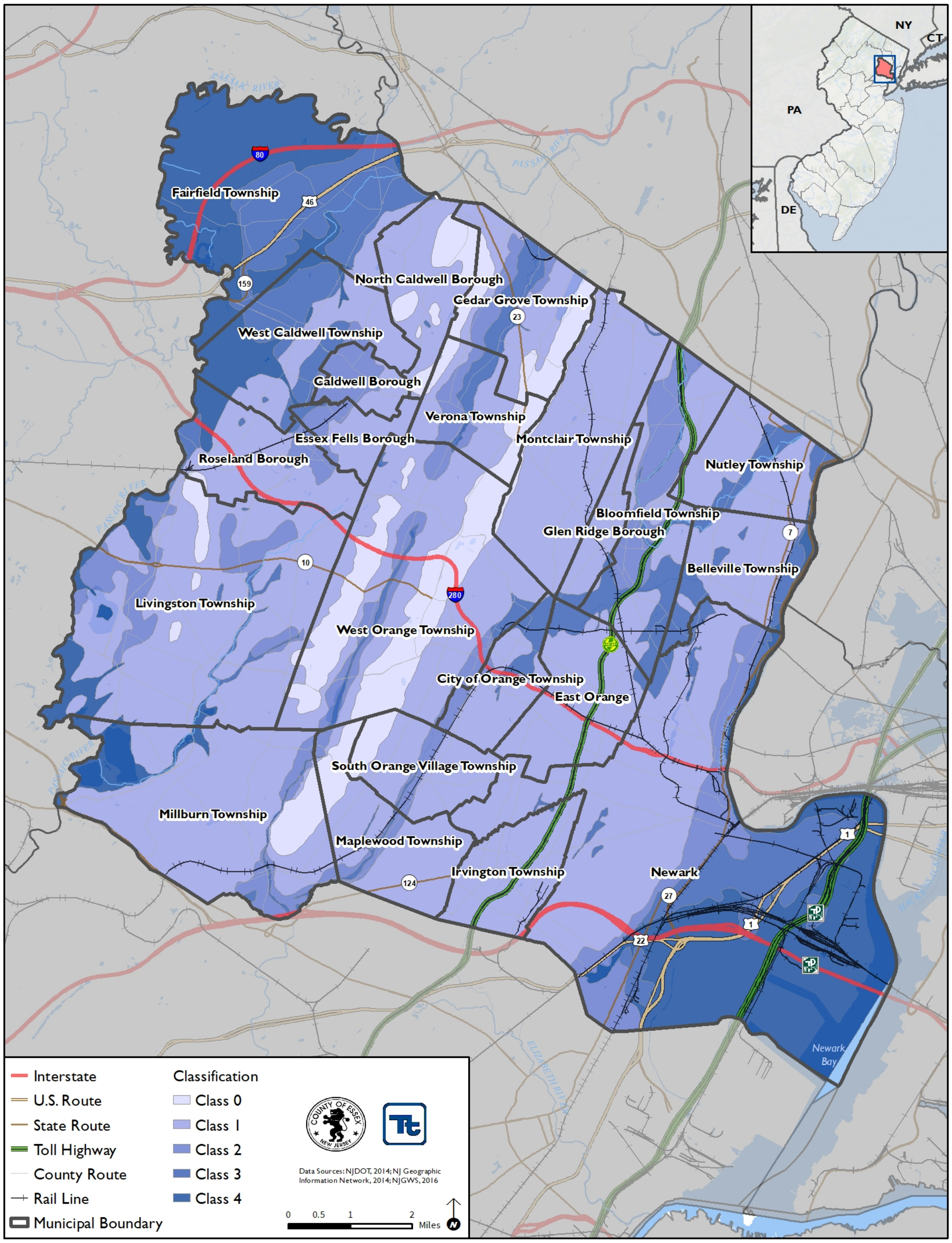
Figure 4.3.4-1. Seismic Soils in Northeastern New Jersey



Source: New Jersey Geological and Water Survey (NJGWS) and New Jersey Department of Environmental Protection (NJDEP) 2011
Note: The white circle indicates the location of Essex County. The County contains mainly Class C soils, with areas of Class A, B, D, and E.

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. In terms of liquefaction susceptibility, the interior of the northwestern and southeastern corners and some parts in central and western Essex County have a medium susceptibility, and southeastern Essex County (City of Newark) and the western edge and northwest corner of the County along the Passaic River have a high liquefaction susceptibility (see Figure 4.3.4-2).

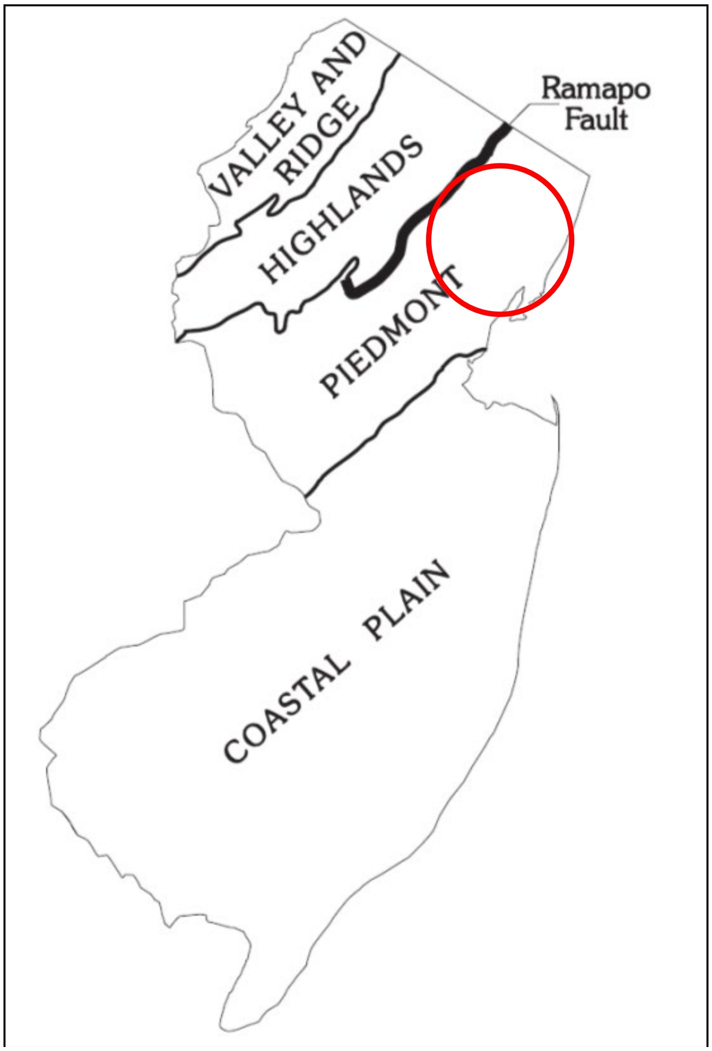
Figure 4.3.4-2. Liquefaction Susceptibility in Essex County



Faults are observed and mapped at the surface. There is no known surface ground displacement along faults in the eastern U.S. from historic earthquakes. Earthquake epicenters in eastern North America and the New Jersey area, in general, do not now occur on known faults. The faults in these parts are from tectonic activity more than 200 million years ago (Muessig, 2013).

There are many faults in New Jersey; however, the Ramapo Fault, which separates the Piedmont and Highlands Physiographic Provinces, is best known. Numerous minor earthquakes have been recorded in the Ramapo Fault zone, a 10- to 20-mile-wide area lying adjacent to, and west, of the actual fault (Dombroski 1973 [revised 2005]). Figure 4.3.4-3 illustrates the relationship of the Ramapo fault line with the physiologic provinces of New Jersey. Essex County is located in the Piedmont Province and near the Ramapo Fault line.

Figure 4.3.4-3. Physiographic Provinces of New Jersey and the Ramapo Fault Line



Source: Dombroski 1973 (revised 2005)

Note: The red circle indicates the approximate location of Essex 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 4.3.4-2. 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 4.3.4-3 displays the MMI scale and its relationship to the areas peak ground acceleration (PGA).

Table 4.3.4-2. 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.
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: USGS 2016c

Table 4.3.4-3. 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 4.3.4-4.

Table 4.3.4-4. 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 2011
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.

Figure 4.3.4-4 through Figure 4.3.4-6 illustrate geographic distributions of the Modified Mercalli Scale based on PGAs (%*g*) across Essex County for 100-, 500-, and 2,500-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. A 2,500-year MRP is an earthquake with 0.04 percent chance that mapped PGAs will be exceeded in any given year.

Figure 4.3.4-4. Peak Ground Acceleration 100-Year Mean Return Period for Essex County

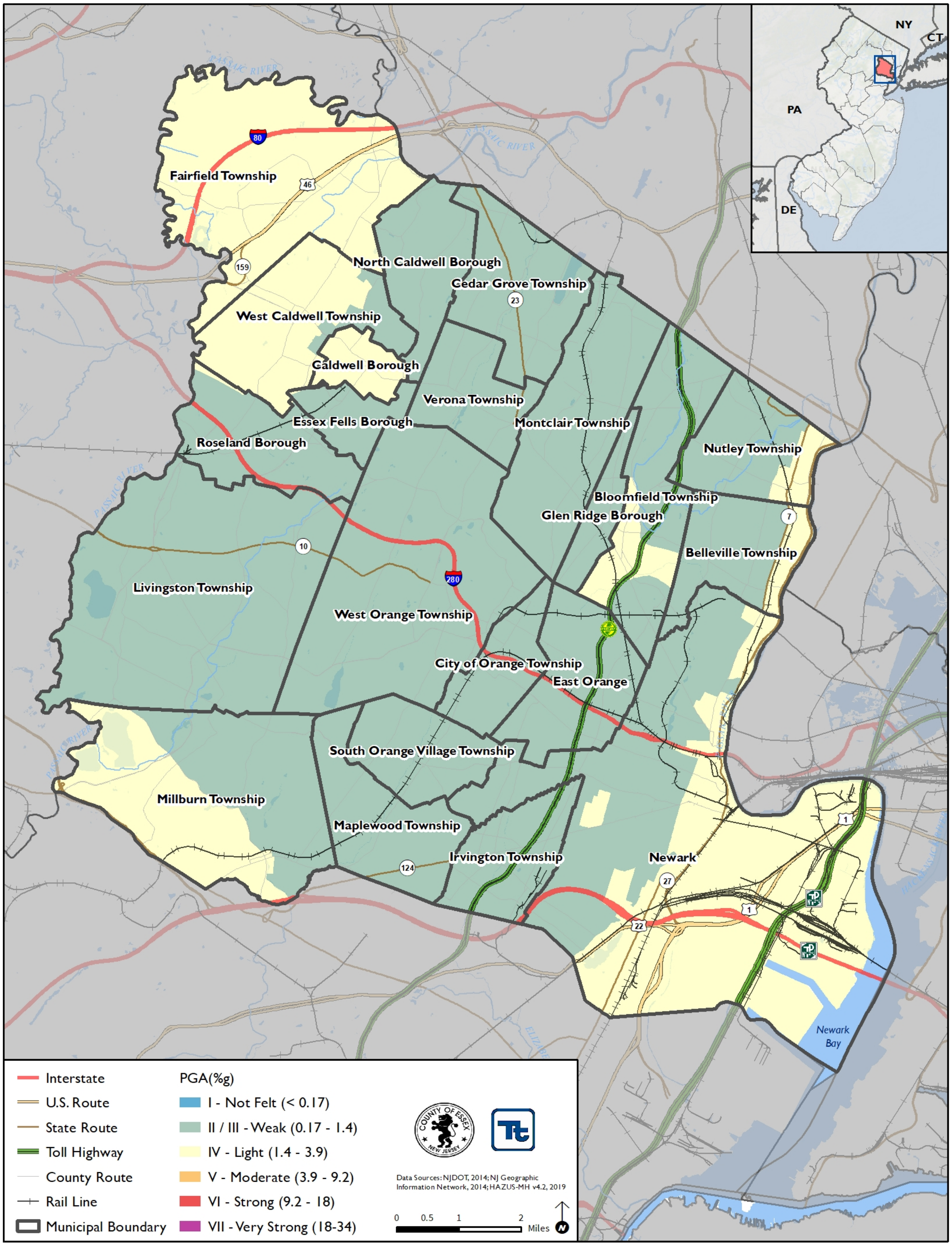


Figure 4.3.4-5. Peak Ground Acceleration 500-Year Mean Return Period for Essex County

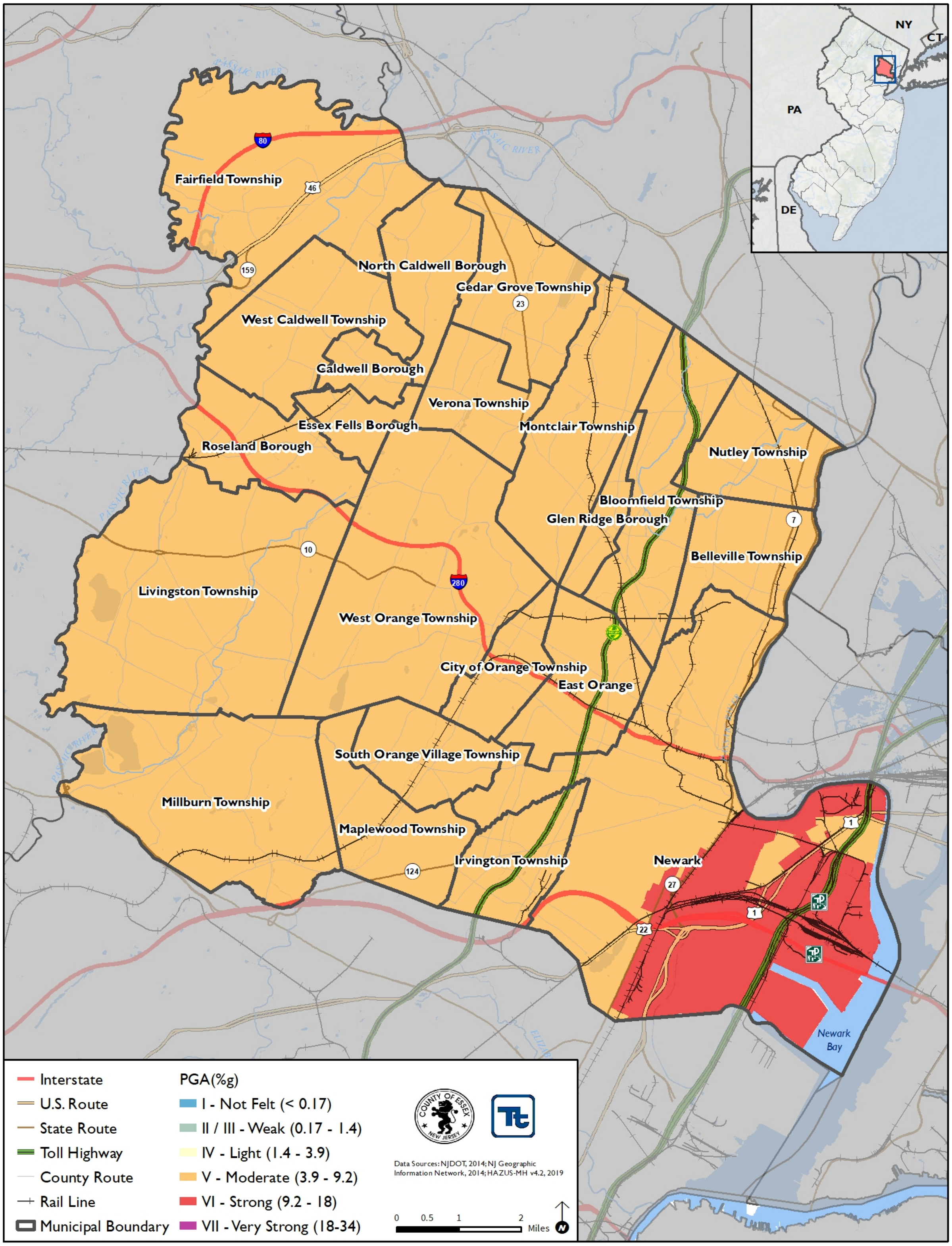
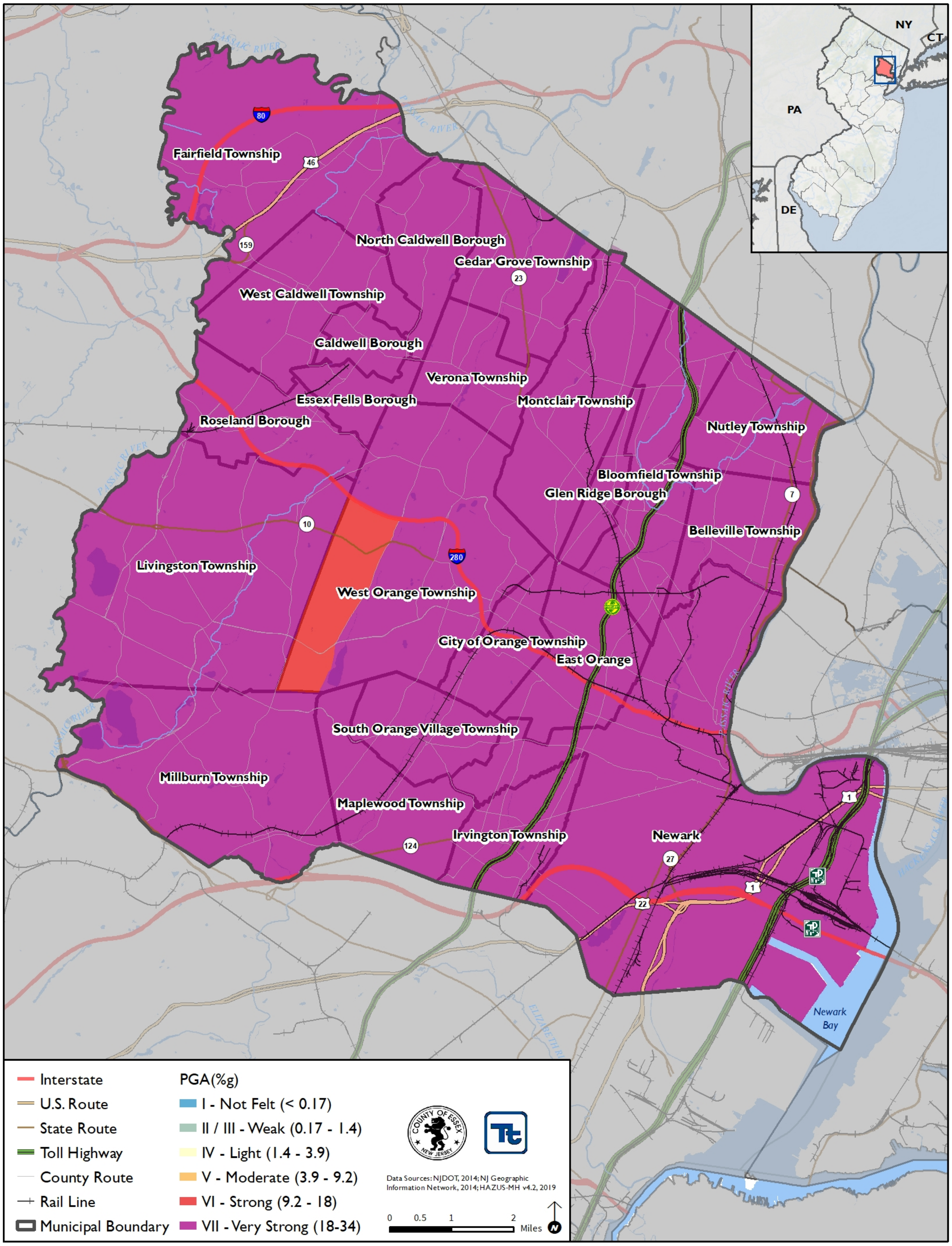


Figure 4.3.4-6. Peak Ground Acceleration 2,500-Year Mean Return Period for Essex County

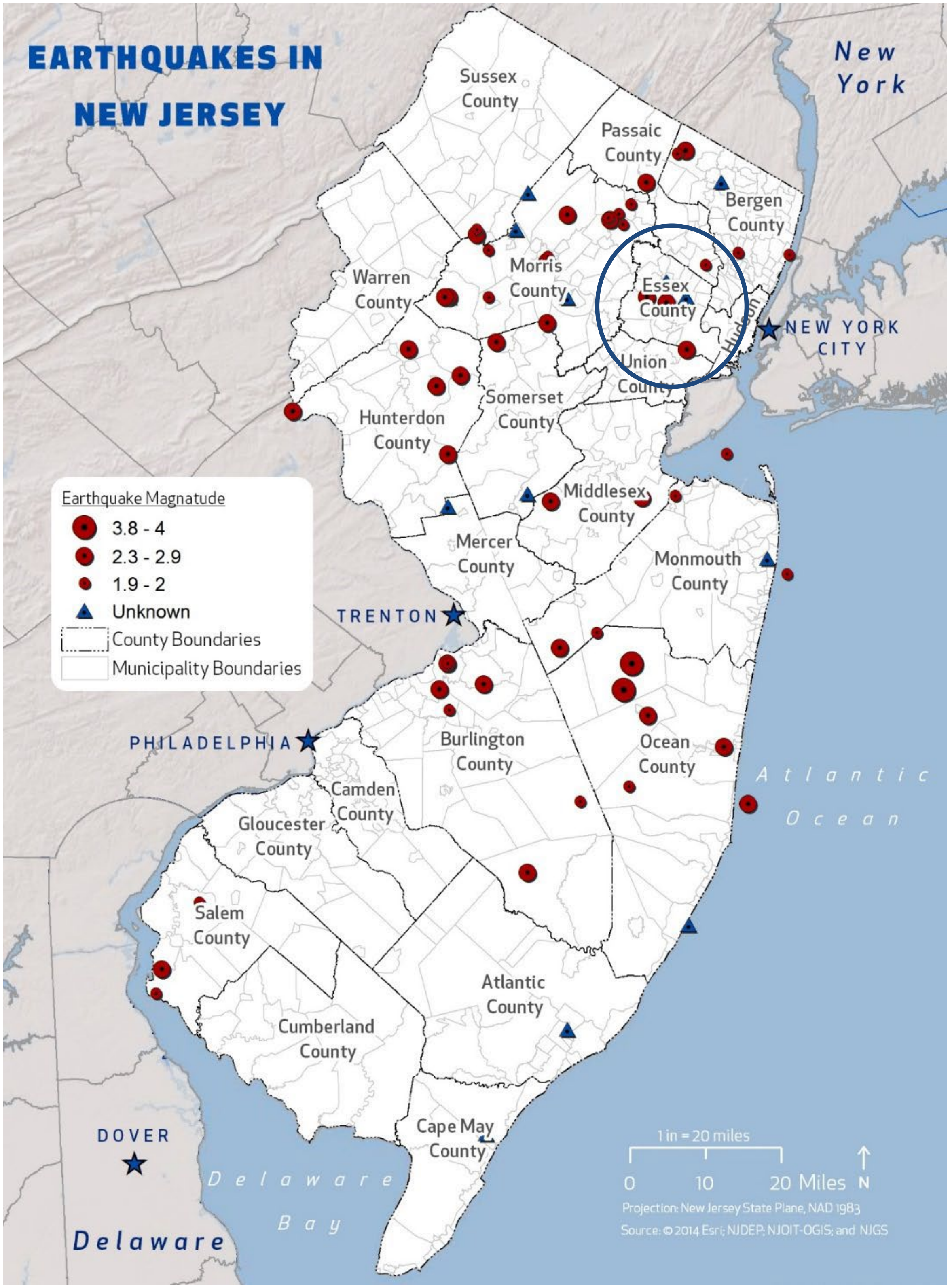


Previous Occurrences and Losses

New Jersey has a fairly extensive history of earthquakes. Small earthquakes occur several times a year and generally do not cause significant damage. The largest earthquake to impact New Jersey occurred in 1783. That earthquake, a magnitude 5.3 quake, occurred west of New York City and was felt from New Hampshire to Pennsylvania (Stover and Coffman 1993). Figure 4.3.4-7 illustrates earthquake events with epicenters located in New Jersey. Of the 178 events in the State, four earthquake epicenters were located in Essex County.

Earthquake events that have impacted Essex County between 2014 and 2019 are listed in Table 4.3.4-5. In the 2015 HMP, previous events were listed for the entirety of New Jersey. For the 2020 HMP, only events that impacted or could be felt in Essex County have been included. For events prior to 2014, refer to Appendix E (Risk Assessment Supplement). Please see Section 9 (Jurisdictional Annexes) for detailed information regarding impacts and losses to each municipality. The State of New Jersey has not been included in any FEMA disaster (DR) or emergency (EM) declarations for earthquake events.

Figure 4.3.4-7. Earthquakes with Epicenters in New Jersey, 1783 to 2017



Source: *NJGWS 2019*

Note: *The blue circle indicates the location of Essex County. The figure shows that several earthquakes have been epicentered in Essex County.*

Table 4.3.4-5. Earthquake Events impacting Essex County, 2014 to 2019

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Location	Losses/Impacts
March 27, 2015	1.1 Earthquake	N/A	N/A	Clifton, New Jersey	A magnitude 1.1 earthquake took place just south of Clifton, NJ at the border of Essex and Passaic County.
August 14, 2015	2.6 Earthquake	N/A	N/A	Bernardsville, New Jersey	A magnitude 2.6 earthquake took place in Bernardsville, NJ. The quake was faintly felt in Essex County.
August 22, 2015	1.2 Earthquake	N/A	N/A	Fairfield	A magnitude 1.2 earthquake took place in Fairfield at the border of Essex and Morris County.
January 2, 2016	2.1 Earthquake	N/A	N/A	Ringwood, New Jersey	A magnitude 2.1 earthquake took place in Ringwood, NJ. The quake was faintly felt in Essex County.
July 31, 2016	0.8 Earthquake	N/A	N/A	Brookdale	A magnitude 0.8 earthquake took place in Brookdale.
November 30, 2017	4.1 Earthquake	N/A	N/A	Dover, Delaware	Essex County residents felt ground shake from nearby 4.1 magnitude earthquake in Dover, Delaware. The quake was felt from central Virginia to Massachusetts.
April 12, 2019	1.8 Earthquake	N/A	N/A	Clifton, New Jersey	A magnitude 1.8 earthquake took place in Clifton, NJ. The quake was faintly felt in the western portion of Essex County.

Source: NJGWS 2019; USGS 2019
N/A Not Applicable/Not Available
NJ New Jersey

Probability of Future Occurrences

Earthquakes cannot be predicted and may occur any time of the day or year. The probability of damaging earthquakes affecting New Jersey and Essex County is low. However, there is a definite threat of major earthquakes that could cause widespread damage and casualties in New Jersey. Major earthquakes are infrequent in the State and may occur only once every few hundred years or longer, but the consequences of major earthquakes would be very high.

In Section 4.4 (Hazard Ranking), the identified hazards of concern for Essex 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 Steering Committee and Planning Committee, the probability of occurrence for earthquake events in the County is considered ‘occasional’.

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).

4.3.4.2 Vulnerability Assessment

Earthquake vulnerability data was generated using HAZUS. A probabilistic assessment was conducted for the 100-, 500- and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH to analyze the earthquake hazard and provide a range of loss estimates. Figure 4.3.4-8 shows the geographic distribution of the NEHRP soil types in the County. Figure 4.3.4-9 shows the geographic distribution of the liquefaction soil types in the County. Refer to Section 4.2 (Methodology and Tools) for additional details on the methodology used to assess earthquake risk.

Impact on Life, Health and Safety

The entire population of Essex County is exposed to the direct and indirect impacts from earthquakes. The degree of exposure is dependent on many factors including the age and type of construction people live in, the soil types their homes are located on, 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.

According to the 2017 American Community Survey annual estimate, Essex County had a population of 800,401 people. Overall, risk to public safety and loss of life from an earthquake in the County is minimal. 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.

As noted earlier, NEHRP Soil Classes D and E and liquefaction Class 4 soils can amplify ground shaking to damaging levels even during a moderate earthquake, and thus increase risk to the population. Populations within municipalities located on NEHRP Class D and E soils and high liquefaction susceptible soils were estimated and are listed in Table 4.3.4-6 below. Overall, approximately 121,736 people (15.2% of the County's population) are located on NEHRP class "D" and "E" soils. In addition, 8,942 people (1.1% of the County's population) are located in areas of high susceptibility to liquefaction. The Township of Fairfield has the greatest percent of its population exposed to both hazard areas (NEHRP Class D and E: 82.6%; Liquefaction Class 4: 23.6%). In the 2015 HMP, only the City of Newark had exposure to Class 4 soils; however, the 2016 NJGWS expanded these areas and indicated increased susceptibility to liquefaction along the Passaic River throughout communities in eastern and western Essex County.

Exhibit 4.3.4-1. Estimated Population Exposure

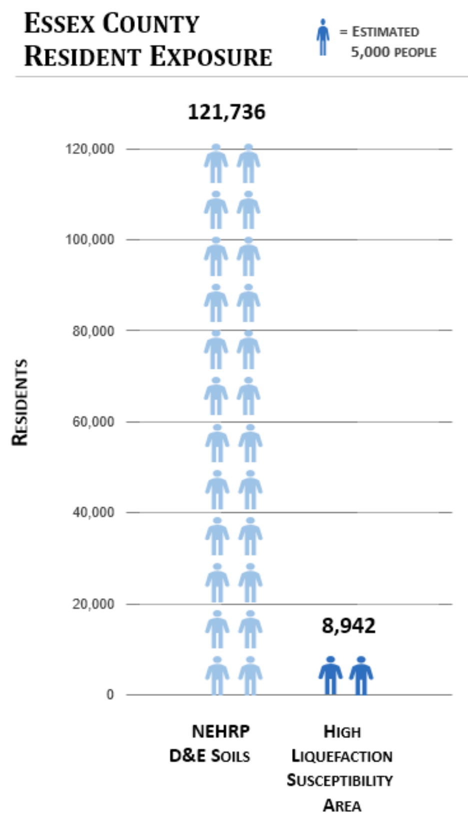


Figure 4.3.4-8. NEHRP Soils Types in Essex County

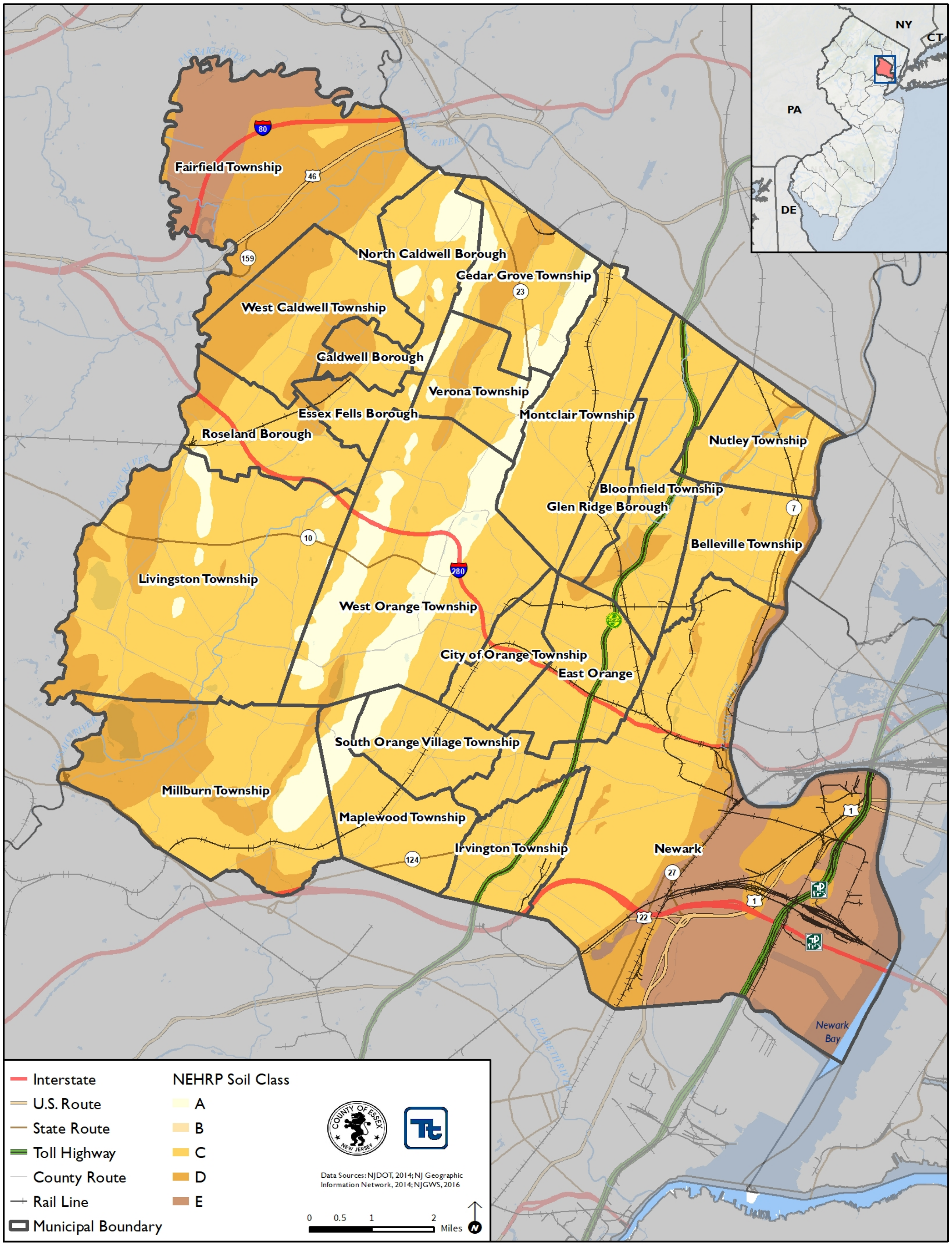


Table 4.3.4-6. Approximate Population within NEHRP and Liquefaction Areas

Municipality	American Community Survey (2013-2017) Population	Population NEHRP Class "D" and "E" Soils		Population Liquefaction Class 4	
		Number	%	Number	%
Township of Belleville	36,383	2,368	6.5%	179	<1%
Township of Bloomfield	48,892	5,085	10.4%	0	0.0%
Borough of Caldwell	8,032	4,808	59.9%	0	0.0%
Township of Cedar Grove	12,638	2,411	19.1%	0	0.0%
City of East Orange	65,151	1,469	2.3%	0	0.0%
Borough of Essex Fells	2,095	176	8.4%	0	0.0%
Township of Fairfield	7,671	6,337	82.6%	1,807	23.6%
Borough of Glen Ridge	7,668	197	2.6%	0	0.0%
Township of Irvington	54,715	219	<1%	0	0.0%
Township of Livingston	29,955	1,022	3.4%	40	<1%
Township of Maplewood	24,706	0	0.0%	0	0.0%
Township of Millburn	20,387	5,560	27.3%	27	<1%
Township of Montclair	38,572	0	0.0%	0	0.0%
City of Newark	282,803	82,555	29.2%	6,610	2.3%
Borough of North Caldwell	6,637	13	<1%	0	0.0%
Township of Nutley	28,829	1,358	4.7%	87	<1%
City of Orange Township	30,731	0	0.0%	0	0.0%
Borough of Roseland	5,907	916	15.5%	3	<1%
Township of South Orange Village	16,503	0	0.0%	0	0.0%
Township of Verona	13,585	3,056	22.5%	0	0.0%
Township of West Caldwell	10,932	3,700	33.8%	190	1.7%
Township of West Orange	47,609	486	1.0%	0	0.0%
Essex County (Total)	**800,401**	**121,736**	**15.2%**	**8,942**	**1.1%**

Sources: American Community Survey 5-year Estimate, 2017; NJGWS, 2016

Populations considered most vulnerable are those located in/near the built environment, particularly those near unreinforced masonry structures. Of these most vulnerable populations, socially vulnerable populations, including the elderly (persons over age 65) and individuals living below the census poverty threshold, are most susceptible. Factors leading 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. Within the NEHRP Class D and E soils, there are 13,913 people over the age of 65 and 21,775 people below the poverty level. Within liquefaction Class 4 soils, there are 786 people over the age of 65 and 1,046 people below the poverty level.

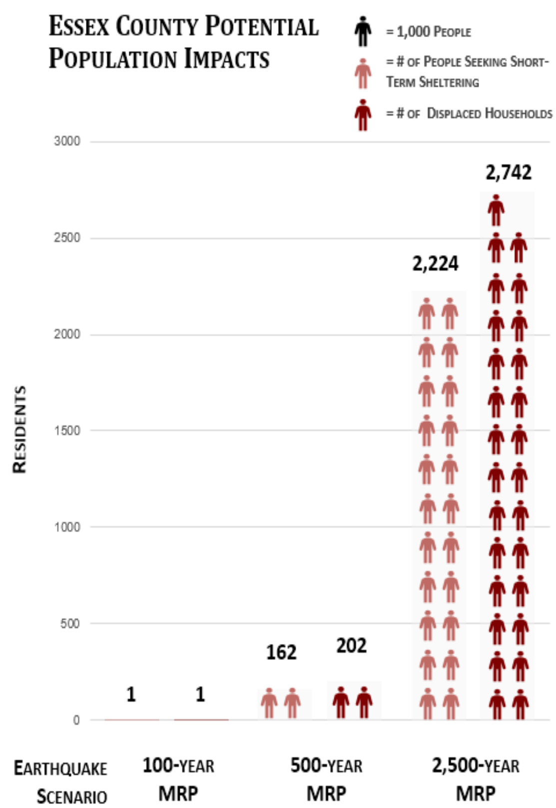
Residents may be displaced or require temporary to long-term sheltering due to an earthquake event. The number of people requiring shelter is generally less than the number displaced as some displaced persons use hotels or stay with family or friends following a disaster event. Table 4.3.4-7 summarizes the households HAZUS-MH v4.2 estimates will be displaced and population that may require short-term sheltering as a result of the 100-, 500- and 2,500-year MRP earthquake events.

Table 4.3.4-7. Summary of Estimated Sheltering Needs for Essex County

Scenario	Displaced Households	Persons Seeking Short-Term Shelter
100-Year Earthquake	1	1
500-Year Earthquake	202	162
2,500-Year Earthquake	2,742	2,224

Source: HAZUS-MH v4.2

Exhibit 4.3.4-2. Estimated Population Impacts



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, time of day also exposes different sectors of the community to the hazard. For example, HAZUS-MH v4.2 considers residential occupancy at its maximum at 2:00 AM, whereas educational, commercial, and industrial sectors are at their maximum at 2:00 PM, and peak commute time is at 5:00 PM. Whether directly impacted or indirectly impacted, the entire population will be affected to some degree. Business interruption could prevent people from working, road closures could isolate populations, and loss of utilities could impact populations that suffered no direct damage from an event.

Table 4.3.4-8 summarizes the County-wide injuries and casualties estimated for the 100-, 500-, and 2,500-year MRP earthquake events.

Table 4.3.4-8. Estimated Number of Injuries and Casualties from the 100-, 500-, and 2,500-Year MRP Earthquake Events

Level of Severity	Time of Day		
	2:00 AM	2:00 PM	5:00 PM
100-year MRP			
Injuries	0	0	1
Hospitalization	0	0	3
Casualties	0	0	0
500-year MRP			
Injuries	30	43	32
Hospitalization	4	6	8
Casualties	1	1	1
2,500-year MRP			
Injuries	325	448	332
Hospitalization	59	91	75

Level of Severity	Time of Day		
	2:00 AM	**2:00 PM**	**5:00 PM**
Casualties	11	18	14

Source: HAZUS-MH v4.2

Impact on General Building Stock

The entire County's general building stock is considered at risk and exposed to this hazard. As stated earlier, soft soils (NEHRP Soil Classes D and E) can amplify ground shaking to damaging levels even during a moderate earthquake (NYCEM 2003). Therefore, buildings located on NEHRP Classes D and E soils and high liquefaction susceptible soils are at increased risk of damage from an earthquake. Table 4.3.4-9 summarizes the number and replacement cost value of buildings in Essex County located on NEHRP Soils Classes D and E and liquefaction Class 4 soils.

Table 4.3.4-9. Number and Replacement Cost Value of Buildings within NEHRP and Liquefaction Areas

Municipality	Total Number of Buildings	Total RCV (Structure and Contents)	Buildings NEHRP Class "D" and "E" Soils			Buildings Liquefaction Class 4		
			Number	RCV	% of Total RCV	Number	RCV	% of Total RCV
Township of Belleville	7,910	$4,483,250,138	504	$550,476,187	12.3%	37	$80,430,934	1.8%
Township of Bloomfield	11,720	$6,021,089,887	1035	$694,069,667	11.5%	0	$0	0.0%
Borough of Caldwell	1,738	$1,183,204,981	1002	$615,988,955	52.1%	0	$0	0.0%
Township of Cedar Grove	3,944	$3,008,045,785	740	$843,004,854	28.0%	0	$0	0.0%
City of East Orange	7,908	$6,090,766,912	282	$110,922,535	1.8%	0	$0	0.0%
Borough of Essex Fells	766	$527,629,662	64	$34,459,982	6.5%	0	$0	0.0%
Township of Fairfield	3,121	$6,082,819,367	2578	$5,349,810,165	87.9%	735	$1,563,613,990	25.7%
Borough of Glen Ridge	2,256	$1,095,474,263	58	$19,937,181	1.8%	0	$0	0.0%
Township of Irvington	7,934	$5,384,838,816	30	$17,026,564	0.3%	0	$0	0.0%
Township of Livingston	9,795	$7,691,376,811	310	$519,221,451	6.8%	12	$69,128,114	0.9%
Township of Maplewood	6,738	$3,575,395,600	0	$0	0.0%	0	$0	0.0%
Township of Millburn	6,437	$5,241,567,136	1762	$1,974,304,439	37.7%	9	$11,628,704	0.2%
Township of Montclair	9,436	$5,845,976,130	0	$0	0.0%	0	$0	0.0%
City of Newark	43,085	$40,970,549,425	11,579	$20,174,784,407	49.2%	1,091	$6,759,796,576	16.5%
Borough of North Caldwell	2,095	$1,727,767,442	4	$3,009,682	0.2%	0	$0	0.0%
Township of Nutley	7,945	$3,841,553,722	414	$262,081,308	6.8%	15	$26,609,238	0.7%
City of Orange Township	3,890	$3,520,865,708	0	$0	0.0%	0	$0	0.0%
Borough of Roseland	1,794	$1,955,487,279	278	$255,621,702	13.1%	1	$4,648,900	0.2%
Township of South Orange Village	4,188	$2,877,374,186	0	$0	0.0%	0	$0	0.0%
Township of Verona	4,113	$2,213,338,613	925	$477,765,931	21.6%	0	$0	0.0%
Township of West Caldwell	3,730	$3,533,044,820	1267	$1,540,696,116	43.6%	66	$271,015,777	7.7%
Township of West Orange	11,845	$8,358,783,858	133	$89,133,008	1.1%	0	$0	0.0%
Essex County	**162,388**	**$125,230,200,542**	**22,965**	**33,532,314,136**	**26.8%**	**1,966**	**8,786,872,232**	**7.0%**

Sources: American Community Survey 5-year Estimate, 2017; Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NJGWS, 2016
RCV Replacment Cost Value.

There is a strong correlation between PGA and damage a building might undergo (NYCEM 2003). The HAZUS-MH model is based on best available earthquake science and aligns with these statements. The HAZUS-MH probabilistic earthquake model was applied to analyze effects from the earthquake hazard on general building stock in Essex County. See Figure 4.3.4-4 through Figure 4.3.4-6 earlier in this profile which illustrates the geographic distribution of PGA (g) across the County for 100-, 500- and 2,500-year MRP events at the Census-tract level.

A building's construction determines how well it can withstand the force of an earthquake. The NYCEM report indicates that 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-MH v4.2 considers building construction and age of building as part of the analysis. Because a custom general building stock was used for this HAZUS-MH v4.2 analysis, the building ages and building types from the inventory were incorporated into the HAZUS-MH v4.2 model.

Potential building damage was evaluated using HAZUS-MH v4.2 across the following damage categories: none, slight, moderate, extensive, and complete. Table 4.3.4-10 provides definitions of these five categories of damage to a light wood-framed building; definitions of categories of damage to other building types appear in HAZUS-MH technical manual documentation.

Table 4.3.4-10. Example of Structural Damage State Definitions for a Light Wood-Framed Building

Damage Category	Description
None	No damage recorded.
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 might have large permanent lateral displacement, can collapse, or be in imminent danger of collapse due to cripple wall failure or the failure of the lateral load resisting system; some structures can slip and fall off the foundations; large foundation cracks.

Source: HAZUS-MH Technical Manual

Building damage as a result of the 100-, 500- and 2,500-year MRP earthquake events was estimated using HAZUS-MH v4.2. Table 4.3.4-11 lists the estimated numbers of buildings damaged (within general occupancy categories) from the 500- and 2,500-year MRP earthquake events. Damage loss estimates include structural and non-structural damage to the building and loss of contents. Table 4.3.4-12 lists estimated replacement cost values (RCVs) of buildings and contents damaged by the 100-, 500- and 2,500-year MRP earthquake events.

Table 4.3.4-11. Estimated Buildings Damaged by General Occupancy for 100-year and 1,000-year MRP Earthquake Events

	Expected Building Damage by Occupancy									
	500-Year MRP					2,500-Year MRP				
Category	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Residential	139,909 (86.2%)	2,384 (1.5%)	528 (<1%)	67 (<1%)	7 (<1%)	118,927 (73.2%)	18,049 (11.1%)	4,939 (3.0%)	839 (<1%)	141 (<1%)

Category	Expected Building Damage by Occupancy									
	500-Year MRP					2,500-Year MRP				
	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Commercial	8,272 (5.1%)	321 (<1%)	111 (<1%)	14 (<1%)	1 (<1%)	6,358 (3.9%)	1,253 (<1%)	849 (<1%)	223 (<1%)	35 (<1%)
Industrial	1,718 (1.2%)	103 (<1%)	45 (<1%)	7 (<1%)	0 (0%)	1,094 (<1%)	332 (<1%)	310 (<1%)	119 (<1%)	19 (<1%)
Education, Government, Religious and Agricultural	8,478 (5.5%)	303 (<1%)	106 (<1%)	13 (<1%)	1 (<1%)	6,637 (4.1%)	1,195 (<1%)	808 (<1%)	225 (<1%)	36 (<1%)

Source: HAZUS-MH v4.2

Table 4.3.4-12. Estimated Value (Building and Contents) Damaged by the 100-, 500- and 2,500-Year MRP Earthquake Events

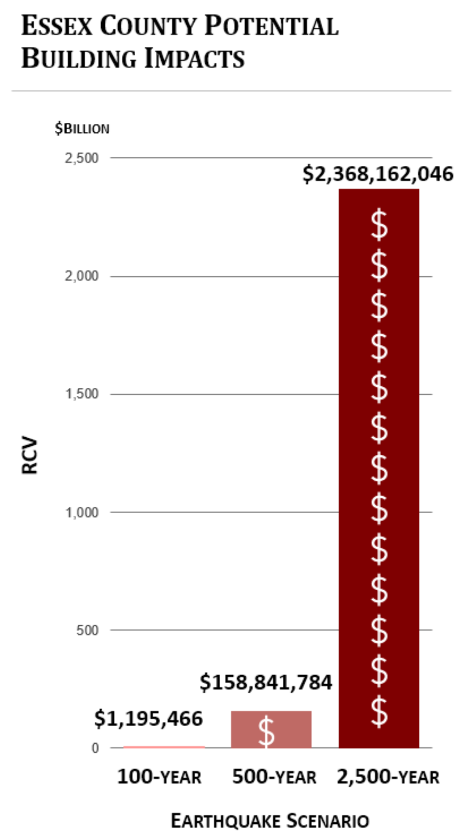
Municipality	Estimated Total Damages (All Occupancies)				Percent of Total RCV
	Annualized Loss	100-Year	500-Year	2,500-Year	2,500-Year
Township of Belleville	$72,807	$0	$4,616,521	$71,094,612	1.6%
Township of Bloomfield	$78,743	$0	$4,910,094	$80,412,843	1.3%
Borough of Caldwell	$18,907	$0	$1,229,842	$18,524,023	1.6%
Township of Cedar Grove	$32,457	$0	$1,941,799	$33,539,291	1.1%
City of East Orange	$75,554	$0	$4,678,812	$77,459,497	1.3%
Borough of Essex Fells	$6,428	$0	$395,156	$6,762,432	1.3%
Township of Fairfield	$214,267	$0	$14,229,766	$183,862,678	3.0%
Borough of Glen Ridge	$12,784	$0	$779,516	$13,407,246	1.2%
Township of Irvington	$65,105	$0	$3,990,827	$66,871,152	1.2%
Township of Livingston	$90,202	$0	$5,568,549	$92,818,762	1.2%
Township of Maplewood	$38,688	$0	$2,343,955	$40,300,317	1.1%
Township of Millburn	$72,377	$0	$4,590,624	$72,940,336	1.4%
Township of Montclair	$67,158	$0	$4,134,051	$69,557,125	1.2%
City of Newark	$1,434,514	$1,195,466	$86,036,956	$1,213,542,653	3.0%
Borough of North Caldwell	$14,448	$0	$829,243	$15,482,457	<1%
Township of Nutley	$49,476	$0	$3,082,906	$51,088,073	1.3%
City of Orange Township	$42,905	$0	$2,661,345	$43,623,386	1.2%
Borough of Roseland	$25,932	$0	$1,626,070	$26,072,734	1.3%
Township of South Orange Village	$29,585	$0	$1,796,487	$30,830,217	1.1%
Township of Verona	$22,253	$0	$1,323,391	$23,452,748	1.1%
Township of West Caldwell	$60,846	$0	$3,880,288	$59,314,601	1.7%
Township of West Orange	$72,542	$0	$4,195,584	$77,204,865	<1%
Essex County (Total)	**$2,597,976**	**$1,195,466**	**$158,841,784**	**$2,368,162,046**	**1.9%**

Source: HAZUS-MH v4.2 **Total Damages is sum of damages for all occupancy classes (residential, commercial, industrial, agricultural, educational, religious and government).*

The City of Newark is the only municipality that is estimated to experience building damages as a result of the 100-year MRP event ($1,195,466). It is estimated that there would be nearly $159 million in damages to buildings in the County as a result of a 500-year earthquake event. This includes structural damage, non-structural damage and loss of contents, representing less than one-percent of the total replacement value for general building stock in Essex County. For a 2,500-year MRP earthquake event, HAZUS-MH estimates nearly $2.4 billion, approximately 1.9-percent of the total general building stock replacement value. Residential buildings account for 8-percent, 31-percent, and 35.2-percent of the total losses for the 100-, 500- and 2,500-year MRP events, respectively and commercial losses account for 16.7-percent, 17.1-percent, and 15.8-percent of the total losses for the 100-, 500- and 2,500-year MRP events.

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.

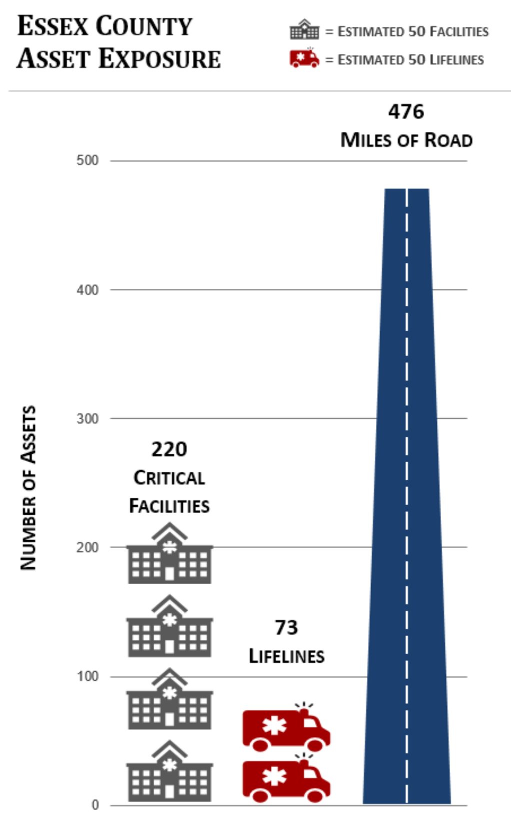
Exhibit 4.3.4-3. Estimated Building Impacts



Impact on Critical Facilities

All critical facilities in Essex 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 Essex County. Of the 1,118 critical facilities exposed countywide, the City of Newark has the greatest number of critical facilities located on NEHRP Classes D or E soils (96 facilities), followed by the Township of Fairfield with 28 facilities. Of the 96 facilities in the City of Newark, two were identified as lifeline facilities, and of the 28 facilities in Fairfield, 13 were identified as lifeline facilities. Appendix E (Risk Assessment Supplemental Data) summarizes the number of critical facilities, by type, located on NEHRP Soil Classes D or E and liquefaction Class 4 soils.

Exhibit 4.3.4-4. Asset Exposure to NEHRP Soils D & E and High Liquefaction Susceptiblity Area



The HAZUS-MH v4.2 earthquake model was used to assign a probability of each damage state category defined in Table 4.3.4.-10, to every critical facility in the planning area, which was then averaged across the facility category. In addition, HAZUS-MH v4.2 estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments (days after the event). For example, HAZUS-MH v4.2 might estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. Results for the 500- and 2,500-year events are summarized in Table 4.3.4-13 and Table 4.3.4-14. As a result of a 100-year MRP event, HAZUS-MH v4.2 estimates that critical facilities will be nearly 100% functional with negligible damages. Therefore, the impact to critical facilities is not significant for the 100-year event. For percent probability of sustaining damage, the minimum and maximum damage estimated value for that facility type is presented.

Table 4.3.4-13. Estimated Damage and Loss of Functionality for Critical Facilities and Utilities 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									
Medical	78-91	6-13	3-7	0-2	<1	78-91	90-97	98-100	99-100
Police	78-90	6-13	3-7	0-2	<1	78-90	90-97	98-100	99-100
Fire	78-96	3-13	1-7	0-2	<1	78-96	91-99	98-100	99-100
EOC	94-96	3-5	1	<1	<1	94-96	98-99	100	100
School	97-99	1-9	0-4	0-1	<1	87-99	96-100	99-100	100
Utilities									
Potable Water	97-100	0-2	<1	<1	0	99-100	100	100	100

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
Wastewater	93-100	0-5	0-2	<1	<1	95-100	100	100	100
Electric Power	93-100	0-5	0-2	<1	<1	98-100	100	100	100
Communication	98-100	0-2	<1	<1	0	100	100	100	100

Source: HAZUS-MH v4.2

Table 4.3.4-14. Estimated Damage and Loss of Functionality for Critical Facilities and Utilities for the 2,500-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									
Medical	31-65	18-23	12-25	4-13	1-9	31-65	53-83	79-96	85-98
Police	26-65	18-23	12-25	4-13	1-24	26-65	44-89	65-96	71-98
Fire	29-92	11-23	6-25	1-13	0-15	29-92	50-93	74-99	80-99
EOC	60-75	14-19	8-12	2-3	0-7	60-75	79-90	90-98	92-99
School	39-91	7-25	2-21	0-7	0-12	39-91	62-97	81-100	85-100
Utilities									
Potable Water	61-98	2-14	0-10	0-1	0-18	71-99	84-100	85-100	91-100
Wastewater	36-98	2-16	0-23	0-5	0-21	44-98	75-100	76-100	81-100
Electric Power	36-98	2-16	0-23	0-5	0-21	58-99	77-100	80-100	95-100
Communication	74-98	2-14	0-11	0-1	0-1	93-100	99-100	99-100	100

Source: HAZUS-MH 4.2

Impact on Economy

Earthquakes also impact the economy, including loss of business function, damage to inventory (buildings, transportation, and utility systems), relocation costs, wage loss, and rental loss due to repair and replacement of buildings. HAZUS-MH v4.2 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-MH v4.2 are summarized in Table 4.3.4-15.

Table 4.3.4-15. Building-Related Economic Losses from the 100-, 500- and 2,500-Year MRP Earthquake Events

Level of Severity	100yr	500yr	2500yr
Income Losses			
Wage	$129,800	$5,565,700	$57,136,300
Capital Related	$20,300	$1,708,500	$17,574,400
Rental	$107,200	$6,200,700	$65,604,200
Relocation	$277,000	$16,589,900	$181,423,000
Subtotal	**$515,000**	**$30,064,800**	**$321,737,900**
Capital Stock Losses			
Structural	$547,100	$32,551,600	$349,663,300

Level of Severity	100yr	500yr	2500yr
Non-Structural	$538,400	$88,311,900	$1,323,203,200
Content	$109,100	$37,977,700	$695,294,800
Inventory	$3,800	$1,146,200	$17,692,600
Subtotal	**$1,198,400**	**$159,987,400**	**$1,198,400**

Source: HAZUS-MH v4.2

Although the HAZUS-MH v4.2 analysis did not compute estimates of damage to 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 (FEMA 2012).

Earthquake events can 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 of these. HAZUS-MH v4.2 estimated economic impacts to Essex County for 15-years after the earthquake event, including impacts to transportation infrastructure. $30 million in damages were estimated as a result of a 500-year event and $1.2 billion as a result of a 2,500-year event for damages to highway bridges.

HAZUS-MH v4.2 estimates volume of debris that may be generated as a result of an earthquake event to enable the study region to prepare for and rapidly and efficiently manage debris removal and disposal. Debris estimates were divided into two categories: (1) reinforced concrete and steel that require special equipment to break up before transport can occur, and (2) brick, wood, and other debris that can be loaded directly onto trucks by use of bulldozers (HAZUS-MH Earthquake User's Manual).

HAZUS-MH v4.2 estimated the generation of over 1,000 tons of total debris during the 100-year MRP event, over 55,000 tons of debris during the 500-year MRP event, and over 565,000 tons of debris during the 2,500-year MRP event. Table 4.3.4-16 below lists estimated debris generated by the 100-, 500- and 2,500-year MRP events.

Table 4.3.4-16. Estimated Debris Generated by the 250- and 1,000-year MRP Earthquake Events

Mean Return Period	Brick/Wood (tons)	Concrete/Steel (tons)
100-Year	739	320
500-Year	36,877	18,682
2,500-Year	268,745	297,192

Source: HAZUS-MH 4.2

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

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across the County.

New development located in areas with softer NEHRP soil classes and high liquefaction susceptibility may be more vulnerable to the earthquake hazard. Information regarding new development, both recent and expected development, within Essex County was received during the planning process. Any development location that could be located using an address or Parcel ID were geocoded and overlaid with the NEHRP Class D and E soils spatial layer to determine vulnerability. In total, there are 10 new development sites located on NEHRP Class D and E soils. 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.

Specific areas of development are indicated in tabular form in the jurisdictional annexes in Volume II, Section 9 (Jurisdictional Annexes). Please refer to Figure 4.3.4-9 for the potential new development in the County and the NEHRP soil class and high liquefaction susceptibility areas.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). As noted above, vulnerability greatly depends upon the location residents reside. The HAZUS-MH earthquake model indicates the City of Newark is vulnerable to greater ground shaking and building impacts as a result of more frequent events such as the 100-year MRP event. Populations moving to Essex County and living in older buildings may be vulnerable to this hazard. As noted earlier, if moving into new construction, current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts.

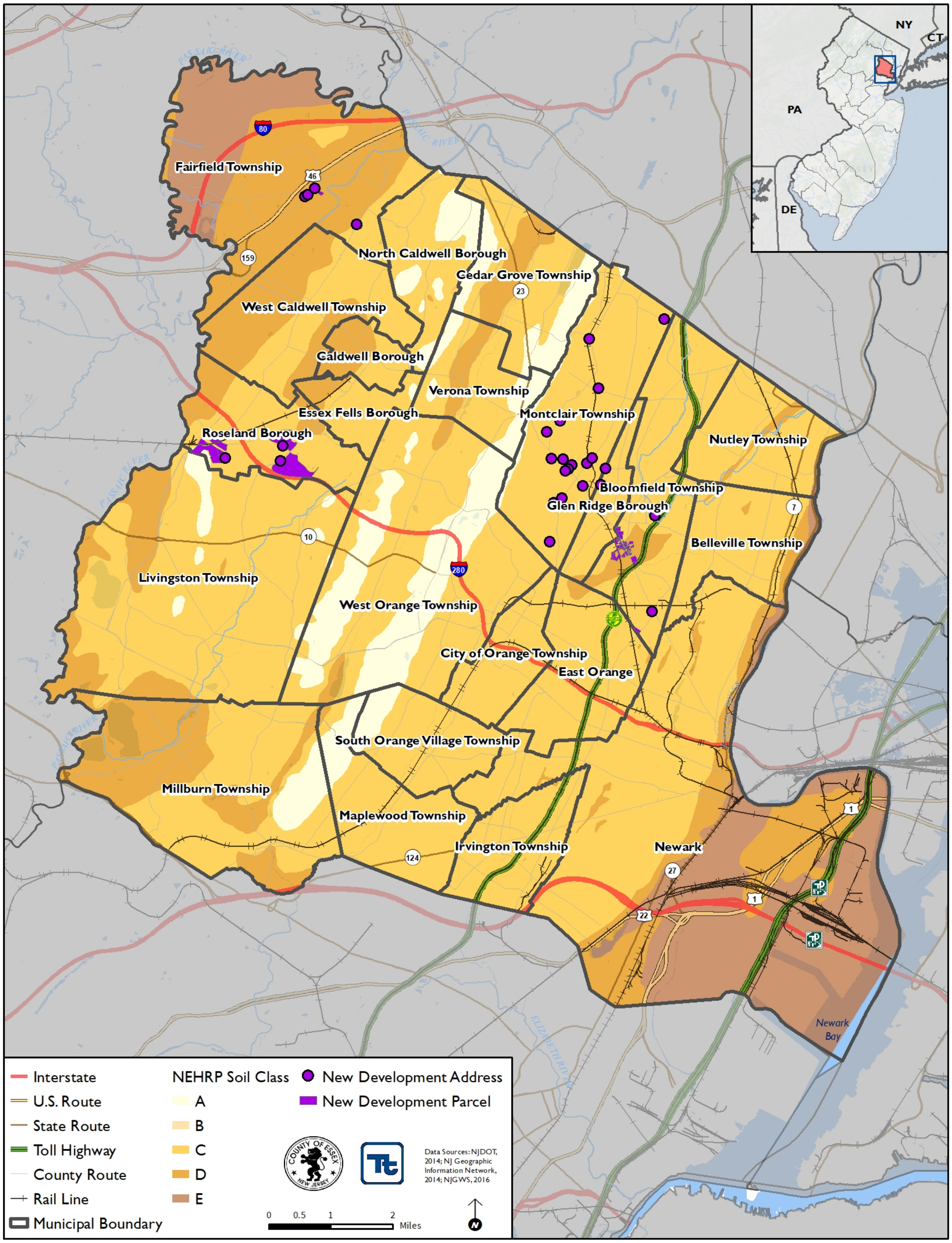
Climate Change

Because the impacts of climate change on the earthquakes are not well understood, a change in the County's vulnerability 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 4.3.7 for additional discussion of the geological hazard. Failure of a dam storing increased volumes of water would result in flooding of the county's assets located in the inundation area.

Change of Vulnerability Since 2015 HMP

Overall, the entire County continues to be vulnerable to earthquakes. Several differences exist between the 2015 plan and this update. For the 2020 plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the hazard areas. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. Updated hazard areas were used as well; since the 2015 Plan, the NJGWS has released updated NEHRP and liquefaction susceptible soils data. The updated data was used for the exposure analysis and to update HAZUS-MH's default earthquake data. The largest increase in vulnerability reported is attributed to the availability of updated data which expands the delineated liquefaction Class 4 soils throughout the western and eastern borders of the County along the Passaic River. For the 2015 plan, these soils were only present in the City of Newark. The updated vulnerability assessment provides a more current exposure analysis for the county.

Figure 4.3.4-9. Potential New Development in Essex County and NEHRP Soil Types



4.3.5 Extreme Temperatures

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 extreme temperature hazard in Essex County.

2020 HMP Update Changes

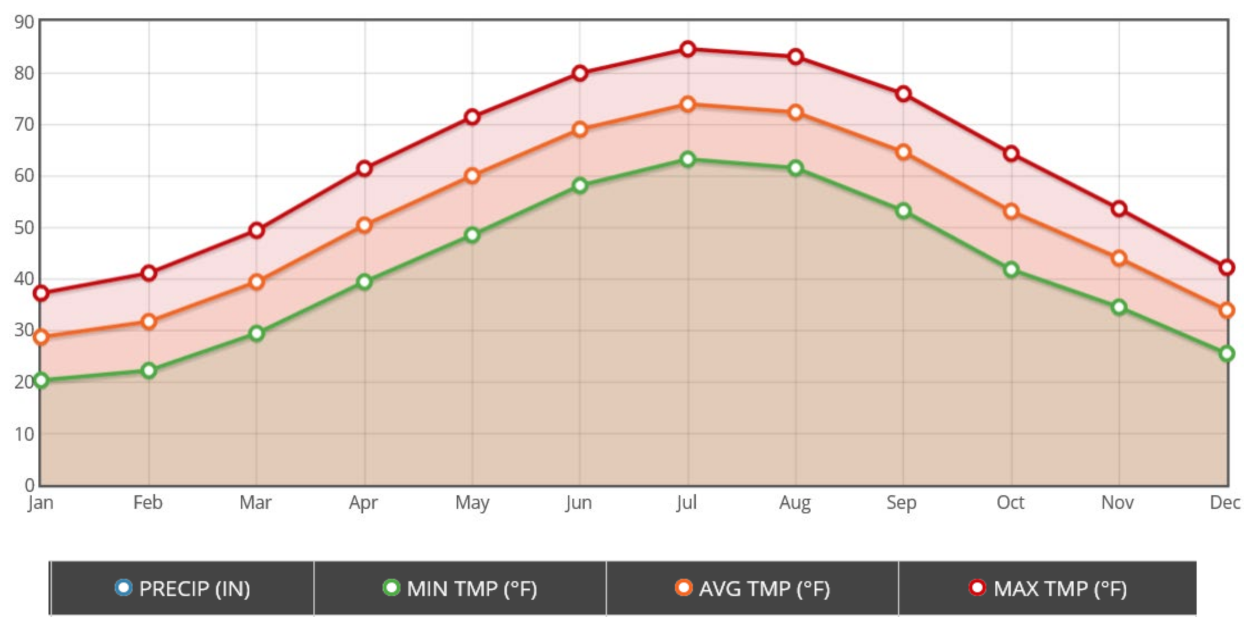
- All subsections have been updated using best available data.
- Previous occurrences are updated with events that occurred between 2014 and 2019.

4.3.5.1 Profile

Hazard Description

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 4.3.5-1 shows the average low and high temperatures each month at the Essex Falls station in Essex County.

Figure 4.3.5-1. Average Temperatures at Essex Falls



Source: NWS 2018a

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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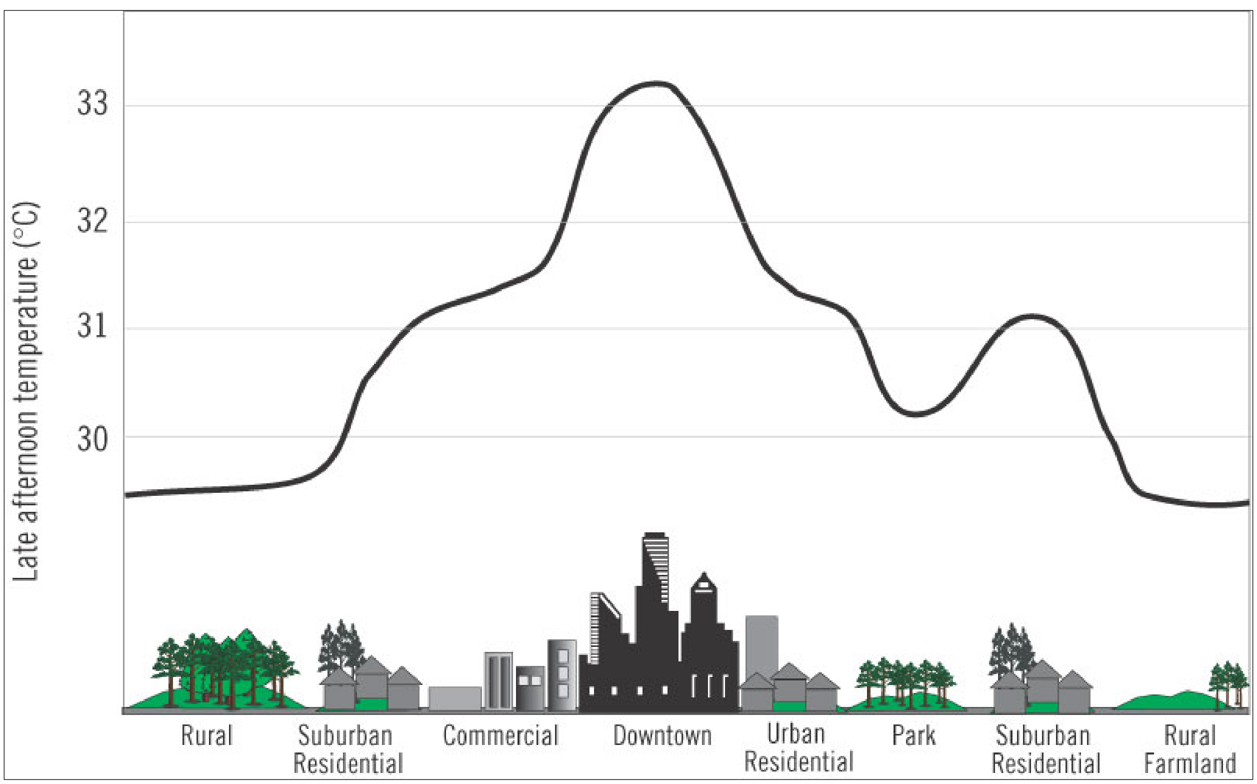
Figure 4.3.5-2 below illustrates an urban heat island profile. The graphic demonstrates that heat islands are typically most intense over dense urban areas. Further, vegetation and parks within a downtown area may help reduce heat islands (U.S. EPA 2019).

Figure 4.3.5-2. Urban Heat Island Profile



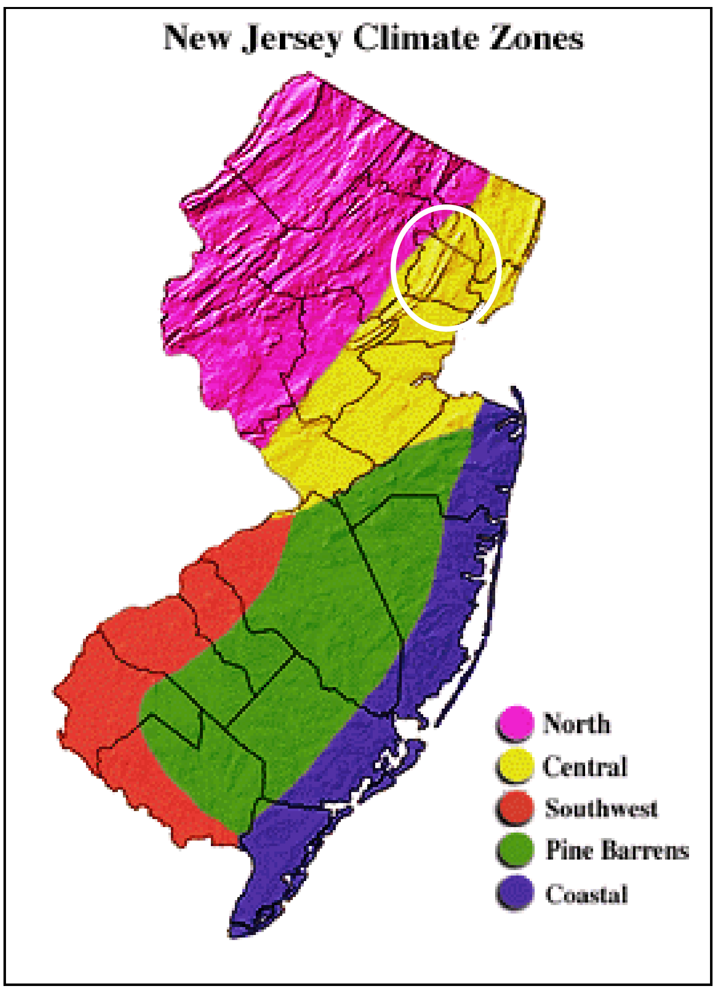
Source: EPA 2019
ºC degrees Celsius

Location

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, Date Unknown). Figure 4.3.5-3 depicts these regions. A majority of Essex County is located within the Central Climate Region with the northwestern corner located in the Northern Climate Region.

The Central Region has a northeast to southeast orientation, running from New York Harbor and the Lower Hudson River to the great bend of the Delaware River in the vicinity of Trenton. This region has many urban locations with large amounts of pollutants produced by the high volume of traffic and industrial establishments. The concentration of buildings and impervious surfaces tend to retain more heat; thereby, affecting the local temperatures. The observed nighttime temperatures in heavily developed areas of this region are typically warmer than surrounding suburban and rural areas due to the amount of asphalt, brick, and concrete. The northern edge of the Central Region is often the boundary between freezing and non-freezing precipitation during the winter months. Areas in the southern part of this region tend to have nearly twice as many days with temperatures above 90°F than other locations in the central portion of the State (ONJSC Rutgers University n.d.).

Figure 4.3.5-3. Climate Regions of New Jersey



Source: ONJSC Rutgers University, Date Unknown

Note: The white circle indicates the location of Essex County. The County is located in the Central Climate Zone of New Jersey.

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with extreme temperatures throughout New Jersey and Essex County; therefore, the loss and impact information for many events could vary depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

New Jersey has been experiencing an increase in extreme temperatures across the State. The number of very hot days has been above average since the early 2000's. However, declines in the number of extreme cold days have occurred since the early 1990's (NOAA NCEI 2019).

FEMA Major Disasters and Emergency Declarations

Between 1954 and March 15, 2019, neither Essex County nor the State of New Jersey were not included in any major disaster (DR) or emergency (EM) declarations due to extreme temperatures. However, during the same time period, the Federal Emergency Management Agency (FEMA) included Essex County in six winter storm-related DR or EM declarations classified as one or a combination of the following disaster types that may have had associated extreme cold temperatures: severe winter storm, snowstorm, snow, ice storm, winter storm, and blizzard (Table 4.3.5-1).

Table 4.3.5-1. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
EM-1954	December 26-27-2010	February 4, 2011	Snow: Severe Winter Storm and Snowstorm
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

Extreme Temperature Events

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

- Cold/Wind Chill is reported in the NOAA-NCEI database when a period of low temperatures or wind chill temperatures reach or exceed locally or regionally defined advisory conditions (typical value is -18 °F or colder).
- Excessive Heat is reported in the NOAA-NCEI database whenever heat index values meet or exceed locally or regionally established excessive heat warning thresholds.
- Extreme Cold/Wind Chill is reported in the NOAA-NCEI database when a period of extremely low temperatures or wind chill temperatures reaches or exceeds locally or regionally defined warning criteria (typical value around -35 °F or colder).
- Heat is reported in the NOAA-NCEI database whenever heat index values meet or exceed locally or regionally established advisory thresholds.

Extreme temperature events that have impacted Essex County between 2014 and 2019 are identified in Table 5.4.5-2. Please see Section 9 (Jurisdictional Annexes) for available information regarding impacts and losses to each municipality.

Table 4.3.5-2. Extreme Temperature Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
August 12-13, 2016	Excessive Heat	N/A	N/A	High pressure over the western Atlantic Ocean ushered in hot and humid air northward across the area. On August 12, hot temperatures along with high humidity resulted in a heat index of 107 at Newark International Airport at 4 pm and a heat index up to 105°F at Caldwell Airport. On August 13, hot temperatures along with high humidity resulted in a heat index of 108 at both Newark International Airport and Caldwell Airport.

Source: NOAA-NCEI 2019; NWS 2019
°F degrees Fahrenheit
N/A Not applicable
Note: With documentation for New Jersey and Essex County being so extensive, not all sources have been identified or researched; therefore, Table 4.3.5-2 may not include all events that have occurred or impacted the County.

Probability of Future Occurrences

It is anticipated that Essex County will continue to experience extreme temperatures annually that may coincide with or induce secondary hazards such as snow, hail, ice or wind storms, thunderstorms, drought, human health impacts, and utility failures. Table 5.4.6-5 shows the annual number of events, recurrence interval, annual probability, and annual percent chance of occurrence for the hazards associated with extreme temperatures and reported in the NOAA-NCEI Storm Events Database.

Based on these historical records and input from the Steering Committee and Planning Committee, the probability of occurrence for extreme temperatures in Essex County is considered "frequent". Refer to Section 4.4. (Hazard Ranking) for more information.

Table 4.3.5-3. Probability of Occurrences of Extreme Temperature Events

Hazard Type	Number of Occurrences Between 1950 and April 2019	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years)	Probability of event Occurring in Any Given Year	% Chance of Occurring in Any Given Year
Cold/Wind Chill	0	0	0	0	0
Excessive Heat	6	0.09	11. 7	0.09	8.6
Extreme Cold/Wind Chill	0	0	0	0	0
Heat	0	0	0	0	0
Total	**6**	**0.09**	**11. 7**	**0.09**	**8.6**

Source: NOAA-NCEI 2019
Note: Probability was calculated using the available data provided in the NOAA-NCDC storm events database.

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.

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (CATF 2013). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). According to a recent state-level analysis, by the middle of the 21st century an estimated 70 percent of summers in this region are anticipated to be hotter than what we now recognize as the warmest summer on record (NOAA NCEI 2019).

4.3.5.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and vulnerable. For the extreme temperature hazard, the entire County is exposed the following discusses Essex County's vulnerability, in a qualitative nature, to the extreme temperature hazard.

Impact on Life, Health and Safety

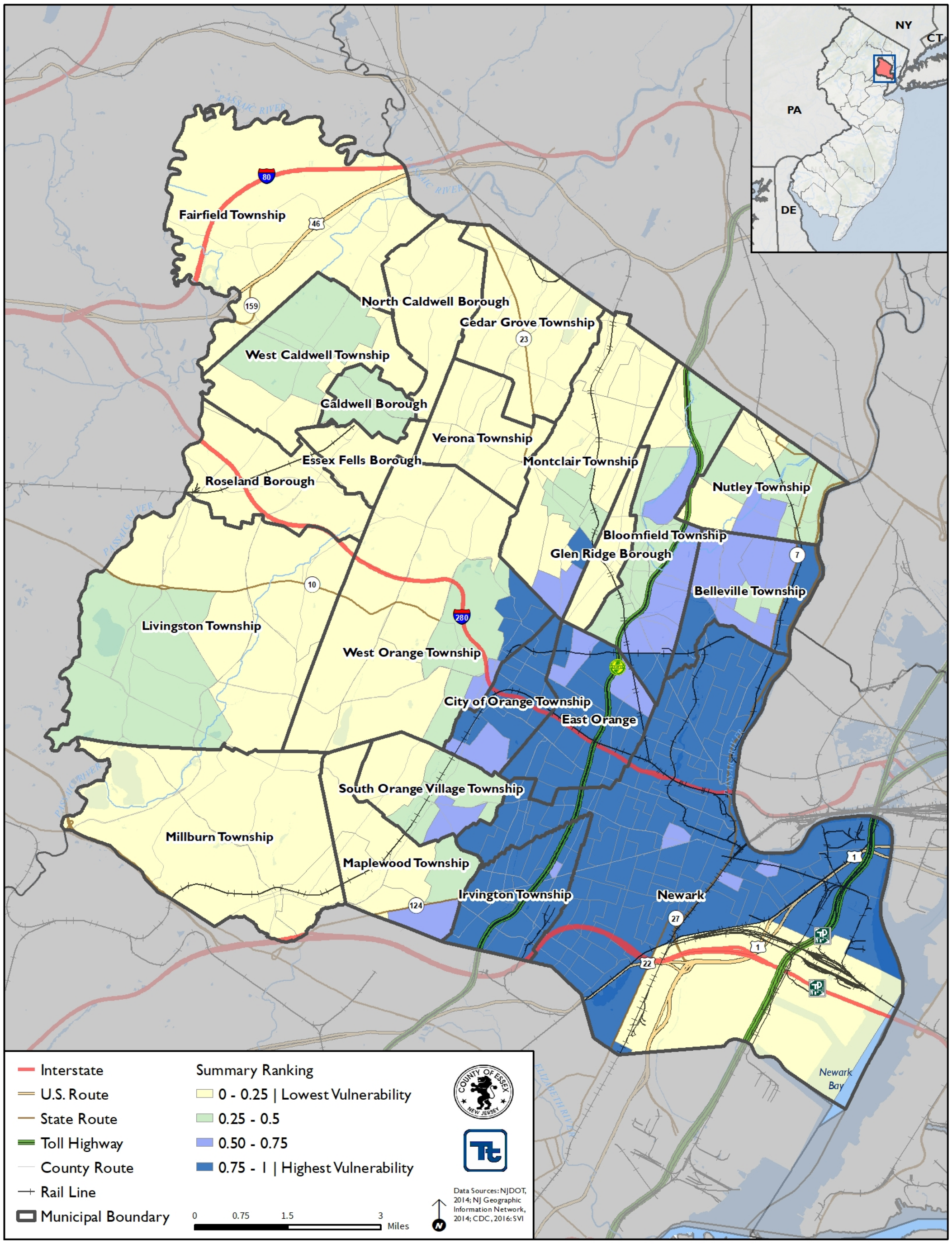
The entire population of Essex County is exposed to extreme temperature events (population of 800,401 people, according to the 2013-2017 American Community Survey population estimates). Extreme temperature events have potential health impacts including injury and death. According to the Centers for Disease Control and Prevention (CDC), populations most at risk to extreme cold and heat events include the following: 1) the elderly, who are less able to withstand temperatures extremes due to their age, health conditions, and limited mobility to access shelters; 2) infants and children up to four years of age; 3) individuals with chronic medical conditions (e.g., heart disease, high blood pressure), 4) low-income persons that cannot afford proper heating and cooling; and 5) the general public who may overexert during work or exercise during extreme heat events or experience hypothermia during extreme cold events (CDC 2016).

In Essex County, each municipality has areas of high concentration of elderly population (over 100 persons per square mile) with higher concentrations located in the more urban, densely populated areas of the County. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of populations over 65 in Essex County.

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 Essex County, areas with the highest concentration of population below the poverty level are located around the Cities of East Orange and Newark and Townships of Irvington and Orange. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of low-income populations in Essex County.

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. Census tracts throughout the Cities of East Orange and Newark and the Townships of Irvington and Orange have been ranked in the highest vulnerability category with values between 0.75 and 1.0; Census tract 92 in the City of Newark has the highest social vulnerability with a ranking of 1.0. These Census tracts in these communities might be more susceptible to impacts from extreme temperatures. Figure 4.3.5-4 below displays the CDC 2016 SVI.

Figure 4.3.5-4. CDC's Social Vulnerability Index 2016



Risk of structural fire in the winter months is elevated, although winter home fires only account for 8 percent of fires within the U.S., approximately 30 percent of all fire deaths occur in the winter months. Cooking, and heat sources too close to combustible materials are leading factors in winter home fires (U.S. Fire Administration 2018). Often times, power outages occur during extreme cold events. Individuals powering their homes with generators are subjected to carbon monoxide poisoning if proper ventilation procedures are not followed. Improperly connected portable generators are capable of 'back feeding' power lines which may cause injury or death to utility works attempting to restore power and may damage house wiring and/or generators (NJOEM 2019).

Meteorologists can accurately forecast extreme heat and cold event development and the severity of the associated conditions with several days of lead time. These forecasts provide an opportunity for public health and other officials to notify vulnerable populations, implement short-term emergency response actions, and focus on surveillance and relief efforts on those at greatest risk. Adhering to extreme temperature warnings can significantly reduce the risk of temperature-related deaths.

Impact on General Building Stock

All buildings are exposed to the extreme temperature hazard. Refer to Section 3 (County Profile), which summarizes the building inventory in Essex County. Extreme heat generally does not impact buildings; however, elevated summer temperatures increase the energy demand for cooling. Losses can be associated with the overheating of heating, ventilation, and air conditioning (HVAC) systems. Extreme cold temperature events can damage buildings through freezing/bursting pipes and freeze/thaw cycles, as well as increasing vulnerability to home fires. Additionally, manufactured homes (mobile homes) and antiquated or poorly constructed facilities can have inadequate capabilities to withstand extreme temperatures.

Impact on Critical Facilities

All critical facilities in the County are exposed to the extreme temperature hazard. Impacts to critical facilities that are buildings are the same as described for general building stock. Additionally, it is essential that critical facilities remain operational during natural hazard events. Extreme heat events can sometimes cause short periods of utility failures, commonly referred to as *brown-outs*, due to increased usage from air conditioners and other energy-intensive appliances. Similarly, heavy snowfall and ice storms, associated with extreme cold temperature events, can cause power interruption. Backup power is recommended for critical facilities and infrastructure.

In 2019, the North Jersey Transportation Planning Authority (NJTPA) released a report for the Passaic River Basin that discusses climate change including extreme heat and impacts to transportation infrastructure. Impacts associated with extreme heat events on bridges, culverts, facilities, rail, roads and transit rolling sock include stress, sagging, thermal expansion and system failure. Refer to the NJTPA study which assessed the level of vulnerability (as measured by criticality, sensitivity and adaptive capacity) of transportation assets in the Passaic River Basin which includes portions of Essex County (NJTPA 2019).

Impact on Economy

Extreme temperature events also have impacts on the economy, including loss of business function and damage to and loss of inventory. Business-owners can be faced with increased financial burdens due to unexpected repairs caused to the building (e.g., pipes bursting), higher than normal utility bills, or business interruption due to power failure (i.e., loss of electricity, telecommunications). Disruptions in public transportation service will also impact the economy for both commuters and customers alike.

Extreme temperature events can impact agriculture yields. Based on information from the 2017 Census of Agriculture, 22 farms were present in Essex County, encompassing 191 acres of total farmland. The total market value of agricultural products from Essex County farms was withheld to avoid disclosing data for individual farms. The 2017 Census indicated that 11 farm operators reported farming as their primary occupation (USDA 2017).

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 and Change in Population

The ability of new development to withstand extreme temperature impacts lies in sound land use practices, building design considerations (e.g. Leadership in Energy and Environmental Design [LEED]), and consistent enforcement of codes and regulations for new construction. New development will change the landscape where buildings, roads, and other infrastructure potentially 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 forming (heat islands as described above). Specific areas of recent and new development are indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 (Jurisdictional Annexes) of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population increases in less densely populated areas of the County may require utility system upgrades to keep up with utility demands (e.g., water, electric) during extreme temperature events to prevent increased stresses on these systems. NJTPA includes high population growth forecasts as one criterion to prioritize transportation adaptation strategies. Refer to Section 3 (County Profile) for a detailed discussion on population change in Essex County.

Climate Change

As discussed above, most studies project that the State of New Jersey will see an increase in average annual temperatures. As the climate warms, extreme cold events might decrease in frequency, while extreme heat events might increase in frequency; the shift in temperatures could also result in hotter extreme heat events. With increased temperatures, vulnerable populations could face increased vulnerability to extreme heat and its associated illnesses, such as heatstroke and cardiovascular and kidney disease. Additionally, as temperatures rise, more buildings, facilities, and infrastructure systems may exceed their ability to cope with the heat.

Change of Vulnerability Since the 2015 HMP

Overall, the entire County remains vulnerable to extreme temperatures. As existing development and infrastructure continue to age, they can be at increased risk to failed utility and transportation systems if they are not properly maintained and do not adapt to the changing environment.

4.3.6 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 Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Storm surge is now discussed in Section 4.3.2 - Coastal Storm.
- The discussion of urban flooding has been expanded.
- Previous events between 2014 and 2019 are listed with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).
- The 2007 effective Essex County FEMA Digital Flood Insurance Rate Map (DFIRM) with a Letter of Map Revision (LOMR) dated December 2018 and the preliminary Essex County FEMA DFIRMs dated May 2014 and June 2017 were used to evaluate exposure and determine potential future losses. Additionally, FEMA released coastal Risk Map products in May 2017, and riverine Risk Map products for the Hackensack-Passaic Watershed in September 2018 which were incorporated into the flood depth grid and imported into the HAZUS-MH flood model.
- An updated version of the HAZUS-MH flood model was used to estimate potential losses version 4.2.
- A repetitive loss area analysis was conducted.

4.3.6.1 Profile

Hazard Description

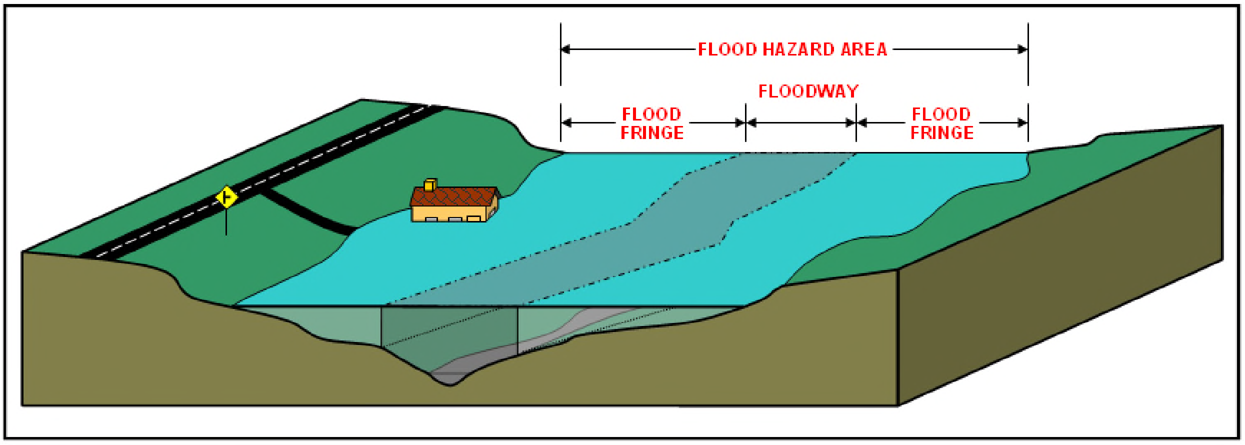
A flood is the inundation of normally dry land resulting from the rising and overflowing of a body of water. They can develop slowly over a period of days or develop quickly, with disastrous effects that can be local (impacting a neighborhood or community) or regional (affecting entire river basins, 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 Essex County are riverine (inland) flooding, coastal flooding from tidally-influenced rivers and flooding as a result of a dam failure. In addition, Essex 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 Essex County, floodplains line the rivers and streams of the County and the coastal areas. The boundaries of the floodplains are altered as a result of changes in land use, the amount of impervious surface, placement of obstructing structures in floodways, changes in precipitation and runoff patterns, improvements in technology for measuring topographic features, and utilization of different hydrologic modeling techniques. Figure 4.3.6-1 depicts the flood hazard area, the flood fringe, and the floodway areas of a floodplain.

Figure 4.3.6-1. Floodplain



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

Dam Failure

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 2018a).

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).

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.

Location

Flooding potential is influenced by climatology, meteorology and topography. Extensive development, such as that seen in Essex County, also 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.

According to the 2017 preliminary FEMA Flood Insurance Study and the 2007 effective FEMA Flood Insurance Study, flooding in Essex County is caused by coastal flooding, (discussed in Section 4.3.2 – Coastal Storm), riverine flooding, and heavy rainfall events.

Riverine flooding takes place in low-lying areas adjacent to Essex County's rivers and brooks. The 2007 FEMA Flood Insurance Study identifies the following waterways as sources of riverine flooding: Passaic River and its tributaries, Second River and its tributaries, Third River, Peckman River, Nishuane Brooke, Pompton River, Toneys Brook, Canoe Brook, Slough Brook, Rahway River, East Branch Rahway River, West Branch Rahway River, Elizabeth River, Crooked Brook, Lightning Brook, Taylor Brook, Great Hills Brook, Wigwam Brook, Foulerton's Brook, North Branch Foulerton's Brook, Pine Brook, Green Brook, and Kane Brook.

For additional information on flood prone areas in each municipality, refer to Section 9 (Jurisdictional Annexes).

There are numerous flood control measures in place to alter the flooding hazard within Essex County (FEMA 2017). In addition to cleaning and repair initiatives, these measures include:

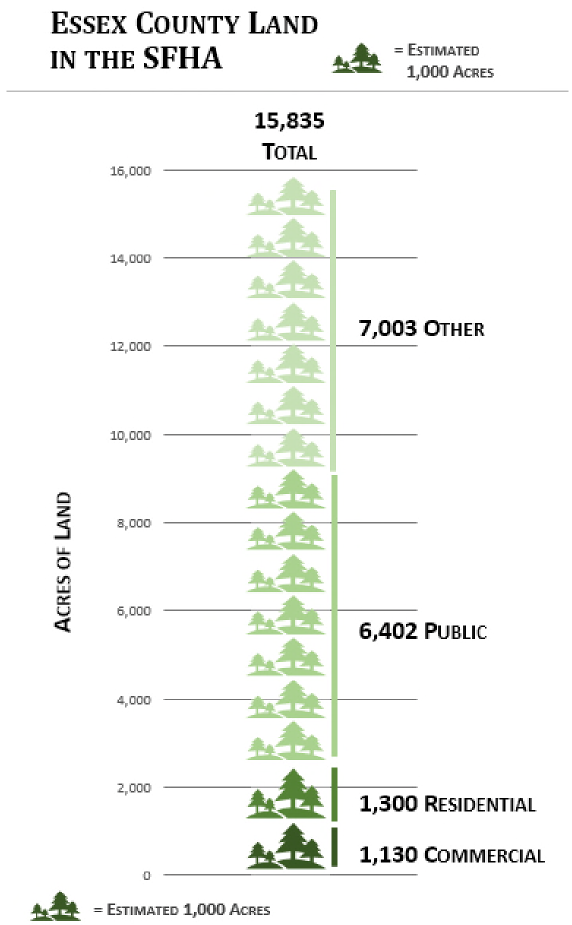
- The Township of Belleville has been granted funds through the Hazard Mitigation Grant Program (HMGP) to fund the installation of a system of values within the existing 17 outfalls from Main Street to the Passaic River.
- Almost the entire length of Nishuane Brook in the City of East Orange was constructed to include concrete sidewalls and inverts. Culverts have also been installed at all the street crossings. These improvements, designed to contain the 2-percent-annual-chance flood, were not enough to prevent some local flooding during the August 1973 storm.
- The Township of Irvington has a flume which was constructed in 1933 along the Elizabeth River. The flume varies from 6 to 10 feet (ft). deep with widths from 20 to 30 ft. A double culvert was built to accommodate the Garden State Parkway.
- Improvements by the Township of Livingston along Canoe Brook, including a new concrete lined channel to improve flow conditions and prevent bank erosion upstream of Cedar Street, were constructed in 1972. In the section between Serbrooke Parkway and East Mount Pleasant Avenue (State Route 10), a concrete lining was created to prevent erosion of the bank slopes, and concrete grade beams were placed across the bottom of the channel to reduce erosion of the streambed. Upstream of Slough Brook, along West Northfield Road, a channel was protected from erosion by lining the bank slopes with riprap.

  During the early 1930s, the Works Progress Administration constructed mortar rubble masonry walls along the East Branch of the Rahway River, from the Jefferson Avenue Bridge to a point approximately 750 ft. downstream from the Baker Street Bridge in the Township of Maplewood. The purpose of this work was to protect the banks of the river and to prevent erosion.
- In the Township of Millburn some of the brooks have paved or piped sections that may aid in reducing channel obstructions and a section of the West Branch Rahway River is channelized although these improvements were not made specifically for flood control.
- The Memorial Park Retention Basin on the Second River in the Township of Montclair was modified around 1950 to provide storage for approximately 357,000 cubic ft. of floodwater.

- An overall Rahway River Flood Control Project was authorized by the Flood Control Act of October 27, 1965. The flood area for which protection is being provided consists of approximately 70 acres on the left and right banks of the East Branch Rahway River. The improvement is designed to protect the area against an overflow of the East Branch Rahway River with a frequency of occurrence of once in 100 years. The improvement is essentially a channel enlargement project, which provides for clearing and excavation for a length of about 7,000 ft. Generally, the project consists of concrete walls, levees, a flume, drainage structures, replacement of four bridges, and miscellaneous changes to existing utilities. The upstream limit of the project is the upstream corporate limits of the Township of South Orange Village and the downstream limit is approximately 800 ft. upstream of the Erie-Lackawanna Railroad spur, about 1,400 ft. below Third Street.

  The area around the Township of South Orange Village water-pumping plant and the service building has been previously flooded and will still be susceptible to future flooding when the upstream channel is completed. Installing flashboards at the doors and windows has temporarily protected the pumping station, and valuable equipment within the service building has been raised above flood levels.
- The East and West Forks of East Branch Rahway River have had channel improvements along substantial lengths.
- No levee type structures exist within Essex County.

Exhibit 4.3.6-1



Floodplains

The Digital Flood Insurance Rate Map (DFIRM) data provided by FEMA for Essex County show the following flood hazard areas:

- 1-Percent Annual Chance Flood Hazard: Areas subject to inundation by the 1-percent-annual-chance flood event. This includes Zone AE and Zone VE. This is also referred to as the Special Flood Hazard Area (SFHA). Mandatory flood insurance requirements and floodplain management standards apply.
- 0.2-Percent Annual Chance Flood Hazard: Area of minimal flood hazard, usually depicted on FIRMs as the 500-year flood level or Shaded X Zone.

Locations of flood zones in Essex County as depicted on the FEMA 2007 effective DFIRM (last LOMR in 2018), preliminary 2014 and 2017 DFIRMs are illustrated in Figure 4.3.6-2 and the total land area in the floodplain, inclusive of waterbodies, is summarized in Table 4.3.6-1.

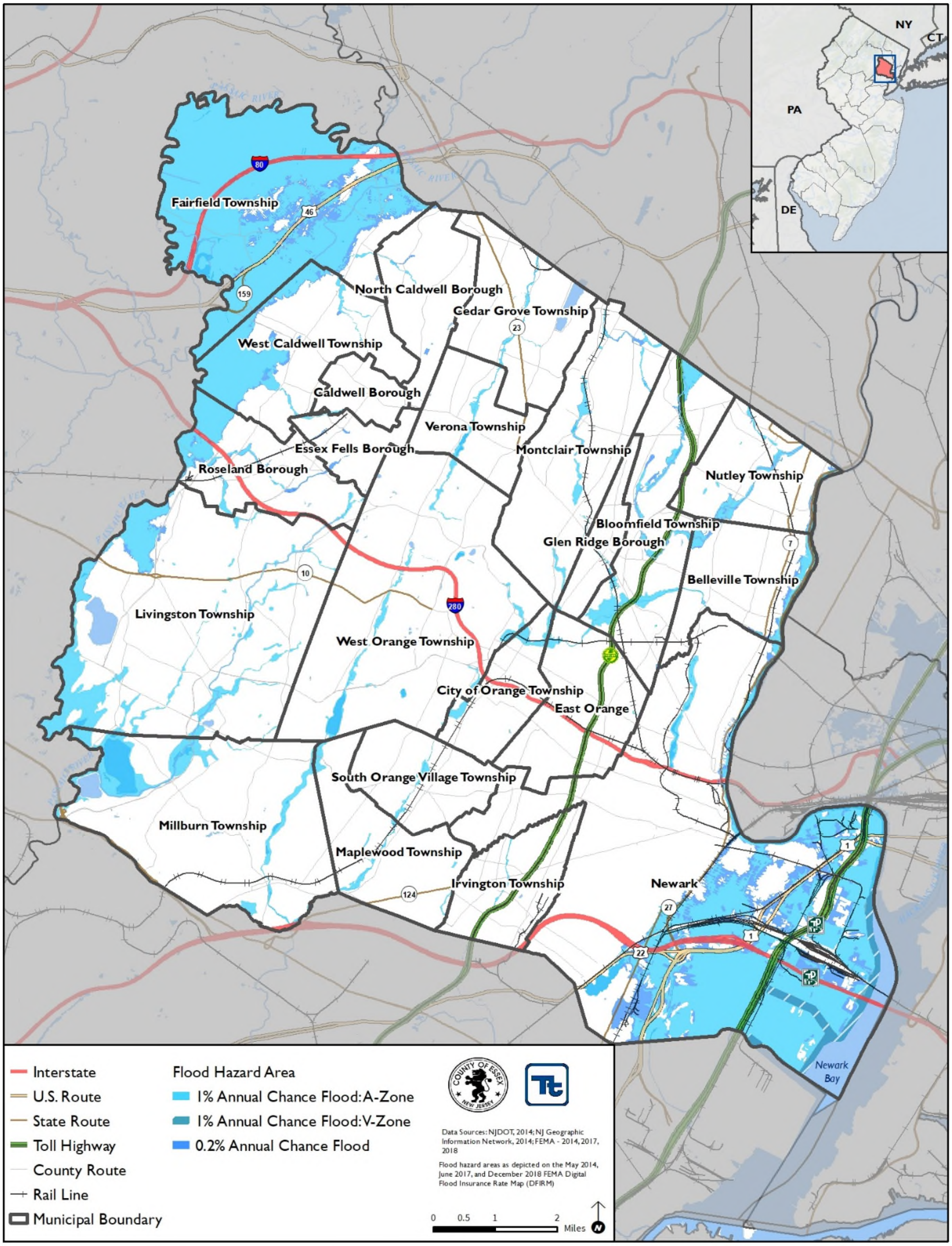
Table 4.3.6-1. Total Land Area in the 1-Percent and 0.2-Percent Annual Chance Flood Zones (Acres)

Municipality	Total Area (acres)	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area	
		A-Zone Area (acres)	% of Total	V-Zone Area (acres)	% of Total	Area (acres)	% of Total
Township of Belleville	2,156	200	9.3%	0	0.0%	270	12.5%
Township of Bloomfield	3,434	390	11.3%	0	0.0%	440	12.8%
Borough of Caldwell	759	6	0.8%	0	0.0%	7	0.9%
Township of Cedar Grove	2,791	47	1.7%	0	0.0%	47	1.7%
City of East Orange	2,514	42	1.7%	0	0.0%	42	1.7%
Borough of Essex Fells	906	9	1.0%	0	0.0%	26	2.8%
Township of Fairfield	6,618	5,374	81.2%	0	0.0%	5,982	90.4%
Borough of Glen Ridge	818	15	1.8%	0	0.0%	16	1.9%
Township of Irvington	1,866	23	1.2%	0	0.0%	23	1.2%
Township of Livingston	9,040	1,257	13.9%	0	0.0%	1,312	14.5%
Township of Maplewood	2,480	116	4.7%	0	0.0%	116	4.7%
Township of Millburn	6,324	816	12.9%	0	0.0%	816	12.9%
Township of Montclair	3,995	150	3.8%	0	0.0%	179	4.5%
City of Newark	16,778	4,938	29.4%	398	2.4%	6,734	40.1%
Borough of North Caldwell	1,968	24	1.2%	0	0.0%	38	1.9%
Township of Nutley	2,186	163	7.4%	0	0.0%	209	9.6%
City of Orange Township	1,418	115	8.1%	0	0.0%	115	8.1%
Borough of Roseland	2,361	463	19.6%	0	0.0%	528	22.4%
Township of South Orange Village	1,822	43	2.4%	0	0.0%	43	2.4%
Township of Verona	1,796	65	3.6%	0	0.0%	65	3.6%
Township of West Caldwell	3,239	897	27.7%	0	0.0%	897	27.7%
Township of West Orange	7,756	285	3.7%	0	0.0%	395	5.1%
Essex County (Total)	**83,023**	**15,437**	**18.6%**	**398**	**0.5%**	**18,297**	**22.0%**

Source: FEMA 2014, 2017, 2018
Note: % = Percent
The area presented includes the total area of the municipality, which may include waterways.

The most extensive areas of the 1-percent annual chance floodplains extend along the Passaic River through much of the Passaic Meadows Complex in Fairfield, West Caldwell and Roseland. In southwestern Essex County, extensive 1/2- to 1-mile-wide floodplains exist in the vicinity of Slough and Canoe Brooks in Millburn Township and near Willow Brook in Livingston. In eastern Essex County, much of Lower Newark City is within the Floodplain of Newark Bay. Other larger floodplains are identified along the West Branch of the Rahway River, and along Second River, Wigwam Brook, and Third River in northeastern Essex County (Essex County Environmental Resource Inventory 2007).

Figure 4.3.6-2. FEMA Flood Hazard Areas in Essex County



Flood Insurance Study (FIS)

The following discussion presents flood information as directly provided in the FEMA FIS document(s) (FEMA 2007, FEMA 2017). The FIS also included dates of historic flood events, which will also be included in this section.

- *Township of Belleville* – The Township of Belleville is subject to flooding from the Passaic River, the Second River, and the Third River. All three flooding sources flow in well-defined channels with flooding occurring in adjacent low-lying areas. Flooding is generally the result of heavy rainfall produced by hurricanes moving up the Atlantic coastline, large frontal storms from the west and south, and local thunderstorms. Frequent flooding is also known to occur along the Third River between Fairway Avenue and Joralemon Street.

  Historic floods occurred in 1902, 1903, 1936, and 1945. The 1903 flood had an estimated peak discharge of 39,800 cubic feet per second (cfs) and estimated 1% annual chance frequency at the confluence of the Passaic River and Newark Bay. The floods inundated large areas, causing damage to buildings and disruption of transportation and utility lines.

- *Township of Bloomfield* – The Township of Bloomfield is subject to flooding from the Passaic River and the Second River. The flooding along the streams within the corporate limits to attributed mainly to backwater created by inadequate storm drains and culverts, clogged bridges, or shallow stream beds. Most of the lands adjacent to the rivers in the Township are affected by flooding, with the exception of the Third River section between John F. Kennedy Drive and Maple Street, where natural high riverbeds combined with natural high grounds confine floodwater to the channel. There are several other areas throughout the Township that experience flooding due to inadequate storm drainage systems. Historic floods in the Township occurred in May 1968, August and September 1971, and February 1973.

- *Township of Cedar Grove* - The Township of Cedar Grove is subject to flooding from the Peckman River and its tributaries. All flooding sources flow in well-defined channels with flooding occurring in adjacent low-lying areas. Flooding occurs along the Peckman River and its tributaries during times of excessive and prolonged rainfall, particularly in residential areas having steep slopes. This flooding is the result of high runoff combined with insufficient carrying capacity of bridge openings and culverts.

- *City of East Orange* - The flooding problem along the channel of the Second River Tributary in the City of East Orange has long been recognized and studied. The first comprehensive report on flooding problems of Second River Tributary in 1940 was stimulated by the 1938 flood. This report contained a master plan for the improvement of Second River Tributary, setting channel slopes and improvements capable of carrying design flows with an expected frequency of 30 years.

  Nishuane Brook has some reported flooding problems at the Dodd Street and Thomas Boulevard crossings. Flood damages during the August 1971 storm (Hurricane Doria) consisted of damage to approximately a dozen homes between Dodd Street and Lake Street along Second River Tributary. No specific damages were reported for East Orange for the flood of August 1973, even though the reported magnitude of this flood was on the same order as that of the 1971 flood in East Orange.

  In addition to the problems outlined above, there is local flooding in East Orange caused by poor pipe drainage facilities along Summit Street and Melmore Gardens west of North Clinton Street, and at the street crossing at the railroad and Fourth Avenue.

- *Borough of Essex Fells* – Flooding within the Borough of Essex Fells usually occurs as a result of heavy rainfall from localized thunderstorms and hurricanes during the summer and fall months. Because of the low permeability of certain soils, the high degree of development, and the borough's inadequate storm sewers, some areas are subject to frequent flooding and ponding of surface water.

The basements of five houses along Devon Road and one house along Hawthorne Road in Essex Fells suffered considerable damage from flooding during Tropical Storm Doria in August 1971. The flood of August 2, 1973 had an 83-year recurrence interval measured at the nearest upstream gage (No. 01379500) to confluence with Passaic River, and had a less than 10-year recurrence interval measured at the nearest downstream gage (No. 01381900) at Pine Brook. The length of record of the upstream gage is from 1903 to 1911, and 1937 to the present, and the latter is from 1966 to the present. The flood of April 6-7, 1984, measured with the aforementioned gages, had a less than a 10-year recurrence interval upstream and a 44-year recurrence interval downstream. Floodwaters resulting from Hurricane Irene on August 29-30, 2011, measured at the same gages, had a recurrence interval of 16 years upstream and 22 years downstream.

- *Township of Fairfield* – The low-lying area of the wide floodplain of the Passaic River comprises much of the Township of Fairfield and forms a large natural storage area. Floodwaters from the Pompton River enter this storage area from the north near the Two Bridges area. During large floods, Beatties Dam, which is located above Little Falls, constricts the river section enough to cause floodwaters from the Pompton River to enter the Passaic River, flowing in both an upstream and downstream direction at the point where the two rivers join (Richard P. Browne Associates, 1975 and 1976). The storage area thus contains flows from the Passaic River and the Pompton River.

  The flood peaks from the Pompton River are reduced and retarded somewhat due to the lake and reservoir storage on the northern upland tributaries and the valley storage between Pompton Lakes and Two Bridges. According to a USACE analysis, the Pompton River peak reaches the Passaic River approximately 12 to 18 hours before the Passaic River peaks. The southern upland tributaries of the Passaic River are as precipitous as the northern tributaries, but they join the Passaic River at widely separated points which results in desynchronization of their peaks. They are greatly affected by the large valley storage in the lower reaches and are, therefore, low flood producers into the Passaic River floodplains.

- *Borough of Glen Ridge* - Toneys Brook is contained in a deep gorge formed by the railroad embankment and Bloomfield Avenue. The gorge runs from a point upstream of Hillside Avenue to a point behind the Parkway Apartments. Downstream of Hillside Avenue, a limited amount of homes and businesses have experienced minor flooding.

- *Township of Irvington* - The two major sources of flooding in the Township of Irvington are the Elizabeth River and inadequate internal drainage. During the August 2, 1973, (40-year recurrence interval, based upon frequency discharge curve for the Elizabeth River at Hillside) storm there was severe flooding throughout the township with many streets being impassable. During the August 17, 1974, (10-percent-annual-chance recurrence interval, based upon frequency discharge curve for the Elizabeth River at Hillside) storm and during Hurricane Doria (2-percent-annual-chance recurrence interval, based upon frequency discharge curve for the Elizabeth River at Hillside) in 1971, the township was declared a flood disaster area.

  Additional flooding due to inadequate internal drainage has occurred in several areas of Irvington located in the vicinity of Durand Place and Wagner Place, Isabella Avenue and Delmar Place, Augusta Street and Ball Street, and Chestnut Avenue.

- *Township of Livingston* - The Livingston area is subject to frequent rainfalls of great intensity and varying origin. The rainfall may be from local thunderstorms, hurricanes, storms originating over the Atlantic Ocean, or storms coming from the mainland. High intensity, short duration storms tend to cause flooding of the smaller drainage basins of the Township. Lower intensity, longer duration storms are more troublesome to the waterways with larger tributary areas, such as Canoe Brook and the Passaic River.

The Township of Livingston is highly developed, with buildings and paved areas covering a significant portion of the land area and effectively reducing the amount of land available to absorb precipitation. Throughout most of the Township, the surface soil has a relatively low permeability, although there are a few local deposits of sand and gravel. In general, the slope of the terrain varies from 1 percent to 10 percent throughout most of the Township. The low permeability of the soil, the steep slope of the terrain, and the high degree of development in Livingston all contribute to relatively high amounts of runoff, especially from the high intensity storms experienced on the east coast of the United States. The runoff is carried in open waterways to the Passaic River. The present problems due to storm water runoff are principally related to high velocity flow, channel erosion (particularly in upstream areas), and subsequent depositions of rock and silt in the downstream portions of the brooks.

Local flooding in Livingston is generally due to inadequate storm sewers, high-water elevations in the streams to which the storm sewers discharge, or blockages, such as silting of the stream channel at the point of discharge from a storm sewer. In addition to causing silting and blockage of the stream channel, the erosion caused by the high velocities also undermines the embankments of the streams and affects the adjacent land area. This type of damage is caused not only by severe floods but also by the cumulative effects of lesser, but more frequent storms.

The downstream portions of Canoe Brook and Slough Brook, as well as the land area bordering the Passaic River, are greatly influenced by high-water levels in the Passaic River. A historic flood in Livingston in the Passaic River Basin occurred during October 1903; however, because of the low level of development at that time, damages were not too severe. The storm of October 1903 was centered over Paterson, where a total of 15.5 inches of rainfall was recorded.

A review of the great storms which have occurred in the northeastern states reveals that the Rahway River and its tributaries are located in the North Atlantic storm belt. Under extremely intensive and prolonged rains, the East Branch Rahway River; its tributary, Crooked Brook; and Lightning Brook, a tributary of the Elizabeth River, overflow their banks in the Township of Maplewood. Also, some bridges over East Branch Rahway River are topped by floodwaters, thus making roads impassable.

- *Township of Maplewood* - At the time the FIS for the Township of Maplewood was published, local flooding was due mainly to poor drainage. The storm sewer system was originally designed for 5- to 10-percent-annual-chance storms and the storm sewer could not accommodate rainfall resulting from the 1-percent-annual-chance storm.

  The Township of Maplewood has sustained damages from floods that have occurred in the past, with the historic floods occurring during July 1901, February 1902, October 1903, August 1927, July 1938, August 1955, September 1971, and August 2, 1973. The damaging storms occurred in Maplewood during the floods of August 2, 1973, and July 1938. The historic flooding occurred during the storm of October 1903; however, because of the absence of development in the community, damages were not as great as those caused by the August 2, 1973 flood.

- *Township of Montclair* - Flooding along the streams within the Township of Montclair is mainly caused by backwater that is created by inadequate pipes, box culverts, and bridges clogged by deposits of silt and debris. Shallow, rocky streambeds and heavy brush cover on overbanks also limit effective flow areas.

The adjacent land area for the streams studied in detail in Montclair is affected by heavy rainfall, with the exception of a few areas where the channel is relatively wide, and the banks are well stabilized. There are several other areas in the township, which, although not adjacent to a body of water, experience flooding due to an inadequate storm water drainage system.

Montclair has sustained damages from past floods. The significant floods occurred during May 1968, August and September 1971, and on February 2, 1973. Floodwaters caused disruption in traffic, inundation of streets, interruption of businesses, danger to life, and flooding of homes.

- *City of Newark* - The City of Newark is subject to tidal flooding from the Passaic River and Newark Bay with VE zones located along the waterfront (FEMA FIS 2017). Most of the flood problems occur in the south and eastwardly (Ironbound Section) adjacent to U.S. Route 22 and Frelinghuysen Avenue. Flooding always occurs when an annual peak rainfall coincides with a high tide in Newark Bay. This area is susceptible to flooding because of its flat topography and low elevations.

  A historic tide record was obtained in Newark during the October 1903 flood. The largest flood on record occurred August 28, 1971, with a peak discharge of approximately 6,500 cfs recorded at the USGS Second River at Belleville gage (no. 1392500). Due to drastic changes in urbanization over the gaging period a meaningful statistical return period could not be computed.

- *Borough of North Caldwell* – Due to the steep terrain through which it passes; the floodplain of Green Brook is confined and causes no major flood problems in the Borough.

- *Township of Nutley* - Flooding along the streams within the Township of Nutley is mainly attributable to backwater created by inadequate storm drains and culverts. Flooding that occurs from the culvert between Elm Street and Hillside Avenue on St. Pauls Branch is of particular concern to the township. The narrow, rocky channel and flat overbanks with heavy vegetation also contribute to the flooding problem. Even though some storms may last only a short period of time, heavy rainfall affects most of the adjacent land area along the streams within the community. Certain areas of River Road, which are parallel to the Passaic River, are subject to flooding during a rainstorm of high intensity.

  There are several other areas within the Township of Nutley that, although not adjacent to a body of water, experience flooding because the storm water drainage system is inadequate. Problems also occur due to flooding conditions in the Third River and St. Pauls Branch, causing backwater in the storm drainage system. Another source of flooding is sanitary sewer backup due to excessive infiltration of the storm waters into the sanitary sewer system.

- *City of Orange Township* – The floodplains of Wigwam Brook, the East Branch Rahway River, and the East Fork of East Branch Rahway River in the City of Orange Township have been encroached upon to the point where most of them are developed. This encroachment has caused flood problems and damage from storms with recurrence intervals of less than one year.

  The principal flood problems in the City of Orange Township are due to a combination of urbanization in the floodplain, manmade restrictions within the streams, and inadequate storm drainage. In a report prepared for the City of Orange Township and the Township of West Orange, it was determined that the approximate capacity of the East Fork of East Branch Rahway River between Forest Street and Central Avenue is only 90 cfs (Elson T. Killman Associates, Inc., 1977). The 1-percent-annual-chance flood at this location produces a flow of 560 cfs.

A significant flood along the East Fork of East Branch Rahway River occurred on August 28-29, 1971 (Tropical Storm Doria) and produced a discharge of 385 cfs at Mitchell Street (USACE, 1973). This discharge is equivalent to a flood with a recurrence interval of approximately 30 years. Flooding along Wigwam Brook is rather extensive throughout its length within the City of Orange Township corporate limits. Due to its highly developed floodplain, even minor flooding produces damage to residential and commercial structures.

- *Borough of Roseland* – Flooding within the Borough of Roseland occurs as a consequence of heavy rains usually resulting from localized thunderstorms and hurricanes during the summer and fall months. Due to the low permeability of certain soils, the high degree of development and less than adequate storm sewers in the borough, some areas are subject to frequent flooding and ponding of surface water. A damaging storm occurred on August 2, 1973, creating considerable overbank flooding along Passaic River, Foulerton's Brook, North Branch Foulerton's Brook, and Canoe Brook. This flood on Passaic River had an estimated return period of 83 years. Flooding associated with this storm caused traffic interruptions, property damage, siltation of streambeds, and erosion of embankments. Hurricane Irene on August 29-30, 2011, caused flooding on Passaic River and was estimated to have a 16-year return period.

  Problem flooding locations in Roseland identified at various times include area along Foulerton's Brook at Locust, Second, Third, and Fourth Avenues, all of which have experienced flooding during severe rainstorms. There are other areas along North Branch Foulerton's Brook at Gates, Mitchell, and Godfrey Avenues, Plymouth Place, Freeman Street, and Condit Court where overbank erosion occurred during the August 1973 storm.

- *Township of South Orange Village* – Due to the topography of the East Branch Rahway River, and the Township of South Orange Village's proximity to the headwaters of the river, flood peaks occur rapidly. The flood cycle usually lasts a matter of hours, and, in most cases, lasts less than a day. Local drainage area flooding in Township of South Orange Village follows the same pattern. The major flood damage has occurred in the business community, where the flood waters have entered first-floor levels of retail and service type establishments and businesses; in addition, flood damage has occurred to the basements of residences. Because the village is highly congested, even minor flooding causes damage to both public and private property and creates traffic hazards.

  The Rahway River and its tributaries are located in the North Atlantic Storm Belt and flooding of the East Branch Rahway River in South Orange occurs frequently. Overflow of the East Branch Rahway River causes a flood problem in the Township of South Orange Village, between the northern and southern boundaries of the village, for residential, commercial, industrial, and public facilities. The principal cause of the flooding is the inability of the existing channel to accommodate the precipitation runoff. This is partly due to bridge constrictions and low channel capacities caused by encroaching development.

  The Township of South Orange Village has sustained damages from floods; the historic floods occurred during July 1901, February 1902, October 1903, August 1927, July 1938, August 1955, May 1968, September 1971, and August 1973. The damaging storms on record occurred in South Orange during the floods of July 1938. The historic flooding occurred during the storm of October 1903; however, because of the absence of development in the community, damages were not as great as those that occurred during the August 1973 flood.

- *Township of Verona* – The Township is subject to flooding from the Peckman River and its tributaries. All flooding sources flow in well-defined channels, within adjacent low-lying areas. Flooding occurs during times of excessive and prolonged rainfall, particularly in residential areas having steep slopes. The flooding is a result of high runoff combined with insufficient carrying capacity of bridge openings and culverts.

- *Township of West Caldwell* - Flooding in West Caldwell is a result of heavy rainfall produced by hurricanes moving up the coast, large frontal storms from the west and south, and local thunderstorms. Historic floods affecting the Township of West Caldwell occurred in 1902, 1903, 1936, and 1945. The 1903 flood, with an estimated peak discharge of 39,800 cfs at the confluence of the Passaic River and Newark Bay, inundated large areas, causing damage to buildings and disruption of transportation and utility lines (New Jersey, 1974). A storm similar to the one which caused the flood of 1903 would result today in a significantly larger area of inundation and greater discharges, due to the increased percentage of impervious areas (New Jersey, 1973). Flooding has occurred in 1968 and 1971, resulting in estimated damages in excess of 1 million dollars in this locality.

  The Passaic River flows along the western boundary of West Caldwell. The low areas in West Caldwell, adjacent to the Passaic River, are subject to flooding. Areas subject to inundation include residential, commercial, and park lands. The low flat areas adjacent to Pine, Green, and Kane Brooks in the lower reaches are also subject to flooding.

- *Township of West Orange* – The Township has been affected by flooding in most of the low-lying areas located along the numerous open stream courses within its boundaries. Several other areas are also affected by flooding due to poor drainage. In 2010, the Township of West Orange passed 2274-10 An Ordinance Amending and Supplementing Chapter 25 Section 28 of the General Ordinances of the Town of West Orange, entitled "Steep Slope and Natural Features Ordinance" which amended the steep slope ordinance by placing additional restrictions of State open waters, wetlands, wetland transition areas, flood hazard areas, floodways and riparian zones. This amendment was warranted to prevent flooding, protect water quality, and preserve wildlife and aquatic habitat.

  A major flood area exists along the East Fork of the East Branch Rahway River in West Orange, east of Valley Road between Freeman Street and Kingsley Street. The flooding problem there, which is due to inadequate channel capacity, has been studied by the USACE (USACE, 1973). The upper portions of this stream are steeply sloped but as of the publication of the [date] countywide FIS report, requests have been made to the USACE and NJDEP to assess whether there is flood storage potential at golf courses and other open spaces as a part of the larger study underway to study flood mitigation alternatives in the Rahway River Basin.

  North Branch Wigwam Brook has had serious flooding problems in the vicinity of Harrison and Mississippi Avenues, and along most downstream parts of the improved channel. This is due to excessive velocity and lack of channel capacity, notably at Ashwood Terrace, Whittelsey Avenue, Watson Avenue, and Washington Avenue. South Branch Wigwam Brook has had serious flooding reported in the vicinity of Watchung Avenue, Lakeside Avenue, Standish Avenue, and Ashland Avenue.

  West Branch Rahway River has had flooding problems along its entire length from Northfield Avenue to Lake Vincent, although parts of this river flow through undeveloped or country club areas.

  Along Peckman River, flooding has occurred between Nicholas Avenue and Kenz Terrace.

  An area on the western boundary of the Township of West Orange known as the Merklin District is subject to frequent flooding due to inadequate pipe sewers and insufficient capacity of the existing storm water pumping station. The area flooded is centered between Hunterdon and Morris Roads and Westover and Tappan Terraces. The Mayfair District centered on Mayfair Drive in the north central part of the township is one such location plagued by flooding related to drainage issues. In this location flooding is caused by an inadequate storm water ejector system (Elson T. Killman Associates, Inc., 1972). The Township of West Orange has been moving forward with plans to undertake storm sewer improvements and in 2011 awarded construction contracts to begin the improvements to help alleviated flooding projects on several streets including Nestro Road, Midro Way, Mayfair Drive and Rosemont Terrace and Rosemont Drive. This project has been financed by a grant from the NJDEP and a loan from the New Jersey Environmental Infrastructure Trust.

Dam Failure

Table 4.3.6-2 lists the dams located in the County according to the National Performance of Dams Program (NPDP) database.

Table 4.3.6-2. Dams Located in Essex County

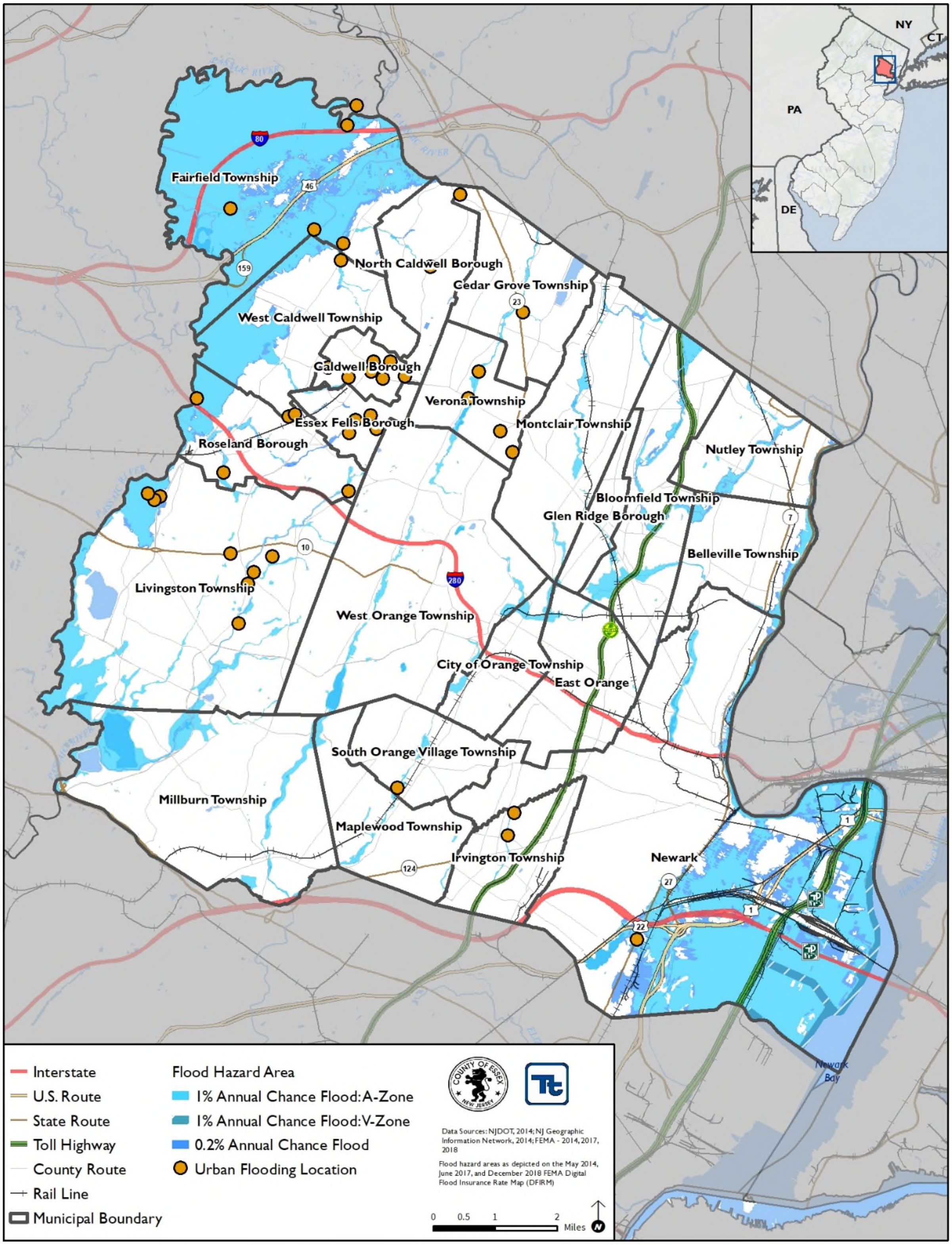
NPDP ID	Dam Name	Dam Type	Location	River	Dam Height (ft)	Dam Storage (acre-feet)
NJ00165	Canoe Brook Dam	Earth Gravity	East Orange	Passaic River	9	160
NJ00361	Orange Reservoir Dam	Earth Gravity	West Orange	West Branch of Rockaway River	34	245
NJ00386	Verona Lake Dam	Masonry	Verona	Peckman River	13	95
NJ00392	Cedar Grove West Res Dam	Earth Gravity	Cedar Grove	Offstream	55	2297
NJ00517	Campbells Pond Dam	Earth Gravity	Millburn	West Branch	18	21
NJ00525	Canoe Brook Reservoir #1 Dam	Earth Gravity	Millburn	Canoe Brook	25	3000
NJ00526	Canoe Brook Reservoir #2 Dam	Earth Gravity	Millburn	Canoe Brook - offstream	29	2200
NJ00527	Canoe Brook Reservoir #3 Dam	Earth Gravity	Livingston	Passaic River – offstream	57	6270
NJ00550	Canoe Brook Reservoir #3 Dike	Earth Gravity	Livingston	Canoe Brook – offstream	40	6000
NJS00031	Diamond Mill Pond Dam	N/A	N/A	N/A	N/A	N/A

Source: NPDP Multi-Attribute Dams Directory Query Summary, Date Unknown
N/A Not Available

Urban Flooding

Throughout Essex County, low-lying surface flooding and interior shallow ponding occurs as a result of heavy rainfall, and in some locations, this is accompanied by high tides. While riverine and coastal flooding is mapped by FEMA, urban flooding is not. Figure 4.3.6-3 illustrates the urban flood areas identified by the municipalities participating in the 2020 HMP update.

Figure 4.3.6-3. Urban Flood Areas Identified in Essex 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. 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 DEP 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. Essex County has 10 active USGS stream gages and one USGS tidal gage; 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.

Dam Failure

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.

A levee failure or breach causes flooding in landward areas adjacent to the structure. The failure of a levee or other flood protection structure could be devastating, depending on the level of flooding for which the structure is designed and the amount of landward development present. Large volumes of water may be moving at high velocities, potentially causing severe damage to buildings, infrastructure, trees, and other large objects. Levee failures are generally worse when they occur abruptly with little warning and result in deep, fast-moving water through highly developed areas.

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 off line 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.

Table 4.3.6-3 summarizes the number of dams and their hazard classifications in Essex County.

Table 4.3.6-3. Number of Dams by County in Essex County

High Hazard	Significant Hazard	Low Hazard	Other	Total
8	3	14	8	33

Source: NJDEP 2013

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with flooding throughout the State of New Jersey and Essex County; therefore, the loss and impact information for many events varies depending on the source. The accuracy of monetary figures discussed is based only on the available information in cited sources.

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2019, FEMA declared that the State of New Jersey experienced 43 flood-related disasters (DR) or emergencies (EM) classified as one or a combination of the following disaster types: hurricane, tropical storm, Nor'Easter, snowstorm, severe storms, flooding, inland and coastal flooding, coastal storm, high tides, heavy rain, and severe storms. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Essex County was included in 22 of these flood-related declarations; refer to Table 4.3.6-4.

Table 4.3.6-4. Flood-Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
DR-245	June 18, 1968	June 18, 1968	Flood: Heavy Rains & Flooding
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-402	August 7, 1973	August 7, 1973	Flood: Severe Storms & Flooding
DR-477	July 23, 1975	July 23, 1975	Flood: Heavy Rains, High Winds, Hail & Tornadoes
DR-701	March 28-April 8, 1984	April 12, 1984	Flood: Coastal Storms & Flooding
DR-973	December 10-17, 1992	December 18, 1992	Flood: Coastal Storm, High Tides, Heavy Rain, & Flooding
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane: Hurricane Floyd Emergency Declarations
DR-1295	September 16-18, 1999	September 18, 1999	Hurricane: Hurricane Floyd Major Disaster Declarations
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
DR 1588	April 1-3, 2005	April 19, 2005	Severe Storm(s): Severe Storms and Flooding
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s): Severe Storms and Inland and Coastal Flooding
DR-1897	March 12-April 15, 2010	April 2, 2010	Severe Storm(s): Severe Storms and Flooding
DR-1954	February 4, 2011	December 26-27, 2010	Snow: Severe Winter Storm and Snowstorm
EM-3332	August 26-September 5, 2011	August 27, 2011	Hurricane: Hurricane Irene
DR-4021	August 27-September 5, 2011	August 31, 2011	Hurricane: Hurricane Irene

Declaration	Event Date	Declaration Date	Event Description
DR-4048	October 29, 2011	November 30, 2011	Severe Storm(s): Severe Storm
EM-3354	October 26-November 8, 2012	October 28, 2012	Hurricane: Hurricane Sandy
DR-4086	October 26-November 8, 2012	October 31, 2012	Hurricane: Hurricane Sandy
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

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, Essex County was not included in any USDA declaration involving flooding.

The USDA crop loss data provide another indicator of the severity of previous events. Additionally, crop losses can have a significant impact on the economy by reducing produce sales and purchases. Such impacts may have long-term consequences, particularly if crop yields are low the following years as well. Between 2015 and 2019, Essex County did not report any crop losses due to flooding.

Flood Events

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.

For the 2020 HMP update, known flood events that have impacted Essex County between May 2014 and March 2019 are identified in Table 4.3.6-5. For events prior to May 2014, refer to the 2015 HMP.

Table 4.3.6-5. Flooding Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
April 29 – May 1, 2014	Heavy Rain	N/A	N/A		Rainfall totals in Essex County ranged from 2.36 inches in the Borough of Essex Fells to 5.36 inches at Newark Airport. Many roads in Newark were closed due to flooding. Lanes were closed along the New Jersey Turnpike in Newark as well.
May 23, 2014	Flash Flood	N/A	N/A	Newark, Silver Lake	A trough of low pressure slowly worked its way through the region, which caused isolated severe thunderstorms that produced large hail and flash flooding in portions of Northeast New Jersey. Route 21 southbound at 3rd Ave. in Newark was closed due to flooding. Numerous cars were trapped in flood waters and rescued on Route 21 near the viaduct in Newark.
June 9, 2014	Flash Flood	N/A	N/A	Newark	Showers and thunderstorms produced heavy rainfall which resulted in isolated flash flooding in Essex County. Multiple motorists were rescued from flood waters in Newark. A woman and her five children as well as two other adults were rescued at the Meeker Ave. underpass. Flood waters were even higher at the Freilinghuysen Ave. underpass and closed to traffic. Another woman was also rescued from flood waters at the intersection of Hawkins St. and Ferry Street.
June 13, 2014	Flash Flood	N/A	N/A	Livingston	An approaching cold front triggered a line of severe thunderstorms that produced heavy rain and resulted in flash flooding in portions of Northeast New Jersey. Route 10 was closed between Hillside Ave. and Livingston Ave. in Livingston due to flooding.
July 3, 2014	Flash Flood	N/A	N/A	Nutley	As a cold front slowly moved across the area, moisture from Tropical Cyclone Arthur passing to the south and east converged along the boundary resulting in severe thunderstorms, heavy rain and flash flooding in portions of Northeast New Jersey. Washington Ave. was closed due to flooding in Nutley.
August 31, 2014	Flash Flood	N/A	N/A	Newark, East Orange, Bloomfield	A very humid air mass combined with a passing surface trough to trigger numerous showers and thunderstorms, with embedded severe thunderstorms. Some of these storms produced very heavy rain which led to isolated flash flooding in Essex County. All exits in both directions on the Garden State Parkway in Newark, East Orange and Bloomfield were under water with a water rescue needed at the underpass at exit 147 southbound. A water rescue was also needed on Hoffman Ave. in East Orange after a car became trapped in flood waters.
December 9, 2014	Flood	N/A	N/A	East Newark	A coastal storm passed just south and east of the area causing strong winds and heavy rain with isolated flooding in portions of Northeast New Jersey. Passaic Ave. was closed between Central Ave. and Johnston Ave. in East Newark due to flooding.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
May 31, 2015	Flash Flood	N/A	N/A	Newark	A cold front approaching the area triggered scattered showers and thunderstorms that produced heavy rain leading to flash flooding across Northeast New Jersey. The intersection of Frelinghuysen Ave. and Meeker St. in Newark was closed due to severe flooding. Eleven people were rescued by the Newark EMS.
November 15, 2016	Flood	N/A	N/A	Bloomfield, Silver Lake	Low pressure moving north along the east coast of the United States resulted in a widespread 1-3 inch rainfall event across northeast New Jersey. Isolated flooding was observed across parts of Essex County, NJ as a result of this rainfall. Newark Airport received 2.79 inches of rain. John F. Kennedy Drive was closed in both directions due to flooding between Hoover Avenue and Belleville Avenue in Bloomfield. Watessing Avenue was closed due to flooding between Grove Street and Franklin Street in Bloomfield. NJ 21 was closed northbound at East 3rd Avenue due to flooding with all lanes detoured.
May 5, 2017	Flash Flood	N/A	N/A	Newark	A warm front approaching the area combined with a strong low level jet ushering in precipitable water values in excess of 1.5 inches, resulted in flash flooding across parts of northeast New Jersey. Newark Airport (3.05 inches) and Teterboro Airport (3.01 inches) received just over 3 inches of rain during the event, with the majority of that rain falling during a three hour period. Hourly rainfall rates of up to 1.5 inches were reported at Teterboro, with rates over one inch per hour at Newark. A vehicle was stuck in flood waters on Broadway in Newark with a water rescue in progress.
April 16, 2018	Flash Flood	N/A	N/A	Bloomfield, Newark	Heavy rainfall developed across the area on the morning of April 16th ahead of a slow moving warm front. This rain developed in an environment with precipitable water values greater than 1.25 inches, well above normal for mid April. Rainfall totals generally ranged from 2.5 to 4.5 inches across northeast New Jersey, with the majority of the rain falling in a 3-4 hour period. This resulted in flash flooding across the region. The Third River at Bloomfield rose above its flood stage of 6.0 feet at 10:05am EDT, crested at a height of 6.25 feet at 11:00am EDT, and fell back below flood stage at 11:50am EDT. The northbound lanes of US Route 1&9 were closed due to flooding at the Pulaski Skyway in Newark. Multiple cars were trapped in flood waters at the intersection of Adams Street and South Street in Newark with a water rescue conducted. At least six people were rescued from their cars due to flooding in the Ironbound District along the Passaic River. Cars were stranded due to flooding at the intersection of Frelinghuysen Avenue and Toler Place in Newark.
July 3, 2018	Flash Flood	N/A	N/A	Fairfield, Montclair	A surface trough developing out ahead of an approaching cold front initiated scattered afternoon showers and thunderstorms across northeast New Jersey. With very slow storm motions and precipitable water values rising from 1.5 to 2.0 inches, this resulted in isolated flash flooding across the region. The Caldwell, NJ ASOS reported 1.89 inches of precipitation, and a COOP observer in Harrison, NJ reported 1.00.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
					Gloria Lane was closed due to flooding in Fairfield. The Peckman River at Verona, NJ rose above its flood stage of 3.5 feet at 2:45pm EDT, crested at a height of 3.93 inches at 2:50pm EDT, and fell back below flood stage at 3:05pm EDT.
August 4, 2018	Flash Flood	N/A	N/A	Millburn	A developing area of low pressure along a surface trough helped produce heavy rainfall across parts of northeast New Jersey on the morning of August 4th that resulted in flash flooding. Rainfall amounts ranged from 1-3 inches in many places. Between the afternoon of August 3rd and the afternoon of August 4th, the Caldwell, NJ ASOS measured 2.75, and CoCoRaHS observers in Park Ridge and Hawthorne measured 2.90 and 2.95, respectively, with a CWOP station in Scotch Plains reporting 2.42. Old Short Hills Road was closed due to flooding in Millburn.
August 11, 2018	Flash Flood	N/A	N/A	Verona, Montclair, Caldwell, Bloomfield	A stalled stationary boundary within a very moist airmass provided a focusing mechanism for several rounds of heavy rain that resulted in widespread flash flooding across northeast New Jersey. The Caldwell, NJ ASOS recorded 4.92 inches of rain, and multiple other stations across northeast New Jersey received between 2.5 inches and 4 inches of precipitation. The Peckman River at Verona rose above its flood stage of 3.5 feet at 4:50pm EDT. The river continued to rise above its moderate flood stage of 4.0 feet (4:55pm EDT) and major flood stage of 5.0 feet (5:10pm EDT) before cresting at a height of 6.36 feet at 5:35pm EDT. The river fell back below flood stage at 6:50pm EDT. The crest of 6.36 feet was within about 0.2 feet of the record crest at this location of 6.6 feet. The Third River at Bloomfield rose above its flood stage of 6.0 feet at 6:40pm EDT, crested at a height of 7.15 feet at 7:40pm EDT, then fell back below flood stage at 9:30pm EDT. The intersection of Bloomfield Avenue and Ryerson Avenue in Caldwell was closed due to flooding. Flash flooding reported throughout the town of Verona. Flash flooding inundated portions of the Montclair Film Festival at 505 Bloomfield Avenue in Montclair. Both the cinema and education center were damaged when the current forced open doors to the building.
September 25, 2018	Flash Flood	N/A	N/A	Newark	Rain developed across the area ahead of an approaching warm front, consolidating into a slow-moving band of heavy rain across northeast New Jersey by late morning. Precipitable water values increased from 1.84 on the morning sounding from Upton, NY to 2.13 by evening. Both of these values are above the 90th percentile based on a sounding climatology, with the 2.13 precipitable water value on the evening of the 25th a record for the date. Rainfall amounts generally ranged from 3-5 inches, with one CoCoRaHS observer reporting 5.56 inches of rain in Palisades Park. All lanes closed on US Routes 1 & 9 in Newark approaching the Pulaski Skyway starting before Wilson Avenue due to flooding. This included the ramp from Routes 1

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
					& 9 north to the Turnpike toll plaza at interchange 15E. The local lanes of US Routes 1 & 9 were flooded northbound approaching Delancy Street in Newark.

Source: FEMA 2019; NCDC 2019; NWS 2019; SPC 2019; NJ HMP 2019; NHC 2019; NOAA 2019

Note: Not all events that have occurred in Essex 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

Essex County is expected to continue experiencing direct and indirect impacts of flooding in the future. Table 4.3.6-6 summarizes data regarding the probability of occurrences of flood events in Essex County based on the historic record. The information used to calculate the probability of occurrences is based solely on NOAA-NCEI storm events database results.

Table 4.3.6-6. Flood Events in Essex County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence	Recurrence Interval (in years)	Probability of Event Occurring in Any Given Year	Percent (%) Chance of Occurring in Any Given Year
Flash Flood	51	0.74	1.4	0.73	72.9
Flood	23	0.33	3.0	0.33	32.9
Total	**74**	**1.07**	**0.95**	**1**	**100**

Source: NOAA-NCEI 2019

Note: Not all events that have occurred in Essex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

K: Thousand

M: Million

There is minimal history of occurrence of dam and levee failure between 1950 and 2019. This suggests a low probability of future occurrence though the construction of new dam and levee structures could increase dam and levee failure risk. Likelihood of a dam failure in Essex County is difficult to predict. Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, and excessive rainfall and snowmelt. However, the risk of such an event increases for each dam as the dam's age increases or frequency of maintenance decreases. Additionally, future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration.

"Residual risk" to dams is risk that remains after implementation of safeguards. Residual risk to dams is associated with events beyond those that the facility was designed to withstand. However, probability of any type of dam failure is low in today's dam safety regulatory and oversight environment.

In Section 5.3, the identified hazards of concern for Essex 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 Steering and Planning Committees, the probability of occurrence for flood in the County is considered 'frequent'; refer to Section 4.4 – Hazard Ranking.

Climate Change Impacts

According to the NJDEP, New Jersey is experiencing increased intensity, frequency and duration of storm events (NJDEP 2019). Northern New Jersey's 1971-2000 precipitation average was over five inches (12-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). The heaviest 1% of daily rainfalls have increased by approximately 70% between 1958 and 2011 in the Northeast (Horton et al. 2015). Average annual precipitation is projected to increase in the region by four to 11-percent by the 2050s and five to 13-percent by the 2080s (New York City Panel on Climate Change [NPCC] 2015). Increased rainfall and heavy rainfalls increase the risk of flooding events.

Annual precipitation for New Jersey has been about 8 percent above average over the last 10 years. The number of extreme precipitation events has also been above average over the last 10 years. During 2010–2014, the state experienced the largest number of extreme precipitation events (days with more than 2 inches) compared to any other 5-year period, about 50 percent above the long-term average. Winter and spring precipitation is projected to increase for the 21st century; extreme precipitation is also projected to increase. The projections of increasing precipitation are characteristic of a large area of the Northern Hemisphere in the northern middle latitudes, as well as increases in heavy precipitation events. This may result in increased coastal and inland flooding risks throughout the state (NCEI 2019).

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.

Climate change may also lead to sea level rise which will lead to more frequent and extensive flooding. According to NJDEP, New Jersey will continue to experience sea level rise with projections estimating another 1 to 1.8 feet by the year 2050 (NJDEP 2019). See Section 4.3.1 (Coastal Erosion and Sea Leve Rise) for detailed information regarding sea level rise.

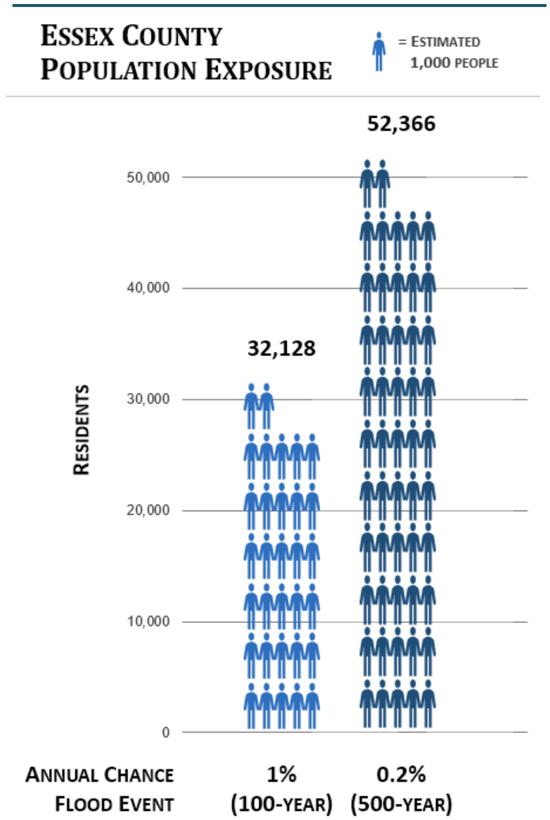
4.3.6.2 Vulnerability Assessment

To assess Essex County's risk to the flood hazard, a spatial analysis was conducted using the best available spatially-delineated flood hazard areas. 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-MH v4.2 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 adequate warning time is provided to residents. Exposure represents the population living in or near floodplain areas that could be impacted should a flood event occur. However, exposure is not be limited to only those who reside in a defined hazard zone, but all individuals who may be affected by the effects of a 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.

Exhibit 4.3.6-2. Population Exposure



Based on the spatial analysis, there are an estimated 32,128 people living in the Special Flood Hazard Area (SFHA, or 1-percent annual chance event floodplain) and an estimated 52,366 people located in the 0.2-percent annual chance flood event floodplain. These residents may be displaced due to their homes flooding, requiring them to seek temporary shelter with friends and family or in emergency shelters. The Township of Fairfield has the greatest percentage of its population located in the floodplain; approximately 56.7-percent and 82.7-percent for the 1-percent chance event and 0.2-percent chance event, respectively. The City of Newark has the greatest number of residents located in the floodplain; approximately 16,688 and 32,935 people located in the 1-percent chance event and 0.2-percent chance event floodplain boundaries, respectively. For this project, the potential population exposed is used as a guide for planning purposes.

Table 4.3.6-7. Estimated Population Exposed to the Flood Hazard

Municipality	Total Population	1-percent Annual Chance Flood Event		0.2-percent Annual Chance Flood Event	
		Number	% of Total	Number	% of Total
Township of Belleville	36,383	716	2.0%	1,606	4.4%
Township of Bloomfield	48,892	2,312	4.7%	2,534	5.2%
Borough of Caldwell	8,032	5	<1%	5	<1%
Township of Cedar Grove	12,638	29	<1%	29	<1%
City of East Orange	65,151	349	<1%	349	<1%
Borough of Essex Fells	2,095	0	0.0%	5	<1%

Municipality	Total Population	1-percent Annual Chance Flood Event		0.2-percent Annual Chance Flood Event	
		Number	% of Total	Number	% of Total
Township of Fairfield	7,671	4,346	56.7%	6,342	82.7%
Borough of Glen Ridge	7,668	102	1.3%	105	1.4%
Township of Irvington	54,715	263	<1%	263	<1%
Township of Livingston	29,955	617	2.1%	669	2.2%
Township of Maplewood	24,706	242	1.0%	242	1.0%
Township of Millburn	20,387	65	<1%	65	<1%
Township of Montclair	38,572	1,281	3.3%	1,500	3.9%
City of Newark	282,803	16,688	5.9%	32,935	11.6%
Borough of North Caldwell	6,637	19	<1%	51	<1%
Township of Nutley	28,829	810	2.8%	1,044	3.6%
City of Orange Township	30,731	2,648	8.6%	2,648	8.6%
Borough of Roseland	5,907	132	2.2%	277	4.7%
Township of South Orange Village	16,503	32	<1%	32	<1%
Township of Verona	13,585	110	<1%	110	<1%
Township of West Caldwell	10,932	132	1.2%	326	3.0%
Township of West Orange	47,609	1,230	2.6%	1,230	2.6%
Essex County (Total)	**800,401**	**32,128**	**4.0%**	**52,366**	**6.5%**

Sources: American Community Survey 5-year Estimate, 2017; FEMA, 2014/2017/2018

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. 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 flood event, and they may have more difficulty evacuating. Within the 1-percent annual chance event, there are approximately 3,423 people over the age of 65 and 4,634 people below the poverty level. These populations are all located within the SFHA. As for the 0.2-percent chance event, there are approximately 5,352 people over the age 65 and 8,059 people below the poverty level.

Using 2010 U.S. Census data, HAZUS-MH v4.2 estimates the potential sheltering needs as a result of a 1-percent annual chance flood event. For the 1-percent flood event, HAZUS-MH v4.2 estimates 33,068 people will be displaced, and 2,232 people will seek short-term sheltering. These statistics, by municipality, are presented in Table 4.3.6-8. 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 4.3.6-8. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	U.S. Census 2010 Population	1-Percent Annual Chance Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Township of Belleville	35,926	1,204	88
Township of Bloomfield	47,315	3,487	258
Borough of Caldwell	7,822	1	0
Township of Cedar Grove	12,411	105	3
City of East Orange	64,270	638	74
Borough of Essex Fells	2,113	1	0
Township of Fairfield	7,466	4,431	220
Borough of Glen Ridge	7,527	117	2
Township of Irvington	53,926	590	66
Township of Livingston	29,366	991	24
Township of Maplewood	23,867	454	9
Township of Millburn	20,149	222	6
Township of Montclair	37,669	1,499	65
City of Newark	277,140	12,619	988
Borough of North Caldwell	6,183	24	0
Township of Nutley	28,370	1,473	95
City of Orange Township	30,134	2,581	226
Borough of Roseland	5,819	166	3
Township of South Orange Village	16,198	184	8
Township of Verona	13,332	182	2
Township of West Caldwell	10,759	432	26
Township of West Orange	46,207	1,667	69
Essex County (Total)	**783,969**	**33,068**	**2,232**

Sources: HAZUS-MH v4.2

Total numbers of injuries and casualties resulting from typical riverine and tidal flooding are generally limited based on advance weather forecasting, blockades, and warnings. Injuries and deaths generally are not anticipated if proper warning and precautions occur. In contrast, warning time for flash flooding is limited. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard.

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. Molds 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, 2015).

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:

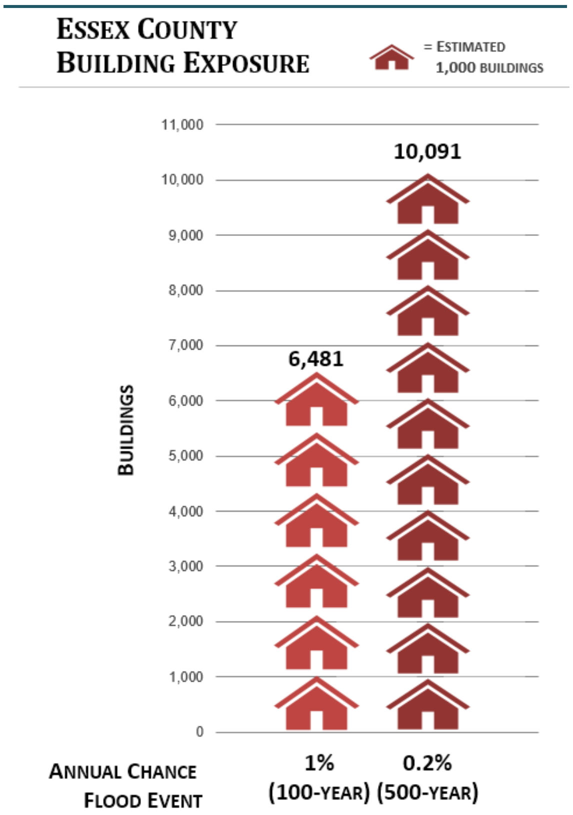
- Unsafe food
- Contaminated drinking and washing water and poor sanitation
- Mosquitos and animals
- Carbon monoxide poisoning
- Secondary hazards associated with re-entering/cleaning flooded structures
- Mental stress and fatigue

Current loss estimation models such as HAZUS-MH 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

Exposure to the flood hazard includes those buildings located in the flood zone. Potential damage is the modeled loss that could occur to the exposed inventory measured by the structural and content value. There are an estimated 6,481 buildings located in the SFHA with a value of approximately $12.8 billion of building and contents (based on replacement cost value). This represents approximately 10.3-percent of the County's total general building stock inventory replacement cost value (approximately $125 billion).

Exhibit 4.3.6-3. Building Exposure



There are 10,091 buildings located in the 0.2-percent annual chance flood boundary with approximately $20 billion of building/contents in replacement cost value (or 15.6-percent of the County's total replacement cost value). The Township of Fairfield has the greatest proportion of its buildings located in the floodplain; approximately 56.6-percent and 82.7-percent for the 1-percent chance event and 0.2-percent chance event, respectively. The City of Newark has the greatest number of its buildings located in the floodplain; approximately 2,411 and 4,691 located in the 1-percent chance event and 0.2-percent chance event boundaries, respectively. Refer to Table 4.3.6-9 and Table 4.3.6-10 for the building flood exposure analysis results by municipality.

HAZUS-MH estimates $2.1 billion in building and content damage as a result of the 1-percent annual chance flood event (or 1.7-percent of the total building stock replacement cost value). Of the $2.1 billion in potential loss, $229 million is estimated to residential structures. Refer to Table 4.3.6-11 for the potential losses estimated by HAZUS-MH v4.2 by municipality.

Table 4.3.6-9. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 1-percent Annual Chance Flood	% of Total	RCV - 1-percent Annual Chance Flood	% of Total
Township of Belleville	7,910	$4,483,250,138	152	1.9%	$269,142,437	6.0%
Township of Bloomfield	11,720	$6,021,089,887	490	4.2%	$322,196,753	5.4%
Borough of Caldwell	1,738	$1,183,204,981	1	0.1%	$460,358	0.0%
Township of Cedar Grove	3,944	$3,008,045,785	9	0.2%	$5,826,693	0.2%
City of East Orange	7,908	$6,090,766,912	50	0.6%	$66,066,174	1.1%
Borough of Essex Fells	766	$527,629,662	0	0.0%	$0	0.0%
Township of Fairfield	3,121	$6,082,819,367	1,768	56.6%	$3,770,560,301	62.0%
Borough of Glen Ridge	2,256	$1,095,474,263	30	1.3%	$11,206,209	1.0%
Township of Irvington	7,934	$5,384,838,816	39	0.5%	$33,487,235	0.6%
Township of Livingston	9,795	$7,691,376,811	206	2.1%	$195,419,853	2.5%
Township of Maplewood	6,738	$3,575,395,600	65	1.0%	$30,653,851	0.9%
Township of Millburn	6,437	$5,241,567,136	19	0.3%	$18,711,975	0.4%
Township of Montclair	9,436	$5,845,976,130	289	3.1%	$147,691,514	2.5%
City of Newark	43,085	$40,970,549,425	2,411	5.6%	$6,993,978,807	17.1%
Borough of North Caldwell	2,095	$1,727,767,442	6	0.3%	$7,579,865	0.4%
Township of Nutley	7,945	$3,841,553,722	231	2.9%	$152,170,149	4.0%
City of Orange Township	3,890	$3,520,865,708	378	9.7%	$349,703,802	9.9%
Borough of Roseland	1,794	$1,955,487,279	40	2.2%	$31,474,456	1.6%
Township of South Orange Village	4,188	$2,877,374,186	6	0.1%	$9,692,920	0.3%
Township of Verona	4,113	$2,213,338,613	33	0.8%	$16,950,844	0.8%
Township of West Caldwell	3,730	$3,533,044,820	46	1.2%	$181,233,465	5.1%
Township of West Orange	11,845	$8,358,783,858	212	1.8%	$230,208,600	2.8%
Essex County (Total)	**162,388**	**$125,230,200,542**	**6,481**	**4.0%**	**$12,844,416,261**	**10.3%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; FEMA 2014/2017/2018

Table 4.3.6-10. Estimated General Building Stock Exposure to the 0.2-Percent Annual Chance Flood Event – All Occupancies

Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 0.2-percent Annual Chance Flood	% of Total	RCV - 0.2-percent Annual Chance Flood	% of Total
Township of Belleville	7,910	$4,483,250,138	340	4.3%	$422,664,450	9.4%
Township of Bloomfield	11,720	$6,021,089,887	545	4.7%	$376,258,468	6.2%
Borough of Caldwell	1,738	$1,183,204,981	1	0.1%	$460,358	0.0%
Township of Cedar Grove	3,944	$3,008,045,785	9	0.2%	$5,826,693	0.2%
City of East Orange	7,908	$6,090,766,912	50	0.6%	$66,066,174	1.1%

Municipality	Total # Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - 0.2-percent Annual Chance Flood	% of Total	RCV - 0.2-percent Annual Chance Flood	% of Total
Borough of Essex Fells	766	$527,629,662	2	0.3%	$883,278	0.2%
Township of Fairfield	3,121	$6,082,819,367	2,580	82.7%	$5,077,660,338	83.5%
Borough of Glen Ridge	2,256	$1,095,474,263	31	1.4%	$11,428,139	1.0%
Township of Irvington	7,934	$5,384,838,816	39	0.5%	$33,487,235	0.6%
Township of Livingston	9,795	$7,691,376,811	223	2.3%	$253,113,825	3.3%
Township of Maplewood	6,738	$3,575,395,600	65	1.0%	$30,653,851	0.9%
Township of Millburn	6,437	$5,241,567,136	19	0.3%	$18,711,975	0.4%
Township of Montclair	9,436	$5,845,976,130	358	3.8%	$174,401,040	3.0%
City of Newark	43,085	$40,970,549,425	4,691	10.9%	$11,898,186,446	29.0%
Borough of North Caldwell	2,095	$1,727,767,442	16	0.8%	$22,307,127	1.3%
Township of Nutley	7,945	$3,841,553,722	295	3.7%	$188,211,964	4.9%
City of Orange Township	3,890	$3,520,865,708	378	9.7%	$349,703,802	9.9%
Borough of Roseland	1,794	$1,955,487,279	84	4.7%	$61,317,271	3.1%
Township of South Orange Village	4,188	$2,877,374,186	6	0.1%	$9,692,920	0.3%
Township of Verona	4,113	$2,213,338,613	33	0.8%	$16,950,844	0.8%
Township of West Caldwell	3,730	$3,533,044,820	114	3.1%	$288,143,027	8.2%
Township of West Orange	11,845	$8,358,783,858	212	1.8%	$230,208,600	2.8%
Essex County (Total)	**162,388**	**$125,230,200,542**	**10,091**	**6.2%**	**$19,536,337,825**	**15.6%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; FEMA 2014/2017/2018

Table 4.3.6-11. Estimated General Building Stock Potential Loss to the 1-Percent Annual Chance Flood Event

Municipality	Total Replacement Cost Value	1-Percent Annual Chance Event							
		All Occupancies		Residential		Commercial		Agricultural, Industrial, Religious, Education and Government	
		Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total	Estimated Loss	% of Total
Township of Belleville	$4,483,250,138	$28,159,334	0.6%	$4,799,573	0.1%	$3,497,298	0.1%	$19,862,463	0.4%
Township of Bloomfield	$6,021,089,887	$65,998,384	1.1%	$35,222,224	0.6%	$10,901,194	0.2%	$19,874,966	0.3%
Borough of Caldwell	$1,183,204,981	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Cedar Grove	$3,008,045,785	$265,734	0.0%	$265,734	0.0%	$0	0.0%	$0	0.0%
City of East Orange	$6,090,766,912	$9,633,804	0.2%	$855,090	0.0%	$2,442,355	0.0%	$6,336,359	0.1%
Borough of Essex Fells	$527,629,662	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Township of Fairfield	$6,082,819,367	$542,543,680	8.9%	$112,439,152	1.8%	$83,939,702	1.4%	$346,164,826	5.7%
Borough of Glen Ridge	$1,095,474,263	$1,203,509	0.1%	$753,495	0.1%	$397,904	0.0%	$52,110	0.0%
Township of Irvington	$5,384,838,816	$3,547,860	0.1%	$2,837,436	0.1%	$710,424	0.0%	$0	0.0%
Township of Livingston	$7,691,376,811	$23,847,476	0.3%	$6,400,208	0.1%	$13,921,626	0.2%	$3,525,643	0.0%
Township of Maplewood	$3,575,395,600	$4,154,899	0.1%	$772,797	0.0%	$3,382,103	0.1%	$0	0.0%
Township of Millburn	$5,241,567,136	$429,737	0.0%	$353,062	0.0%	$0	0.0%	$76,676	0.0%
Township of Montclair	$5,845,976,130	$6,252,388	0.1%	$4,614,422	0.1%	$1,607,084	0.0%	$30,882	0.0%
City of Newark	$40,970,549,425	$1,337,220,168	3.3%	$29,243,029	0.1%	$78,860,702	0.2%	$1,229,116,436	3.0%
Borough of North Caldwell	$1,727,767,442	$18,789	0.0%	$18,789	0.0%	$0	0.0%	$0	0.0%
Township of Nutley	$3,841,553,722	$19,096,478	0.5%	$8,450,732	0.2%	$7,786,476	0.2%	$2,859,271	0.1%
City of Orange Township	$3,520,865,708	$32,313,694	0.9%	$13,883,450	0.4%	$6,360,974	0.2%	$12,069,270	0.3%
Borough of Roseland	$1,955,487,279	$1,173,160	0.1%	$109,247	0.0%	$967,026	0.0%	$96,887	0.0%
Township of South Orange Village	$2,877,374,186	$7,869,838	0.3%	$0	0.0%	$162,066	0.0%	$7,707,772	0.3%
Township of Verona	$2,213,338,613	$2,226,580	0.1%	$1,320,995	0.1%	$905,586	0.0%	$0	0.0%
Township of West Caldwell	$3,533,044,820	$22,672,000	0.6%	$828,289	0.0%	$8,303,965	0.2%	$13,539,747	0.4%
Township of West Orange	$8,358,783,858	$22,605,480	0.3%	$6,267,696	0.1%	$2,777,674	0.0%	$13,560,111	0.2%
Essex County (Total)	**$125,230,200,542**	**$2,131,232,996**	**1.7%**	**$229,435,419**	**0.2%**	**$226,924,158**	**0.2%**	**$1,674,873,419**	**1.3%**

Source: HAZUS-MH v4.2

Impact on Land Uses

An exposure analysis was completed to assess the vulnerability of the residential and non-residential land uses within the County to flooding. To estimate the land use exposure to the 1- and 0.2-percent flood events, the floodplain boundaries were overlaid upon the 2018 parcel data in GIS (2018 New Jersey Geographic Information Network) and used to calculate the estimated the number and area of residential and non-residential properties exposed to this hazard.

The analysis shows while most of the residential properties in the County are not vulnerable to flooding, the majority of the residential properties in Fairfield Township are vulnerable. Across Essex County, approximately 5-percent of all structures and approximately 4-percent of the total residential land use area are within the 1-percent annual chance of flooding flood hazard area. Approximately 8-percent of all properties and 6-percent of residential land use area in the County are within the 0.2-percent annual chance of flooding flood hazard area. Fairfield Township has the highest amount of residential structures and land use area exposed. Approximately 66-percent of the total residential land use acreage and 77-percent of the residential properties are located in the 1-percent annual chance of flooding flood hazard area. Approximately 86-percent of the total residential land use area and 89-percent the residential properties are located in the 0.2-percent annual chance of flooding flood hazard area.

The analysis shows approximately 15-percent of the total acreage of non-residential properties and 37-percent of the non-residential land use area in the County are vulnerable to flooding. In Fairfield Township, approximately 87% of the total non- residential land use acreage and 86-percent of the non-residential properties are located in the 1-percent annual chance of flooding flood hazard area. Approximately 92-percent of the total non-residential land use area and 92-percent of the non-residential properties are located in the 0.2-percent annual chance of flooding flood hazard area.

Figure 4.3.6-4. Essex County Residential Land Uses Flooding Exposure

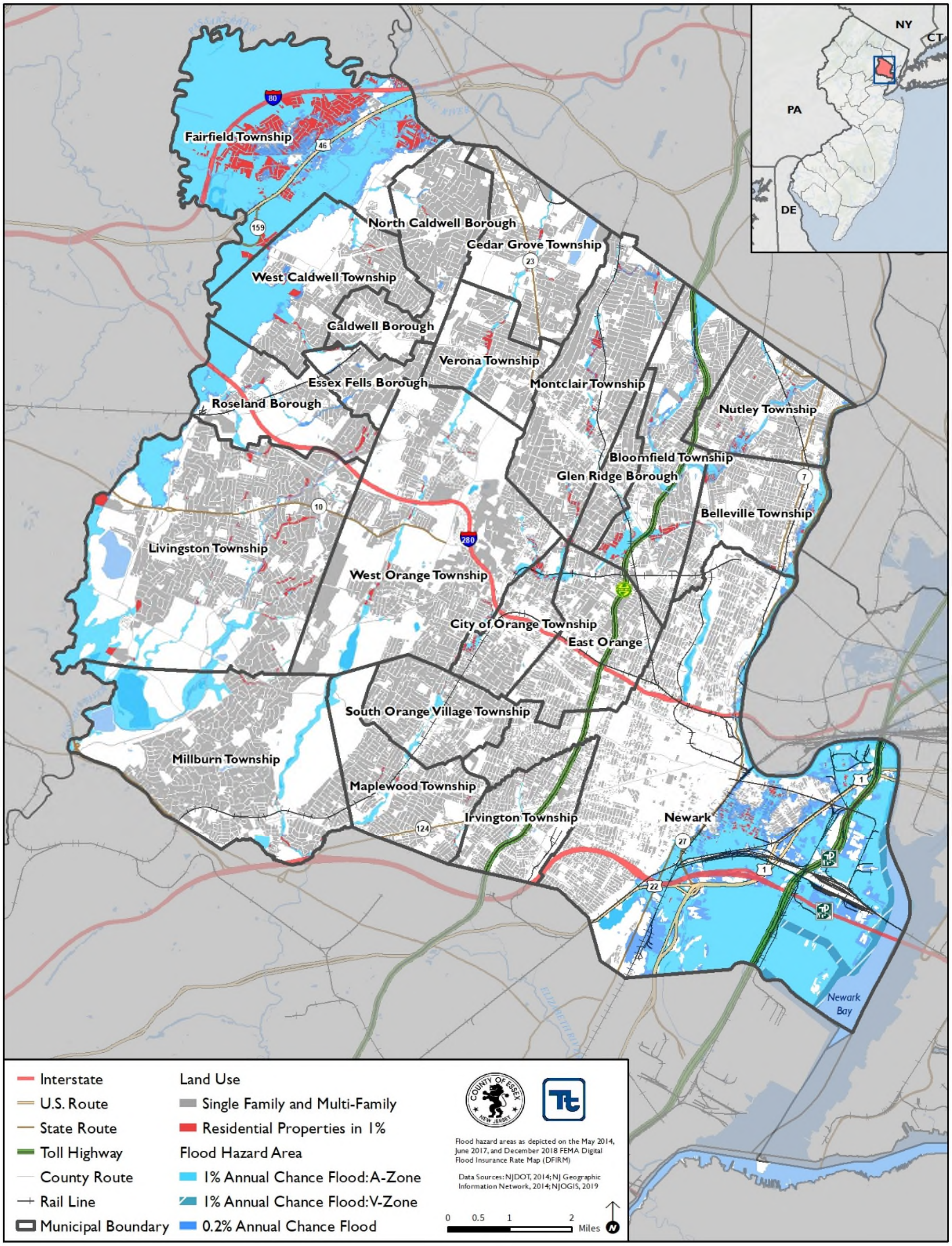


Table 4.3.6-12. Residential Land Use Exposure to the 1-Percent and 0.2-Percent Annual Chance Flood Events

Municipality	Total Residential Land Use Area (acres)	Total Number of Residential Properties	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area			
			Number of Residential Properties in A and V-Zone	% of Total	Residential Land Use Area in A and V-Zone (acres)	% of Total	Number of Residential Properties in 0.2%	% of Total	Residential Land Use Area in 0.2% (acres)	% of Total
Township of Belleville	908	8,288	550	6.6%	31	3.4%	826	10.0%	52	5.7%
Township of Bloomfield	1,516	10,597	713	6.7%	73	4.8%	776	8.0%	86	5.7%
Borough of Caldwell	401	1,851	0	0.0%	0	0.0%	0	0.0%	0	0.0%
Township of Cedar Grove	1,180	3,617	52	1.4%	10	0.9%	52	2.4%	10	0.9%
City of East Orange	1,164	8,365	137	1.6%	9	0.8%	137	1.7%	9	0.8%
Borough of Essex Fells	531	737	10	1.4%	1	0.3%	27	10.0%	6	1.1%
Township of Fairfield	1,092	2,468	1,896	76.8%	715	65.5%	2,198	89.4%	935	85.6%
Borough of Glen Ridge	529	2,165	64	3.0%	5	0.9%	65	3.0%	5	0.9%
Township of Irvington	826	8,209	124	1.5%	7	0.9%	124	3.6%	7	0.9%
Township of Livingston	3,711	9,808	668	6.8%	131	3.5%	680	7.7%	134	3.6%
Township of Maplewood	1,142	6,897	143	2.1%	12	1.0%	143	2.7%	12	1.0%
Township of Millburn	2,499	6,147	97	1.6%	12	0.5%	97	8.1%	12	0.5%
Township of Montclair	2,423	9,719	537	5.5%	61	2.5%	616	6.7%	79	3.3%
City of Newark	2,523	29,709	1,291	4.3%	57	2.2%	2,661	9.1%	141	5.6%
Borough of North Caldwell	1,245	2,097	18	0.9%	5	0.4%	39	3.8%	8	0.6%
Township of Nutley	1,152	8,305	402	4.8%	31	2.7%	505	6.2%	41	3.5%
City of Orange Township	638	3,980	471	11.8%	41	6.4%	471	13.6%	41	6.4%
Borough of Roseland	634	2,026	103	5.1%	24	3.8%	175	11.4%	36	5.6%
Township of South Orange Village	1,140	4,270	36	0.8%	1	0.1%	36	0.9%	1	0.1%
Township of Verona	915	4,843	130	2.7%	19	2.1%	130	5.2%	19	2.1%
Township of West Caldwell	1,149	3,419	153	4.5%	38	3.3%	215	6.6%	62	5.4%
Township of West Orange	2,729	12,215	431	3.5%	38	1.4%	431	5.3%	38	1.4%

Municipality	Total Residential Land Use Area (acres)	Total Number of Residential Properties	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area			
			Number of Residential Properties in A and V-Zone	% of Total	Residential Land Use Area in A and V-Zone (acres)	% of Total	Number of Residential Properties in 0.2%	% of Total	Residential Land Use Area in 0.2% (acres)	% of Total
Essex County (Total)	**30,045**	**149,732**	**8,026**	**5.4%**	**1,326**	**4.4%**	**10,404**	**7.9%**	**1,732**	**5.8%**

Source: FEMA 2014, 2017, 2018
Note: % = Percent
The area presented includes the area of inland waterways and excludes bays or oceans.

Figure 4.3.6-5. Essex County Non-Residential Land Uses Flooding Exposure

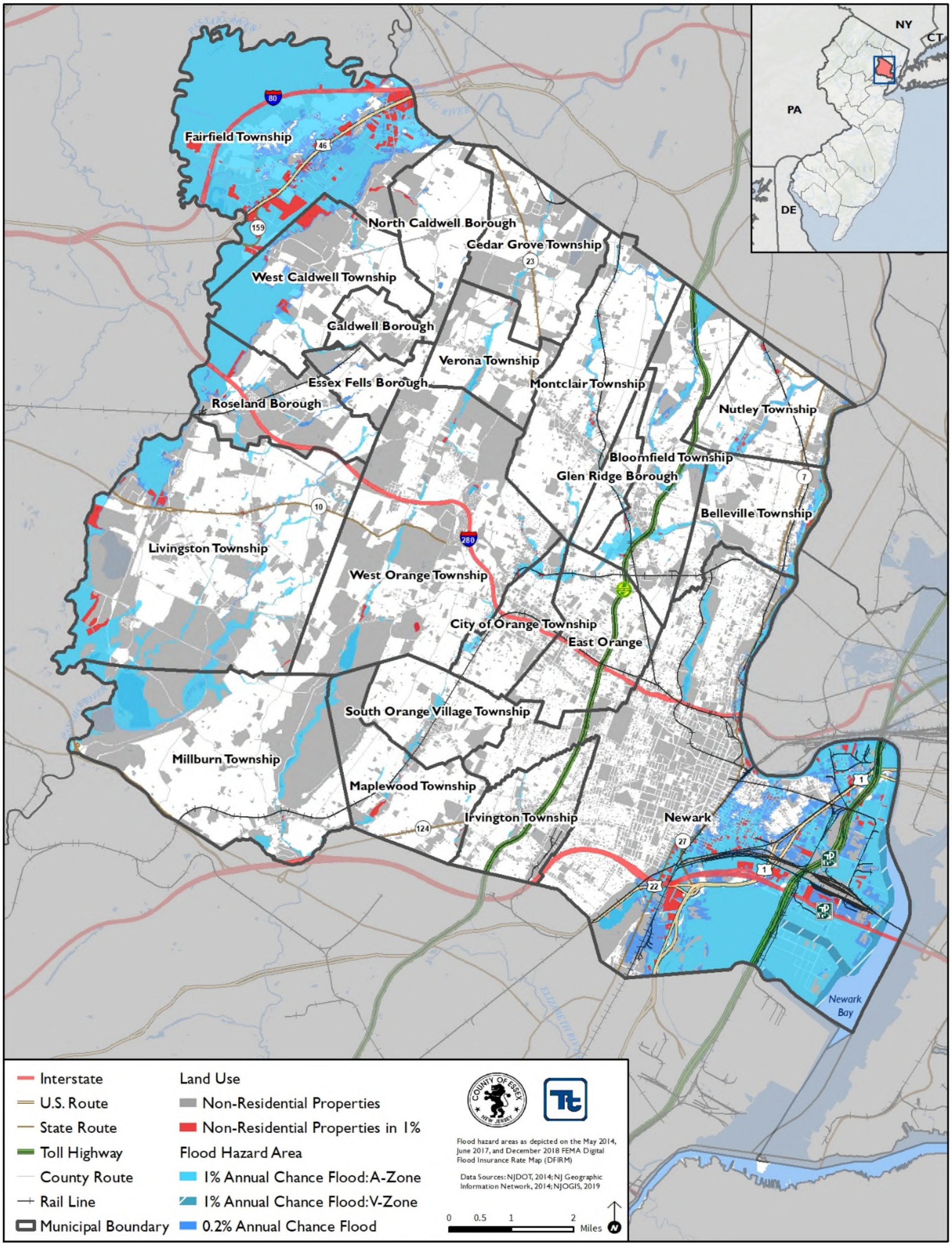


Table 4.3.6-13. Non-Residential Land Use Exposure to the 1-Percent and 0.2 Percent Annual Chance Flood Events

Municipality	Total Non-Res Land Use Area (acres)	Total Number of Non-Res Properties	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area			
			Number of Non-Res Properties in A and V-Zone	% of Total	Non-Res Land Use Area in A and V-Zone (acres)	% of Total	Number of Non-Res Properties in 0.2%	% of Total	Non-Res Land Use Area in 0.2% (acres)	% of Total
Township of Belleville	766	1,536	132	8.6%	83	10.8%	188	12.24%	105	13.7%
Township of Bloomfield	1,134	1,560	249	16.0%	253	22.3%	267	17.12%	276	24.3%
Borough of Caldwell	233	375	1	0.3%	6	2.7%	1	0.27%	7	2.8%
Township of Cedar Grove	1,315	495	61	12.3%	34	2.6%	61	12.32%	34	2.6%
City of East Orange	707	1,968	76	3.9%	26	3.7%	76	3.86%	26	3.7%
Borough of Essex Fells	268	92	7	7.6%	8	2.9%	17	18.48%	18	6.6%
Township of Fairfield	4,744	1,265	1,092	86.3%	4,128	87.0%	1,173	92.73%	4,376	92.3%
Borough of Glen Ridge	129	182	21	11.5%	9	6.7%	22	12.09%	9	7.3%
Township of Irvington	530	1,824	62	3.4%	12	2.3%	62	3.40%	12	2.3%
Township of Livingston	4,320	1,053	234	22.2%	1,091	25.3%	249	23.65%	1,138	26.3%
Township of Maplewood	946	588	68	11.6%	95	10.0%	68	11.56%	95	10.0%
Township of Millburn	3,094	530	85	16.0%	782	25.3%	85	16.04%	782	25.3%
Township of Montclair	909	1,288	148	11.5%	66	7.2%	152	11.80%	71	7.8%
City of Newark	9,594	16,813	2,191	13.0%	4,168	43.4%	3,081	18.33%	5,160	53.8%
Borough of North Caldwell	510	134	11	8.2%	18	3.5%	15	11.19%	28	5.4%
Township of Nutley	559	842	139	16.5%	79	14.2%	155	18.41%	94	16.8%
City of Orange Township	476	1,356	181	13.3%	44	9.2%	181	13.35%	44	9.2%
Borough of Roseland	1,404	241	68	28.2%	398	28.4%	79	32.78%	444	31.6%
Township of South Orange Village	369	736	28	3.8%	39	10.6%	28	3.80%	39	10.6%
Township of Verona	645	351	19	5.4%	43	6.6%	19	5.41%	43	6.6%
Township of West Caldwell	1,809	306	102	33.3%	882	48.7%	118	38.56%	961	53.1%
Township of West Orange	3,797	2,712	385	14.2%	227	6.0%	385	14.20%	227	6.0%

Municipality	Total Non-Res Land Use Area (acres)	Total Number of Non-Res Properties	1% Flood Event Hazard Area				0.2% Flood Event Hazard Area			
			Number of Non-Res Properties in A and V-Zone	% of Total	Non-Res Land Use Area in A and V-Zone (acres)	% of Total	Number of Non-Res Properties in 0.2%	% of Total	Non-Res Land Use Area in 0.2% (acres)	% of Total
Essex County (Total)	**38,258**	**36,247**	**5,360**	**14.8%**	**12,490**	**32.6%**	**6,482**	**17.88%**	**13,987**	**36.6%**

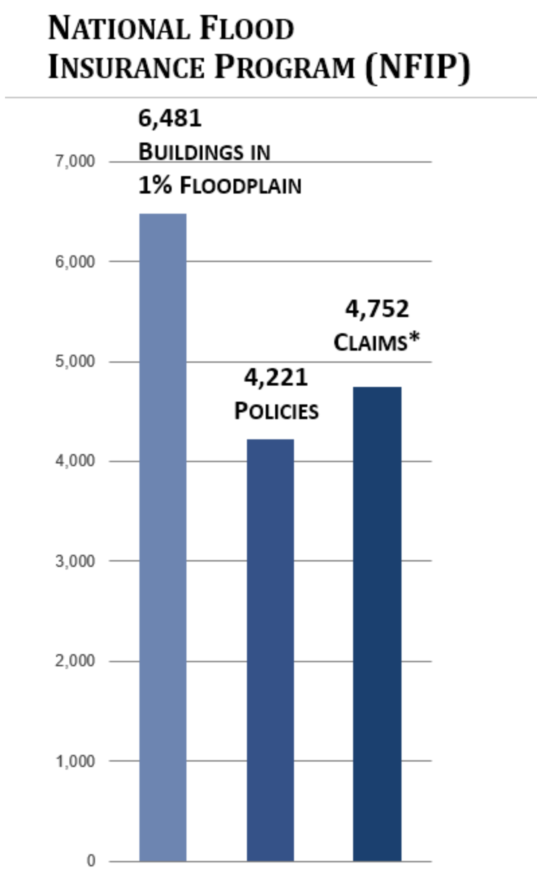
Source: FEMA 2014, 2017, 2018
Note: % = Percent
Non-Res = Non-residential
The area presented includes the area of inland waterways and excludes bays or oceans.

NFIP Statistics

FEMA Region 2 provided a list of NFIP policies, past claims, repetitive loss properties (RL), and severe repetitive loss properties (SRL) in Essex County. According to FEMA, a 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 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 4.3.6-14 through Table 4.3.6-16 and Figure 4.3.6-6 summarize the NFIP policies, claims and repetitive loss statistics for Essex County. Table 4.3.6-14 and Table 4.3.6-15summarize the occupancy classes of the repetitive loss and severe repetitive loss properties in the County. Single family residences account for 69% of the RL properties and 90% of the SRL properties. This information is current as of March 31, 2019.

Exhibit 4.3.6-4 NFIP Statistics



*Claims cumulative between January 1, 1978 until September 30, 2018

Table 4.3.6-14. Occupancy Class of Repetitive Loss Structures in Essex County

Occupancy Class	Total Number of Repetitive Loss Properties	Total Number of Severe Repetitive Loss Properties	Total (RL + SRL)
Single Family	312	56	368
Condo	4	1	5
2-4 Family	49	4	53
Other Residential	6	1	7
Non-Residential	79	0	79
Essex County	**450**	**62**	**512**

Source: FEMA Region 2 2019
Note: Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 03/31/19
The total number of repetitive loss properties does not include the severe repetitive loss properties; The severe repetitive loss properties totals only include validated properties.

Table 4.3.6-15. Occupancy Class of Repetitive Loss Structures in Essex County, by Municipality

Municipality	Repetitive Loss Properties					Severe Repetitive Loss Properties				
	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family	2-4 Family	Assumed Condo	Non-Residential	Other Residential	Single Family
Township of Belleville	6	0	11	1	14	2	0	0	0	1
Township of Bloomfield	8	2	2	0	15	0	0	0	0	0
Borough of Caldwell	0	0	0	0	0	0	0	0	0	0
Township of Cedar Grove	0	0	0	0	2	0	0	0	0	0
City of East Orange	2	0	0	0	1	0	0	0	0	0
Borough of Essex Fells	0	0	0	0	0	0	0	0	0	0
Township of Fairfield	3	1	27	0	186	2	1	0	0	52
Borough of Glen Ridge	0	0	0	0	1	0	0	0	0	0
Township of Irvington	7	0	1	0	4	0	0	0	0	0
Township of Livingston	0	0	0	0	11	0	0	0	0	0
Township of Maplewood	3	0	5	1	2	0	0	0	0	0
Township of Millburn	0	0	9	0	24	0	0	0	0	0
Township of Montclair	6	0	1	2	12	0	0	0	0	0
City of Newark	3	0	13	1	4	0	0	0	0	0
Borough of North Caldwell	0	0	0	0	3	0	0	0	0	0
Township of Nutley	3	1	2	0	15	0	0	0	1	0
City of Orange Township	7	0	1	1	4	0	0	0	0	1
Borough of Roseland	0	0	0	0	2	0	0	0	0	0
Township of South Orange Village	0	0	2	0	2	0	0	0	0	0
Township of Verona	0	0	0	0	2	0	0	0	0	1
Township of West Caldwell	0	0	3	0	0	0	0	0	0	1
Township of West Orange	1	0	2	0	8	0	0	0	0	0
Essex County	**49**	**4**	**79**	**6**	**312**	**4**	**1**	**0**	**1**	**56**

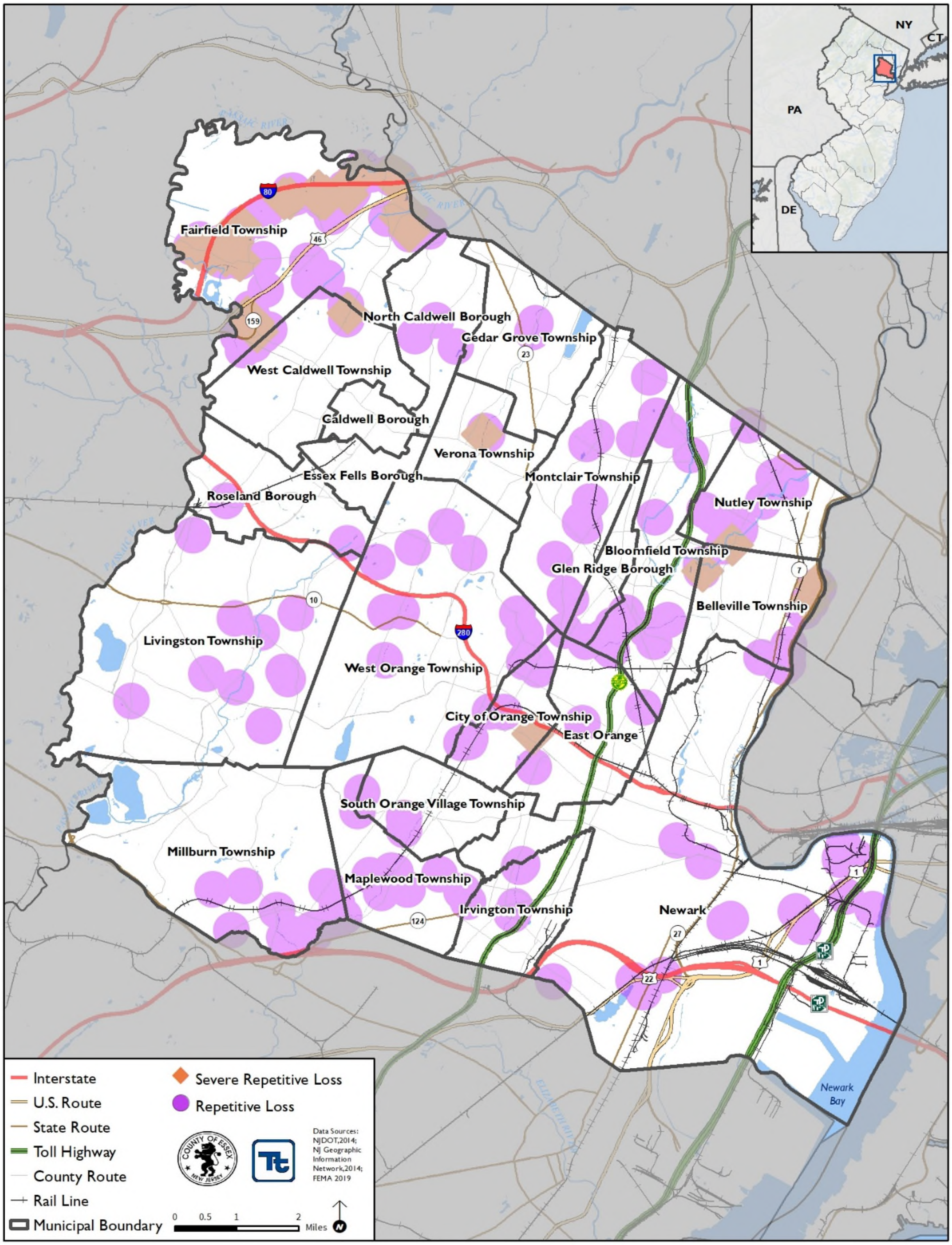
Source: *FEMA Region 2 2019*
Note: *Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 03/31/19*
The total number of repetitive loss properties does not include the severe repetitive loss properties; The severe repetitive loss properties totals only include validated properties.

Table 4.3.6-16. NFIP Policies, Claims and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	Total Loss Payments (2)	# Rep. Loss Prop. (1)	Severe Rep. Loss Prop. (1)
Township of Belleville	376	182	$6,932,839	32	3
Township of Bloomfield	475	434	$2,896,258	27	0
Borough of Caldwell	3	1	$4,617	0	0
Township of Cedar Grove	37	21	$211,068	2	0
City of East Orange	76	57	$295,880	3	0
Borough of Essex Fells	9	12	$100,750	0	0
Township of Fairfield	1,016	1,948	$64,662,589	217	55
Borough of Glen Ridge	43	19	$40,864	1	0
Township of Irvington	47	105	$488,116	12	0
Township of Livingston	243	243	$1,217,213	11	0
Township of Maplewood	128	105	$1,178,060	11	0
Township of Millburn	266	308	$6,633,853	33	0
Township of Montclair	297	215	$1,258,078	21	0
City of Newark	198	287	$18,131,115	21	0
Borough of North Caldwell	32	23	$121,188	3	0
Township of Nutley	241	242	$1,735,278	21	1
City of Orange Township	294	163	$963,709	13	1
Borough of Roseland	24	23	$180,672	2	0
Township of South Orange Village	61	38	$150,472	4	0
Township of Verona	65	60	$284,742	2	1
Township of West Caldwell	86	47	$2,000,067	3	1
Township of West Orange	204	219	$901,606	11	0
Essex County	**4,221**	**4,752**	**$110,389,033**	**450**	**62**

Source: FEMA Region 2 2018
Rep. = Repetitive
(1) Repetitive loss and severe repetitive loss statistics provided by FEMA Region 2 and are current as of 03/31/19; Policies and claims are current as of 9/30/2019.
The total number of repetitive loss properties does not include the severe repetitive loss properties; The severe repetitive loss properties totals only include validated properties.
(2) Total building and content losses from the claims file provided by FEMA Region 2 https://bsa.nfipstat.fema.gov/reports/1040.htm

Figure 4.3.6-6. NFIP Repetitive Loss Properties in Essex County

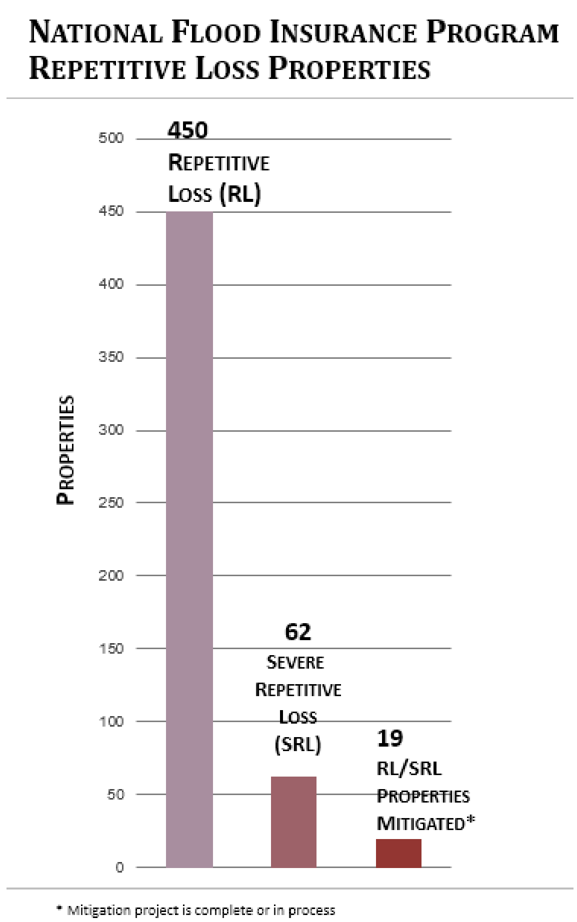


Repetitive Loss Area Analysis (RLAA)

A repetitive loss area analysis was performed to enhance the flood analysis and support future targeted outreach and more effective floodplain management. The repetitive loss area includes repetitive loss properties, as determined by FEMA, and properties that may undergo repetitive flood damage but are either not participating in the NFIP or not technically classified as repetitive loss properties by the NFIP. Properties that may undergo repetitive flood damage but are not classified as NFIP RLs or SRLs can occur for a variety of reasons, including the following:

- Property owners may not have flood insurance. Only properties within the floodplain and with a federally-backed mortgage are required to carry flood insurance.
- Owners of a flooded property may choose not to file a claim, even if the owner has flood insurance.
- The flood damage may not meet the minimum $1,000 threshold necessary for repetitive loss, but the property may still undergo recurring flood damage.

Exhibit 4.3.6-5. Repetitive Loss Statistics



Description of Selected Approach - RLAA Delineation Process

In ArcMap v10.5.1, repetitive loss areas were delineated using RL and SRL properties and the 1-percent annual chance flood event depth grid, 2-foot contours delineated from the USGS DEM, and FEMA flood hazard areas. For each repetitive loss area, the RL and SRL properties were displayed in ArcMap v10.5.1 along with the depth grid, contours, and flood hazard areas to identify clusters of RL and SRL properties that having similar flooding conditions. Initially, the 1-percent annual chance event floodplain was used to group together RL and SRL properties where applicable, and the depth grid and contours were used to delineate a more precise boundary within the floodplain.

A total of 85 of the 450 repetitive loss properties located outside of the floodplain; of these, two could not be geocoded within the County because the address is not the property location. For the 85 properties located outside the floodplain, contours were referenced to attempt to delineate a boundary around a low elevation area where stormwater may pond and cause repetitive damages. If contours did not provide a clear delineation, the area was identified as a single property repetitive loss area. Four of the areas delineated were categorized as riverine/stormwater flooding. Three of these areas are near the floodplain but located outside of the FEMA-delineated SFHA and 0.2-percent annual chance flood boundary; therefore, the cause of flooding could not be determined between riverine and stormwater flooding as both could be a contributing factor. The other is in an approximate A-zone that appeared to be delineating an area of ponding water from the Canoe Brook 1-percent annual chance event floodplain in Livingston.

RLAA Results

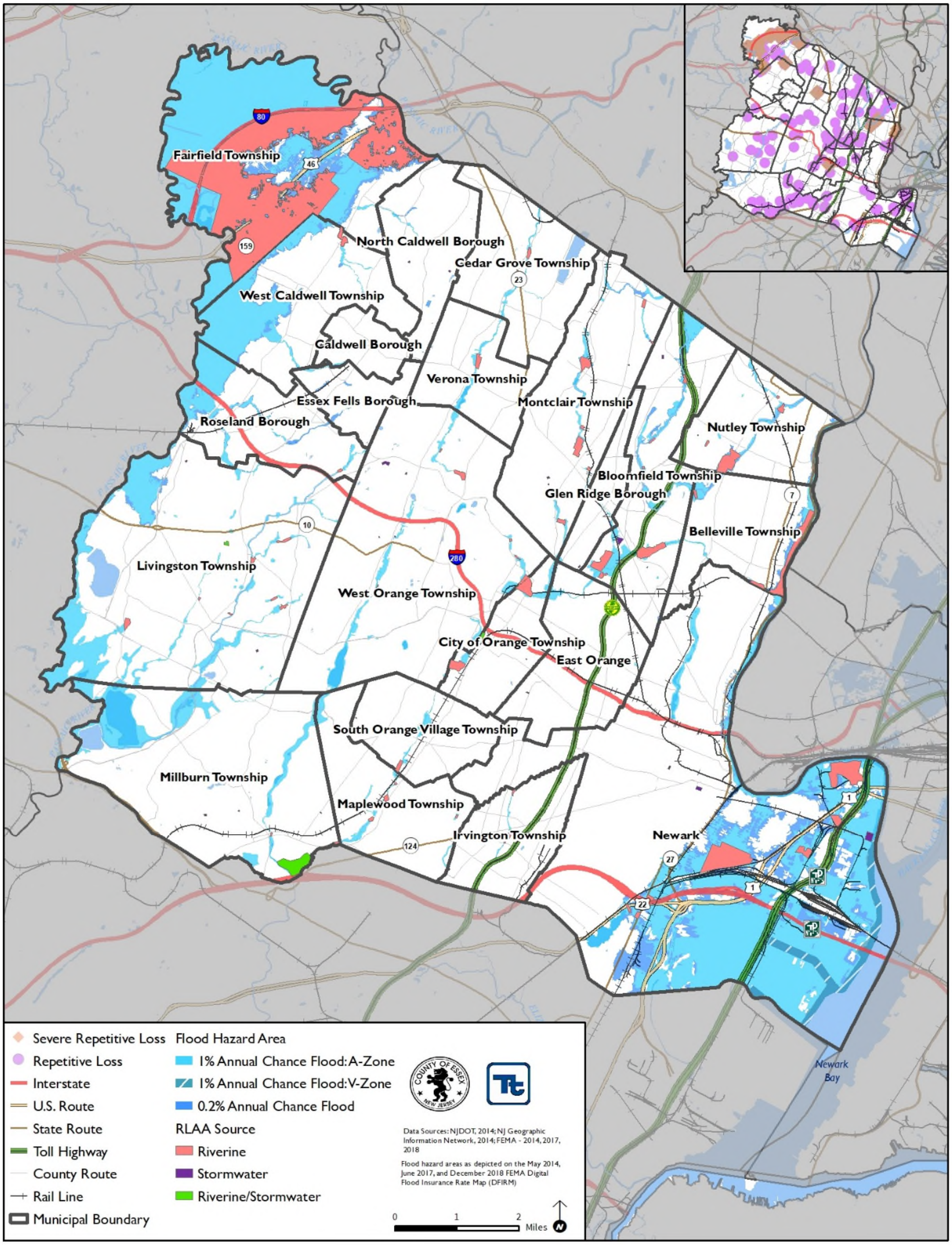
Table 4.3.6-17 displays the number of repetitive loss areas and number of structures located within these areas for each municipality. Figure 4.3.6-7 displays the repetitive loss areas to illustrate the relationship of the areas with documented NFIP RL properties and the probable causes of flooding. In Essex County, most repetitive loss properties are located in the floodplain. The cause of repetitive flooding at these properties is commensurate with the flood risk reflected on the current preliminary FIRM. There were 85 of the 450 repetitive loss properties located outside of the floodplain; of these, two could not be geocoded within the County because the address is not the property location. For these properties, it is assumed that stormwater flooding is the main cause of flooding. In total, 96 repetitive loss areas were identified including 3,830 structures based on the methodology detailed below.

Table 4.3.6-17. Number of Repetitive Loss Areas and Number of Structures Located in Each Area by Municipality

Municipality	Number of Repetitive Loss Areas	Number of Structures Located in a Repetitive Loss Area	# Rep. Loss Prop. (1)	Severe Rep. Loss Prop. (1)
Township of Belleville	2	116	32	3
Township of Bloomfield	10	419	27	0
Borough of Caldwell	0	0	0	0
Township of Cedar Grove	1	12	2	0
City of East Orange	3	14	3	0
Borough of Essex Fells	0	0	0	0
Township of Fairfield	1	1,630	217	55
Borough of Glen Ridge	1	5	1	0
Township of Irvington	2	28	12	0
Township of Livingston	10	53	11	0
Township of Maplewood	6	28	11	0
Township of Millburn	8	232	33	0
Township of Montclair	10	195	21	0
City of Newark	11	384	21	0
Borough of North Caldwell	3	4	3	0
Township of Nutley	8	192	21	1
City of Orange Township	4	264	13	1
Borough of Roseland	2	5	2	0
Township of South Orange Village	3	6	4	0
Township of Verona	1	29	2	1
Township of West Caldwell	1	4	3	1
Township of West Orange	10	74	11	0
Essex County (Total)	**96**	**3,694**	**450**	**62**

Rep. = Repetitive

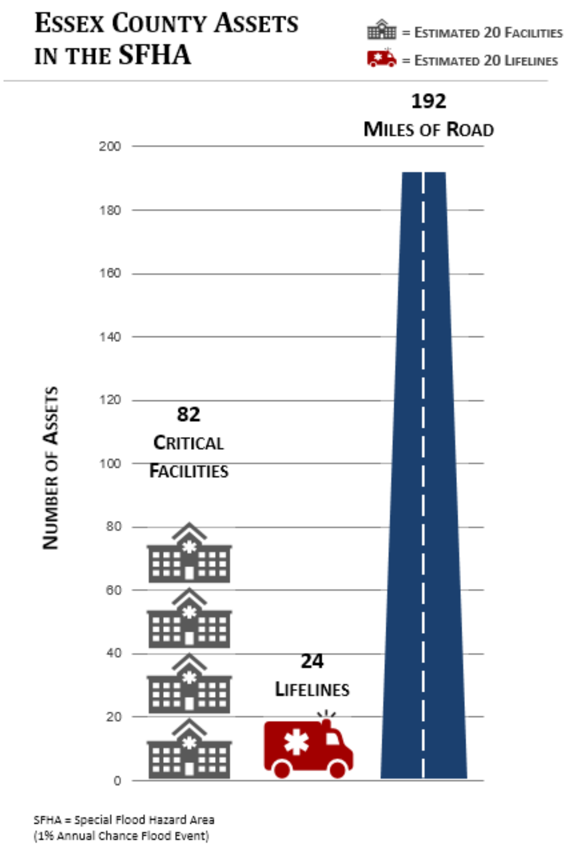
Figure 4.3.6-7. Repetitive Loss Areas in Essex County



Impact on Critical Facilities

It is important to determine the critical facilities and infrastructure 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 get to vulnerable populations or to make repairs.

Exhibit 4.3.6-6. Assets Located in the SFHA



Critical facility exposure to the flood hazard was examined. In addition, HAZUS-MH v4.2 was used to estimate the flood loss potential to critical facilities located in the FEMA mapped floodplains. Table 4.3.6-18 summarizes these results. Figure 4.3.6-9 and Figure 4.3.6-10 display the distribution of critical facilities in the 1- and 0.2-percent annual chance flood event boundaries. Of the 82 critical facilities located in the 1-percent annual chance flood event boundary, 24 were identified as lifeline facilities.

Figure 4.3.6-8 displays the major roadways that may be impacted by the 1-percent annual chance flood event. These include NJ-7, NJ-10, NJ-21, NJ-23, NJ-24, NJ-27, NJ-124, NJ-159, I-78, I-80 I-95, I-280, US-1, US-22, and US-46 and the Garden State Parkway. Bridges washed out or blocked by floods or debris also can cause isolation. Floodwaters can get into drinking water supplies, causing contamination. Culverts can be blocked by debris from flood events, also causing localized urban flooding. Sewer systems can be backed up, causing wastewater to spill into homes, neighborhoods, rivers, and streams.

Additional critical facilities that have flooding issues were identified during a series of stakeholder workshops. The Clay Street combined sewer overflow in the City of Newark is prone to flooding and is worsened by high tide flooding. The Essex County Correctional Facility in Newark is also prone to inundation during flooding events. The Township of Millburn has flooding issues on the JFK Parkway (County road) which is a major thoroughfare and Brookside Drive, a cut through to the hospital. The Garden State Parkway floods during heavy rain events near the Route 280 interchange in East Orange. Flooding from the Passaic River can shut down Route 10 in Livingston.

Figure 4.3.6-8. Major Roadways Located in the 1-percent Annual Chance Floodplain

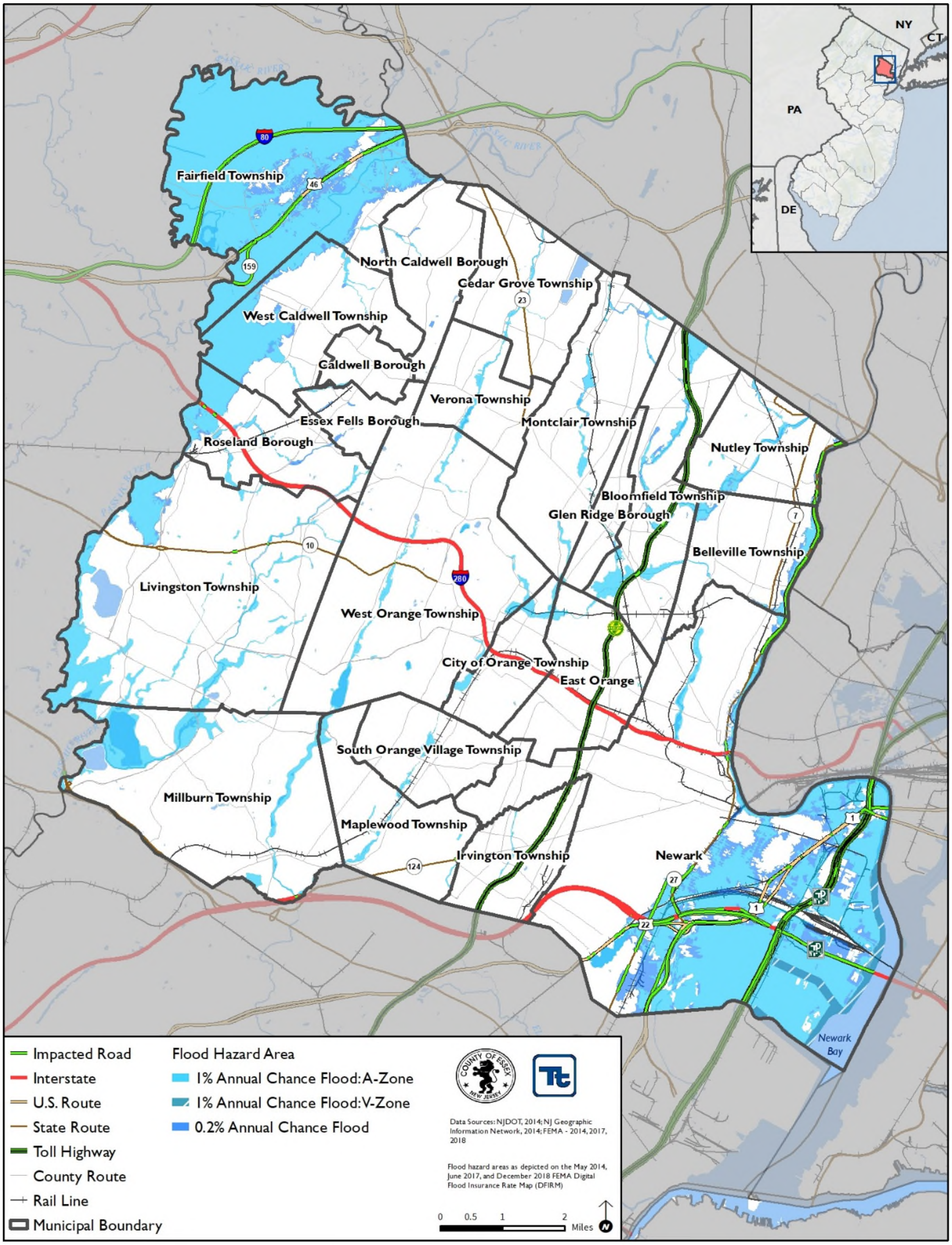


Table 4.3.6-18. Critical Facilities Located in the 1- and 0.2-Percent Annual Chance Event Floodplains by Asset Type

Facility Type	Number of Critical Facilities Located in the 1-Percent Annual Chance Event Floodplain	Number of Critical Facilities Located in the 0.2-Percent Annual Chance Event Floodplain
Airport	2	2
Bus	2	3
Chemical Storage	3	3
Commercial	2	2
Correctional Institution	2	2
County Building	1	1
Dam	6	7
Electric Power	3	3
Electric Substation	1	1
EMS	2	2
EOC	0	1
Fire	2	4
Government	4	7
Hazardous Materials	1	1
Health Care	1	1
Highway Bridge	2	2
Light Rail	0	1
Newark Housing Authority	2	3
Nursing Home	1	1
Oil Facility	4	4
Police	4	6
Port	4	4
Potable Pump Station	6	6
Potable Well	3	4
Public Works Department	1	1
Safety	0	1
School	14	21
Shelter	1	3
Train Station	1	1
Transportation*	5	8
Wastewater Treatment Plant	2	3
Total/Average	**82**	**109**

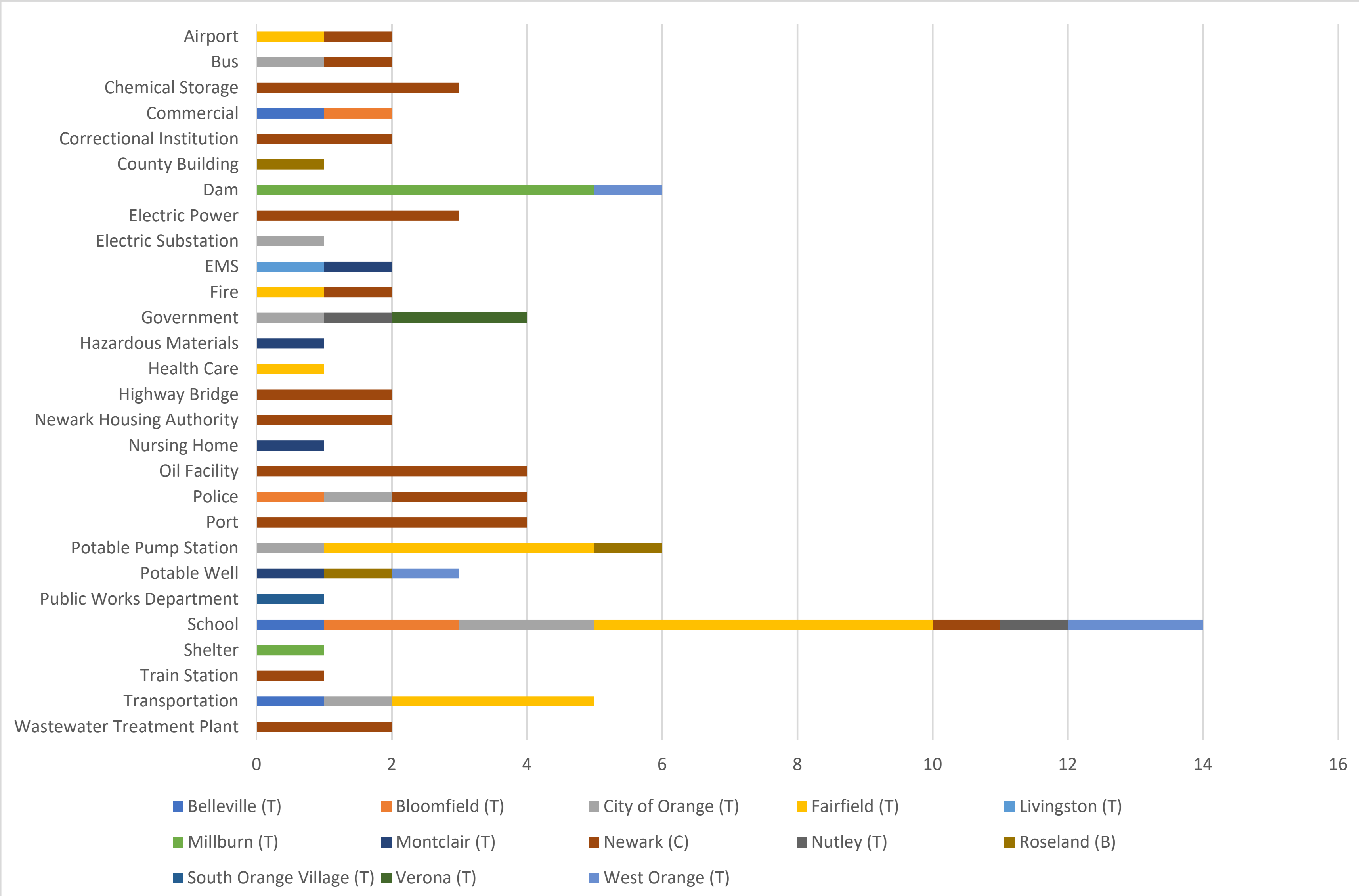
Source: Essex County, 2019; FEMA 2014/2017/2018; HAZUS-MH v4.2
** Only one facility was estimated to have structure and contents losses*
EMS = Emergency Medical Services
EOC = Emergency Operations Center

Table 4.3.6-19. Critical Facilities Located in the 1- and 0.2-Percent Annual Chance Event Floodplains by Municipality

Municipality	1% Annual Chance Flood Event		0.2% Annual Chance Flood Event	
	# Critical Facilities	# Lifelines	# Critical Facilities	# Lifelines
Township of Belleville	3	2	4	3
Township of Bloomfield	4	2	4	2
Borough of Caldwell	0	0	0	0
Township of Cedar Grove	0	0	0	0
City of East Orange	0	0	0	0
Borough of Essex Fells	0	0	1	0
Township of Fairfield	15	6	25	12
Borough of Glen Ridge	0	0	0	0
Township of Irvington	0	0	0	0
Township of Livingston	1	1	2	2
Township of Maplewood	0	0	0	0
Township of Millburn	6	1	6	1
Township of Montclair	4	4	4	4
City of Newark	29	1	39	2
Borough of North Caldwell	0	0	1	1
Township of Nutley	2	2	5	5
City of Orange Township	8	1	8	1
Borough of Roseland	3	1	3	1
Township of South Orange Village	1	1	1	1
Township of Verona	2	1	2	1
Township of West Caldwell	0	0	0	0
Township of West Orange	4	1	4	1
Essex County (Total)	**82**	**24**	**109**	**37**

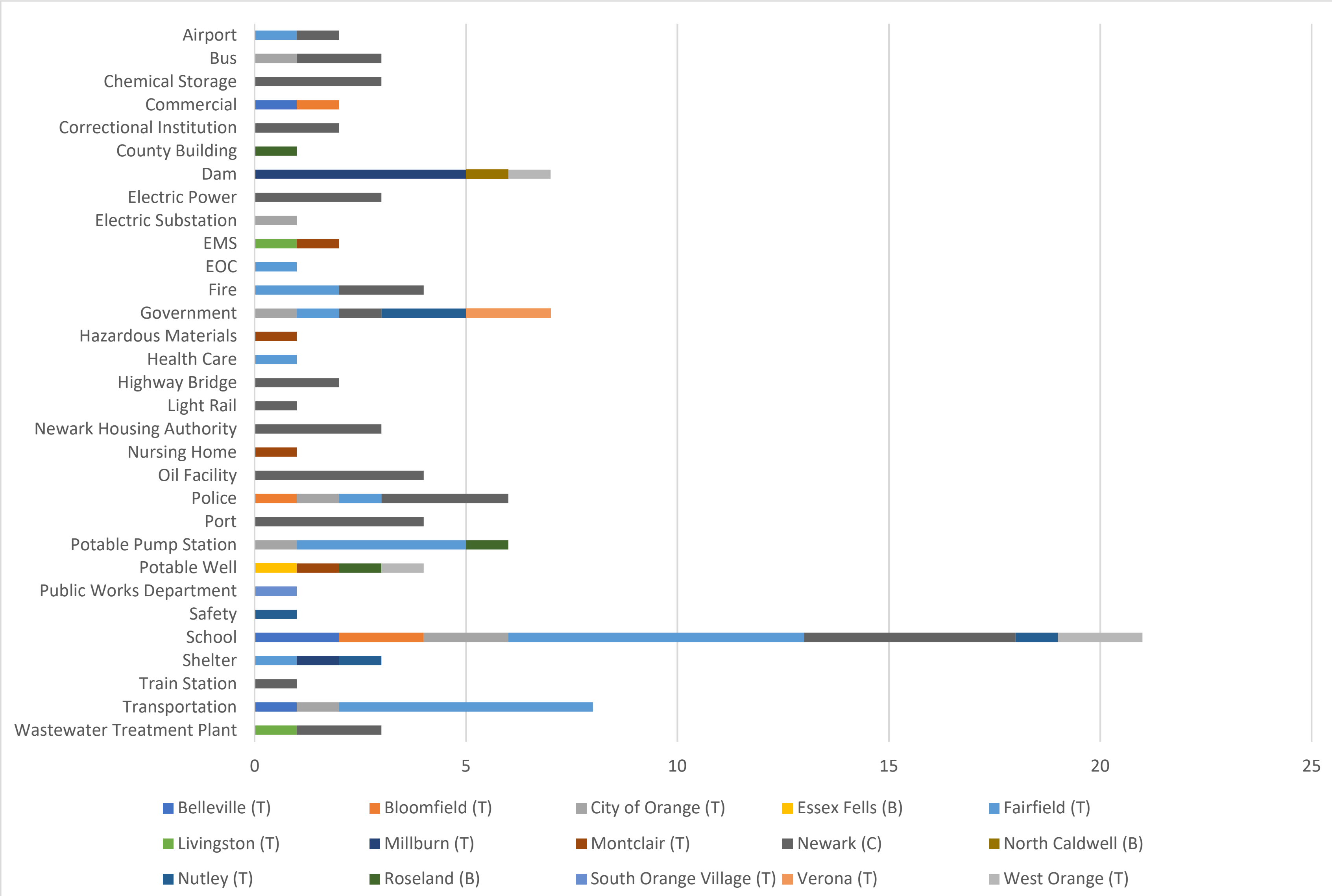
Note: Critical facility total includes lifelines.

Figure 4.3.6-9. Distribution of Critical Facilities in the 1-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2014/2017/2018; Essex County, 2019

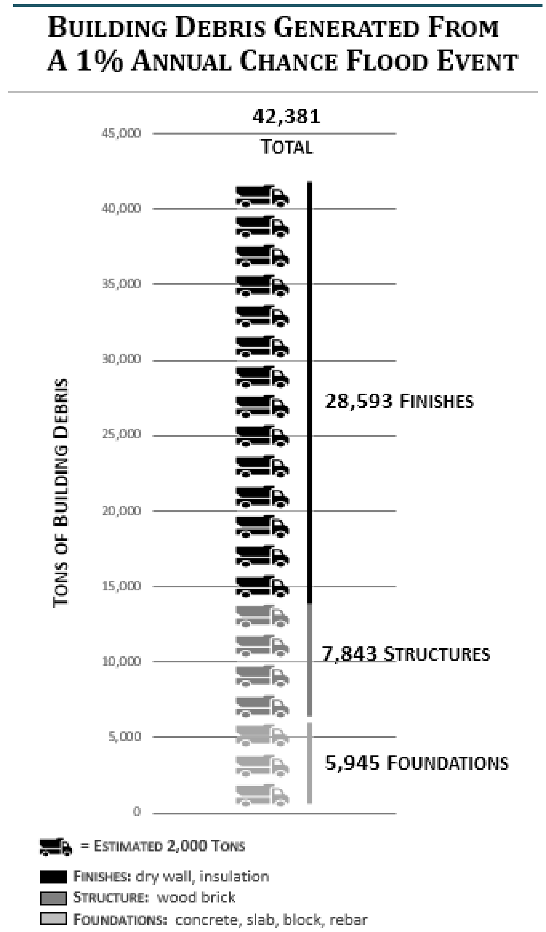
Figure 4.3.6-10. Distribution of Critical Facilities in the 0.2-Percent Annual Chance Flood Event Floodplain by Type and Municipality



Sources: FEMA 2014/2017/2018; Essex County, 2019

Impact on the Economy

Exhibit 4.3.6-7. Debris Generated



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, and effects on tourism. In areas that are directly flooded, renovations of commercial and industrial buildings may be necessary, disrupting associated services. Refer to the section earlier which discusses direct impacts to buildings in Essex County.

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. As presented in Figure 4.3.6-8, 82 critical facilities are exposed and potentially vulnerable to the 1-percent annual chance flood event.

Debris management may also be a large expense after a flood event. HAZUS-MH v4.2 estimates the amount of structural debris generated during a flood 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.). These distinctions are necessary because of the different types of equipment needed to handle debris. Table 4.3.6-20 summarizes the HAZUS-MH v4.2 countywide debris estimates for the 1-percent annual chance flood event. This table only estimates structural debris generated by flooding and does not include non-structural debris or additional potential damage and debris possibly generated by wind that may be associated with a flood event or storm that causes flooding.

Table 4.3.6-20. Estimated Debris Generated from the 1-Percent Flood Event

Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
42,381	28,593	7,843	5,945

Source: HAZUS-MH v4.2

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 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 the flood hazard if located within the floodplain and mitigation measures are not considered. 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.

Each municipality identified areas of recent development and proposed development in their community. Development that could be located using an address or Parcel ID were geocoded and overlain with the FEMA DFIRM boundaries to determine exposure to the flood hazard. There are 7 recent, proposed, and future developments vulnerable to the flood hazard; this represents approximately 25.0 percent of the 28 identified developments. There is 1 development site located in the 1-percent annual chance flood event boundary, 1 of which is a recent development. There are 3 proposed developments located in the 0.2-percent annual chance flood event boundary. Refer to Section 3 (County Profile), and Volume II Section 9 (Jurisdictional Annexes) for more detailed information on potential new development areas in Essex County. Refer to Figure 4.3.6-11 for a map of proposed new development and the FEMA DFIRM boundaries for Essex County.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population change is not expected to have a measurable effect on the overall vulnerability of the County's population over time. Those moving from areas of lower vulnerability to higher will increase their vulnerability to flood. This includes areas that are directly impacted by flood events and those that are indirectly impacted (i.e., isolated neighborhoods, flood-prone roadways, etc.). Refer to Section 4.3.1, Population Trends in the 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 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.

The North Jersey Transportation Planning Authority (NJTPA) recently completed the Passaic River Basin Climate Resilience Planning Study (2019) which assessed the potential for increasingly severe and frequent storm and heat events along with rising sea levels in the Passaic River Basin. The riverine and coastal spatial data generated as a result of this study (25- and 100-year precipitation events for today and planning horizons 2045 and 2080) were used to help understand the change in building exposure as the climate changes. Table 4.3.6-21 summarizes the estimated number of buildings exposed to future projected flood inundation extents. It is important to note that not the entire 1-percent annual chance floodplain was included in this analysis; only the existing 100-year precipitation event in the Passaic River Basin as depicted on Figure 4.3.6-12. As summarized in the table, the climate models anticipate an increase in flood inundation extents in 2045 and 2080 for the 25- and 100-year precipitation events, respectively, leading to an increase in number of buildings exposed to the hazard.

Table 4.3.6-21. Estimated Building Exposure to the Existing and Projected 25- and 100-Year Precipitation Events

Municipality	Existing 25-year Event (4%)	2045 25-year Event	Existing 100-year Event (1%)	2080 100-year Event*
Belleville Township	8	33	15	101
Fairfield Township	230	256	352	520
Newark	404	475	485	569
North Caldwell Borough	0	0	0	2
Nutley Township	0	0	0	3
West Caldwell Township	0	0	2	6
Total	**642**	**764**	**854**	**1,201**

Source: NJTPA 2019
**The all representative concentration pathway scenario was used for this analysis.*

In addition, 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.

Change of Vulnerability Since 2015 HMP

The entire County continues to be vulnerable to the flood hazard. Several differences exist between the 2015 HMP flood vulnerability assessment and the assessment performed for this update. An updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the hazard areas. The 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. In addition, updated DFIRMs for Essex County were released since the 2015 HMP and used to inform this analysis. Due to changes in the data used, a direct comparison of the change in vulnerability is challenging. The updated vulnerability assessment provides a more current exposure analysis for the County.

There have been changes to the County's NFIP statistics since the 2015 HMP. The 2015 HMP summarized 2014 NFIP statistics provided by FEMA, while the 2019 HMP summarizes 2018 and 2019 NFIP statistics. Since 2015, the County has seen an increase in the number of claims and repetitive and severe repetitive loss properties. There were 1,110 new claims totally an estimated $3 million, and an increase of 104 repetitive and severe repetitive loss properties since 2014. Most of these additional repetitive loss properties are located in the Township of Fairfield (27). There was an overall decrease of 198 NFIP policies with some municipalities experiencing an increase while others a decrease. The greatest increase in policies occurred in the Township of Belleville (238 policies), while the greatest decrease in policies occurred in the Township of Fairfield (-132 policies).

Overall, the vulnerability assessment presented uses a more accurate and updated building inventory, which provides more accurate exposure and potential loss estimates for Essex County. Essex County and its municipalities continue to be vulnerable to the flood hazard; however, progress has been made to decrease vulnerability through the implementation of mitigation projects (i.e., acquisition and elevation of flood-prone properties). Mitigation measures undertaken by each jurisdiction are described in the jurisdictional annexes in Section 9 of this HMP.

Figure 4.3.6-11. Potential New Development and Flood Boundaries

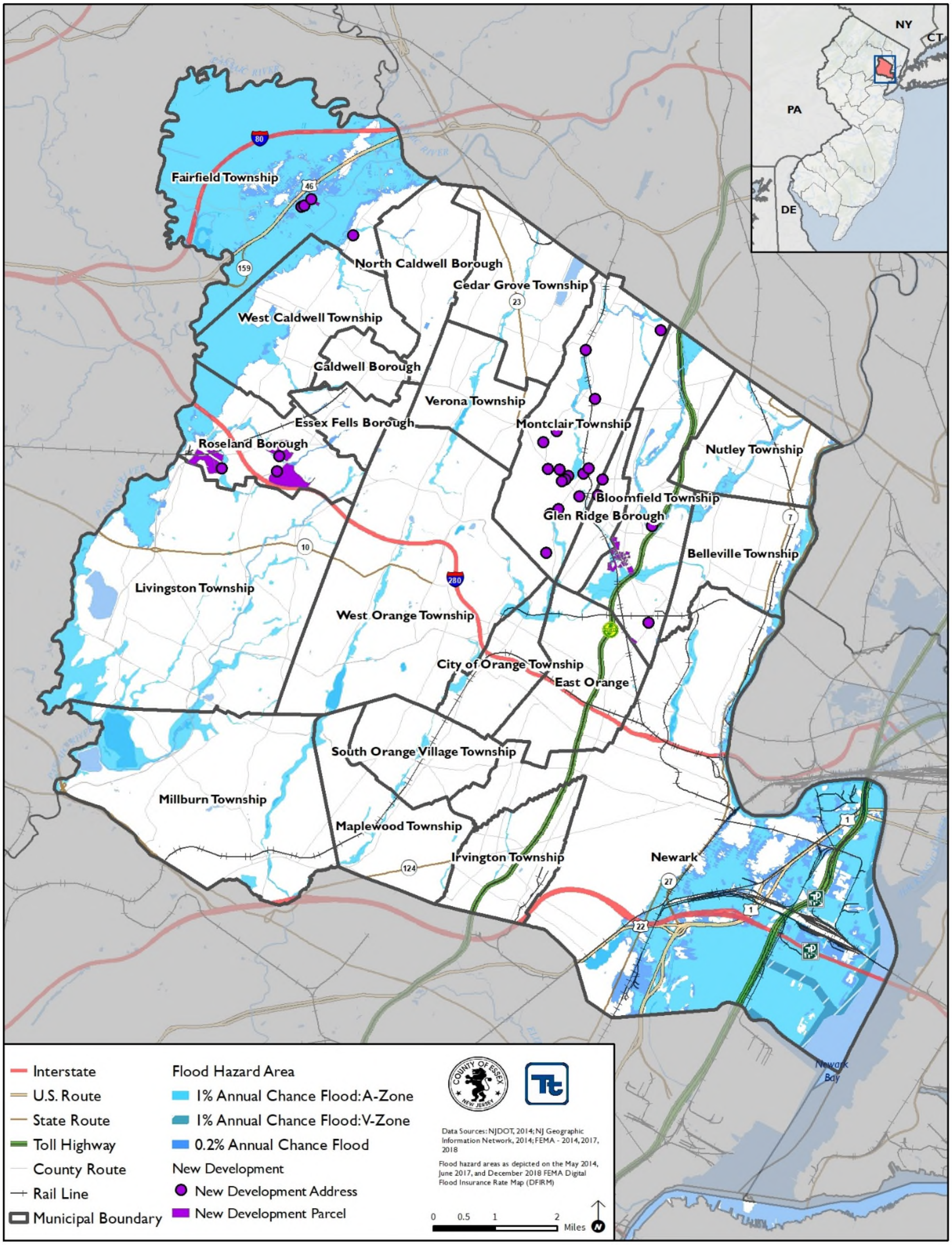
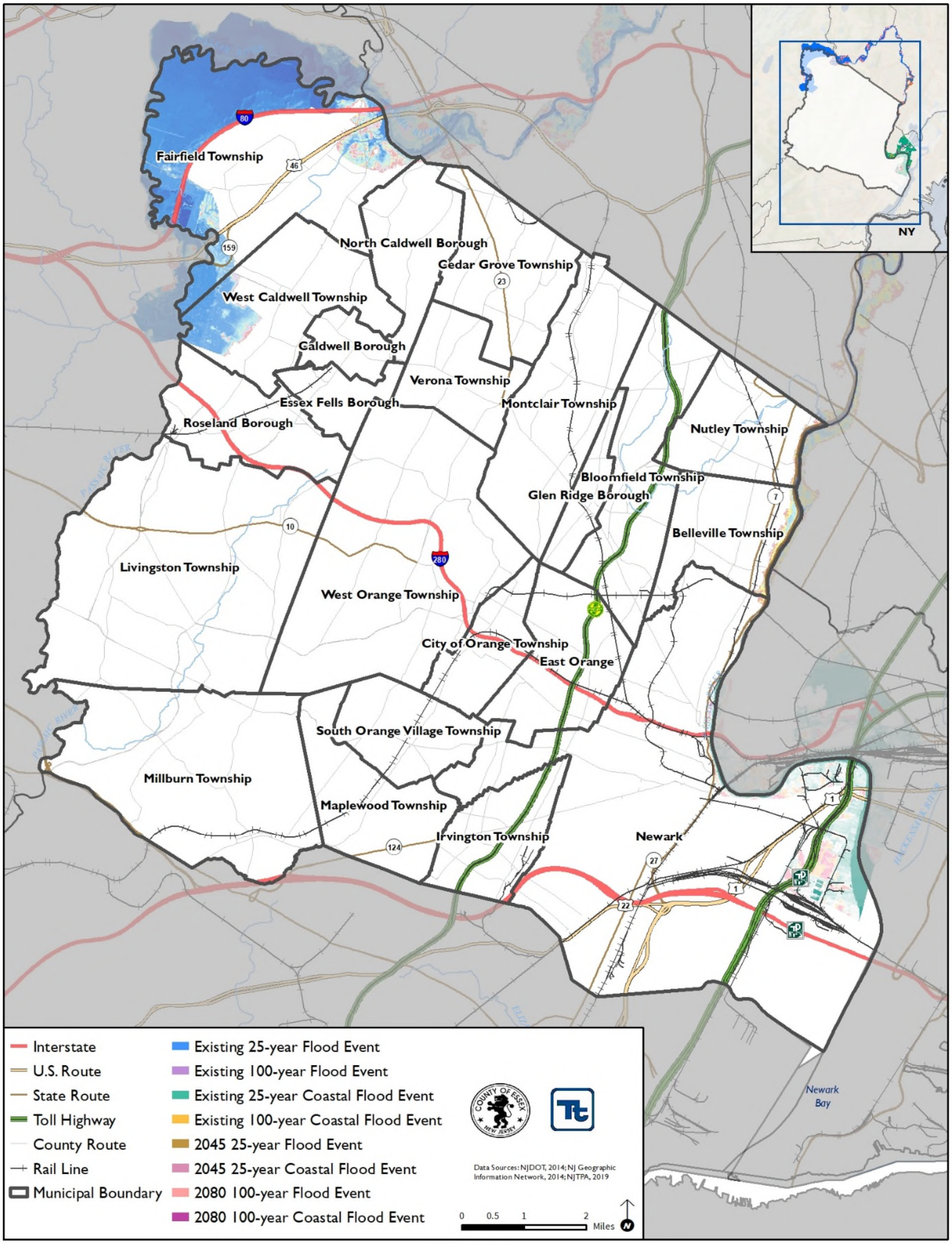


Figure 4.3.6-12. NJTPA Study Area



4.3.7 Geological Hazards

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 Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2014 and 2019.
- Updated New Jersey Geological Survey and Water landslide susceptibility data (2016) was utilized for the risk assessment.

4.3.7.1 Profile

Hazard Description

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 (USGS 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 1975). 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).

Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors that include:

- Erosion by rivers, glaciers, or ocean waves create over-steepened slopes
- Rock and soil slopes are weakened through saturation by snowmelt or heavy rains
- Earthquakes create stresses that make weak slopes fail
- Earthquakes of magnitude 4.0 and greater have been known to trigger landslides
- Volcanic eruptions produce loose ash deposits, heavy rain, and debris flows
- Excess weight from accumulation of rain or snow or stockpiling of rock or ore, from waste piles or man-made structures may stress weak slopes to failure (USGS 2013).

Landslides may be triggered by both natural and human-caused changes in the environment. Warning signs for landslide activity include:

- Springs, seeps, or saturated ground in areas that have not typically been wet before
- New cracks or unusual bulges in the ground, street pavement, or sidewalk
- Soil moving away from foundations
- Ancillary structures, such as decks and patios, tilting and moving relative to the main house
- Tilting or cracking of concrete floors and foundations
- Broken water lines and other underground utilities
- Leaning telephone poles, trees, retaining walls, or fences
- Offset fence lines
- Sunken or down-dropped road beds
- Rapid increase in creek water levels, possibly accompanied by increased turbidity
- Sudden increase in creek water levels while rain is still falling or just recently ended
- Sticking doors and windows, and visible open spaces indicating jambs and frames out of plumb
- A faint rumbling sound that increases in volume as the landslide nears
- Unusual sounds, such as trees cracking or boulders knocking together (USGS 2013).

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 the 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 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 those that involve 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 serve to accelerate the natural processes of creation of soil voids, which can have a direct impact on sinkhole creation (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).

Expansive Soils

Expansive soil is usually comprised of a fine-grained clay that occurs naturally and is generally found in areas that historically were a flood plain or lake area, but can occur in hillside areas also. Expansive soil is subject to swelling and shrinkage, varying in proportion to the amount of moisture present in the soil (Essex County HMP 2007).

Other than soil moisture, the most important property affecting the degree of volume change in a soil is mineralogy. Clay minerals are the most common cause of expansive soils, although calcium sulfates (gypsum and anhydrite) and iron sulfides can also experience volume changes. Generally speaking, expansive soils often appear sticky when wet, and have surface cracks when dry (Essex County HMP 2007).

Structures built on this type soil tend to subside. Expansive movement can easily crack foundations, slabs, walls, stucco and fences. Because soils dry from the surface down, this type of soil can successfully host structures if foundations and/or footings are placed deep enough into the soil. If the surface receives enough moisture so that the soil column never dries to the bottom of the footing, the structure should not settle or lift (Essex County HMP 2007).

Location

Within Essex County, the highest elevations of approximately 660 feet above sea level are found at four areas along the Second Watchung Mountain within Verona, North Caldwell and Essex Fells. Areas along the First Watchung Mountain near Eagle Rock Reservation and Mills Reservation reach elevations of approximately 600 feet. Elevations decrease eastward of the first Watchung; ranging between 500 and 600 feet approximately eight miles outside central Newark and decreasing to around 200 feet five miles from the city. Elevations are near sea level at Newark Bay (Essex County Environmental Resource Inventory 2007).

Essex County contains a number of steep slope areas, particularly along the Watchung Ridges. “Steep” slopes are those slopes typically at a 15% gradient or greater. S lopes included in the mapping are between 15% and 60% gradients. Essex County steep slope areas exist primarily along the second Watchung Mountain Ridge in Cedar Grove, Verona, and south through portions of the Second and along the First Watchung Mountain Ridge in West Orange and through Maplewood. NJDEP mapping identifies steep slopes extending along the eastern edge of the First Watchung Mountain from South Mountain in Montclair southwest through West Orange and South Orange. Many additional small areas of steep slopes are mapped in central Essex County. In east Essex County, pockets of steep slope areas are mapped around portions of Weequahic Lake in Newark and near Yantacaw Park in Nutley (Essex County Environmental Resource Inventory 2007).

Landslides

Landslides are common in New Jersey, primarily in the northern region of the State. The New Jersey Geologic Survey (currently known as the New Jersey Geological and Water Survey) determined landslide susceptibility for nine counties in New Jersey (Bergen, Essex, Hudson, Middlesex, Monmouth, Morris, Passaic, Somerset, and Union). Areas within these counties are classified into Class A, B, and C landslide susceptible classes, and several subclasses within the main classifications. These classes are consistent with HAZUS User Manual Table 9.2. Class A areas in New Jersey include classes AII, AIV, AVI which is strongly cemented rock at varying slope angles; Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles; and Class C includes classes CV, CVI, CVII, CIX, and CX which includes shale and clayey soil at varying slope angles.

Figure 4.3.7-1 shows landslide susceptibility in Essex County. A majority of the County is not susceptible to landslides. There are small areas in the central portion of the County that are susceptible to landslide events (Class AI, AII, AIV, AVI, BIII, and BIV). Table 4.3.7-1 summarizes the area within each class. According to the figure and table, the Townships of Fairfield and Millburn have the largest areas landslide susceptible areas. Overall, approximately 1.4 square miles of Essex County are located in landslide hazard areas; 0.42 square miles in Class A and 0.94 square miles in Class B.

Figure 4.3.7-1. Landslide Susceptibility in Essex County

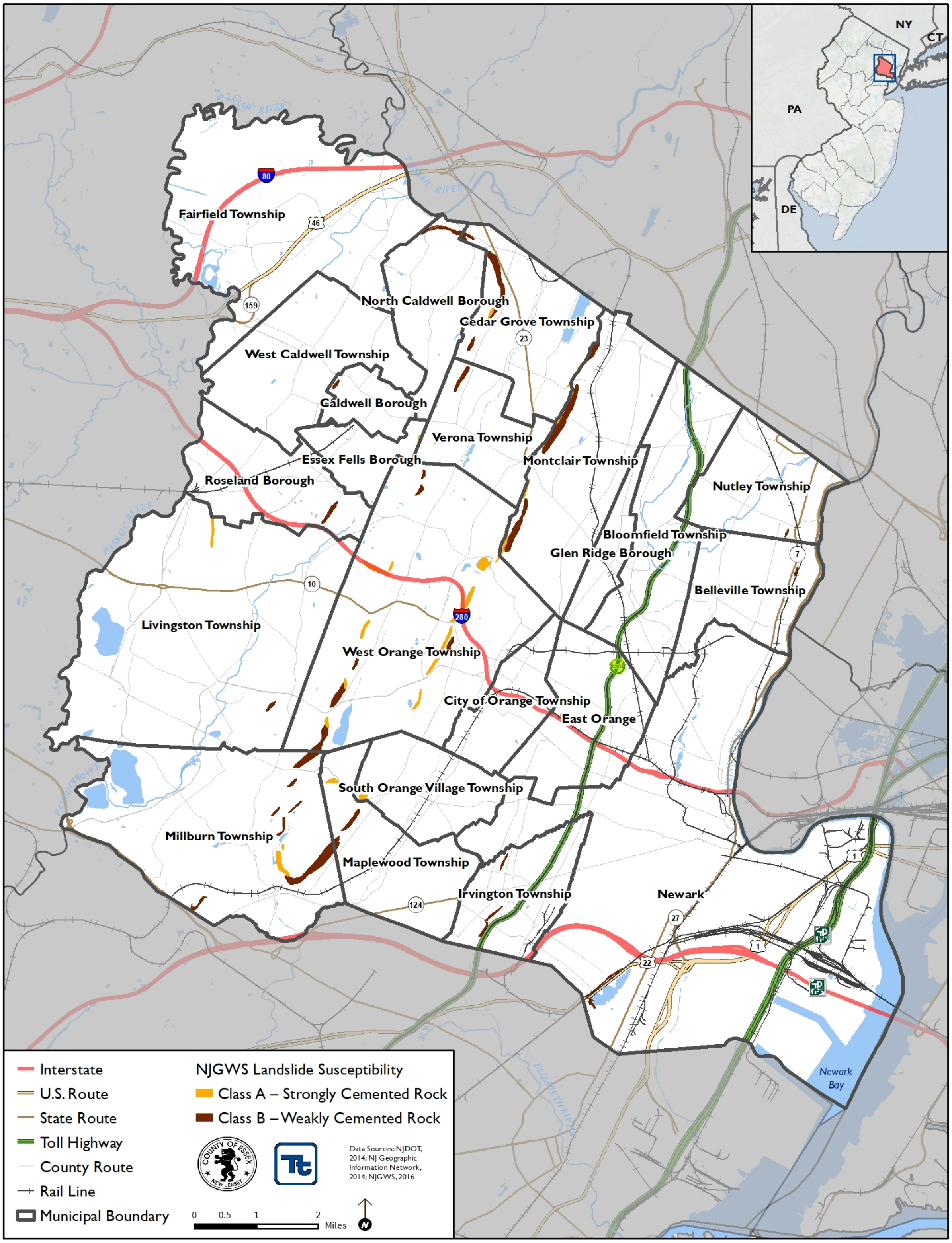


Table 4.3.7-1. Total Land Area Located in the Landslide Susceptible Areas

Municipality	Total Area (acres)	NJGWS-Defined Landslide Susceptible Areas	
		Class A and B (acres)	% Total
Township of Belleville	2,156	4	0.2%
Township of Bloomfield	3,434	0	0.0%
Borough of Caldwell	759	5	0.7%
Township of Cedar Grove	2,791	103	3.7%
City of East Orange	2,514	0	0.0%
Borough of Essex Fells	906	3	0.3%
Township of Fairfield	6,618	0	0.0%
Borough of Glen Ridge	818	3	0.4%
Township of Irvington	1,866	22	1.2%
Township of Livingston	9,040	20	0.2%
Township of Maplewood	2,480	37	1.5%
Township of Millburn	6,324	166	2.6%
Township of Montclair	3,995	179	4.5%
City of Newark	16,778	21	0.1%
Borough of North Caldwell	1,968	26	1.3%
Township of Nutley	2,186	3	0.1%
City of Orange Township	1,418	0	0.0%
Borough of Roseland	2,361	16	0.7%
Township of South Orange Village	1,822	9	0.5%
Township of Verona	1,796	24	1.3%
Township of West Caldwell	3,239	0	0.0%
Township of West Orange	7,756	230	3.0%
Essex County (Total)	**83,023**	**870**	1.0%

Source: NJGWS 2016

Notes: Class A includes classes AII, AIV, AVI which is strongly cemented rock at varying slope angles. Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles. No Class C soils types were identified in Essex County. Total area includes land and water.

% percent

sq mi square miles

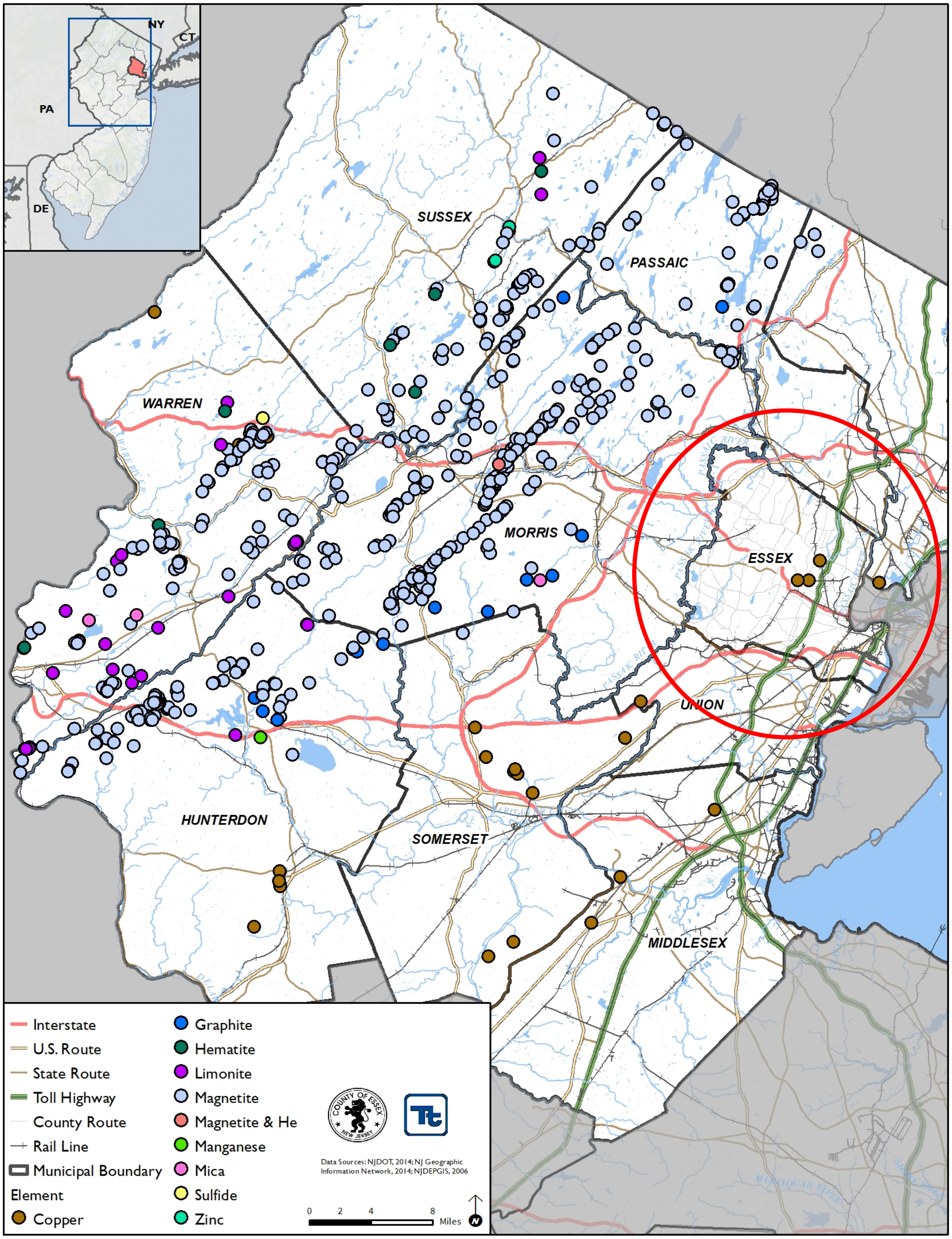
Subsidence/Sinkholes

New Jersey is susceptible to the effects of subsidence and sinkholes, primarily in the northern region of the State. The State's susceptibility to subsidence is due in part to the number of abandoned mines throughout New Jersey. The State historically was an iron-producing state and the first mines in New Jersey were drilled in the early

1700s, with operations continuing until 1986 when the last active mine was closed. 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.

Figure 4.3.7-2 shows the location of the mapped abandoned mines in New Jersey. The data from NJGWS and the figure indicate that Essex County has three abandoned mines. All three mines in Essex County were copper mines: located in East Orange, Orange, and Glen Ridge (NJGWS 2006).

Figure 4.3.7-2. Abandoned Mines in New Jersey



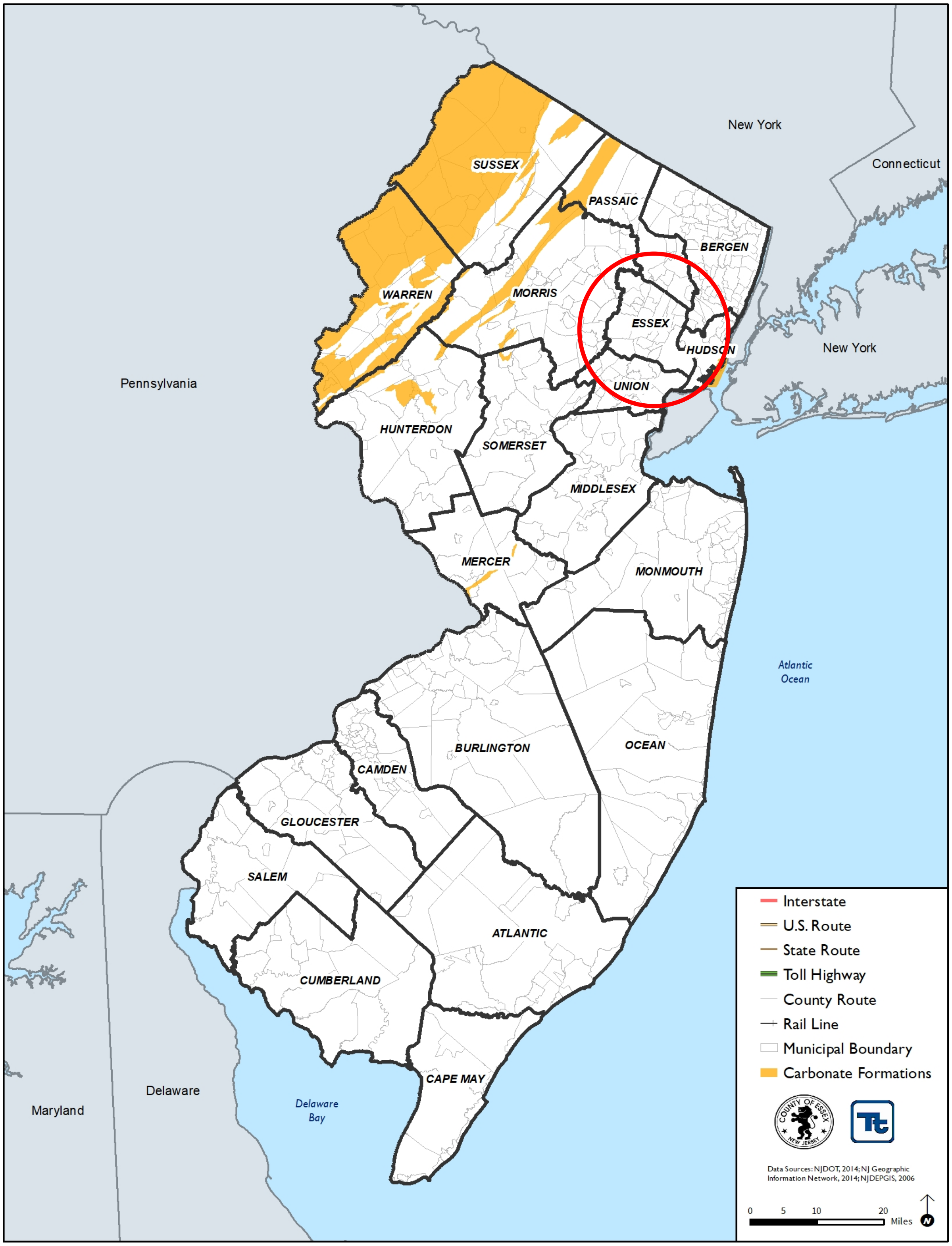
Note: *The red circle indicates the location of Essex County.*

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. No collapse sinkholes have been identified; however, there are some features which could be either very shallow solution depressions or wind blowout features. Sinkholes in New Jersey are generally concentrated in the northwestern part.

Areas underlain by carbonate rock may contain surface depressions and open drainage passages making such areas unstable and susceptible to subsidence and surface collapse. As a result, the alteration of drainage patterns, placement of impervious coverage, grade changes or increased loads can result in land subsidence and sinkhole formation (Piefer 2006).

Figure 4.3.7-3 illustrates the locations of carbonate-bearing geologic formations of New Jersey. These formations are areas of potential natural subsidence. These geologic units contain a high enough percentage of carbonate minerals such as calcite and/or dolomite for karst features such as sinkholes to form. Some of these units are more prone to sinkhole development than others due to a greater carbonate content in the rock. Although not every unit listed has documented sinkholes, all are susceptible to dissolution by groundwater so various karst features, including sinkholes, may be found on any of these units. According to this figure, Essex County does not contain carbonate rock formations.

Figure 4.3.7-3. Carbonate Rock Regions of New Jersey



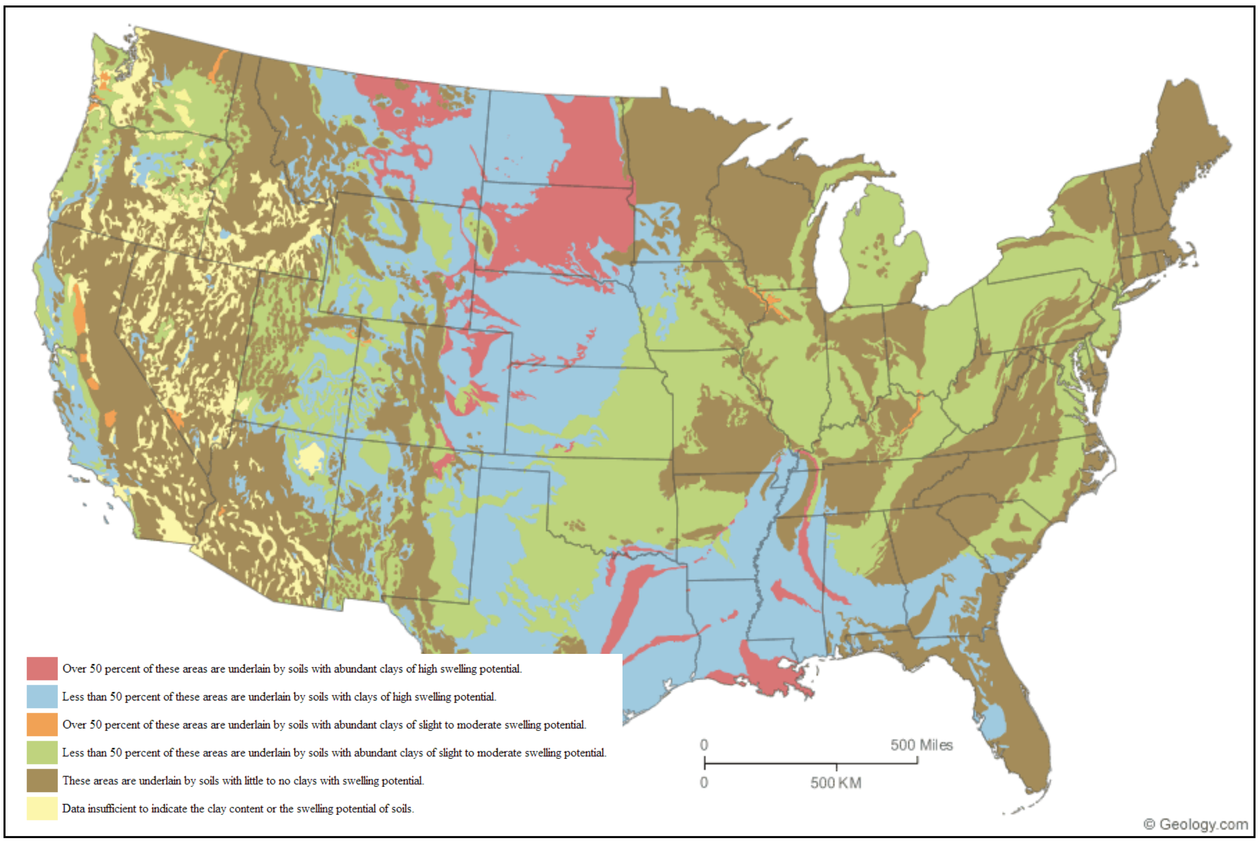
Note: The red circle indicates the location of Essex County. The County does not have carbonate formations.

While fewer karst features have been mapped in existing urban areas, human activity can often be the cause of a subsidence or sinkhole event. Furthermore, the lack of karst features exhibited in maps of urban areas is likely a result of development activities that disguise, cover, or fill existing features rather than an absence of the features themselves. Leaking water pipes or structures that convey stormwater runoff may also result in areas of subsidence as the water dissolves substantial amounts of rock over time. In some cases, construction, land grading, or earthmoving activities that cause changes in stormwater flow can trigger sinkhole events. Subsidence or sinkhole events may occur in the presence of mining activity, especially in areas where the cover of a mine is thin, even in areas where bedrock is not necessarily conducive to their formation. Piggott and Eynon (1978) indicated that sinkhole development normally occurs where the interval to the ground surface is less than three to five times the thickness of the extracted seam, and the maximum interval is up to ten times the thickness of the extracted seam. Sub-surface (i.e. underground) extraction of materials such as oil, gas, coal, metal ores (copper, iron, and zinc), clay, shale, limestone, or water may result in slow-moving or abrupt shifts in the ground surface.

Expansive Soils

Portions of New Jersey are underlain by soils with little to no clays with swelling potential. Essex County has less than 50 percent of the area underlain by soils with abundant clays of slight to moderate swelling potential (Figure 4.3.7-4).

Figure 4.3.7-4. Expansive Soils of the United States



Source: Geology.com 2014

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% of a given area has been involved in landsliding; medium incidence means that 1.5 to 15% of an area has been involved; and low incidence means that less than 1.5% of an area has been involved (Geological Hazards Program Date Unknown).
- 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 (Geological Hazards Program Date Unknown, OAS 1991).

Subsidence/Sinkhole

Subsidence and sinkholes occur 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 (Galloway et al. 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 2014).

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 2014).

Expansive Soils

The plasticity index (PI) is expressed as the numerical difference between the plastic limit (the percent moisture content at which clay passes from the solid to the plastic state) and the liquid limit (the percent moisture content at which clay passes from the plastic to liquid state). The PI bears a direct relation to the amount and type of clay minerals present and to the orientation and size of clay particles. Other factors remain constant, the PI increases with amount of clay minerals, decreases with degree of parallel orientation of the clay minerals, and decreases with clay particle size (FEMA 1997).

The PI is generally a good indicator of swelling potential. Scientists have found the PI to be one of the most useful indicators of swelling potential. Expansive soils can be recognized either by visual inspection in the field or by conducting laboratory analyses (FEMA 1997).

Previous Occurrences and Losses

Between 1954 and 2019, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for one geological hazard-related event, classified as a mudslide. Of those events, Essex County has not been included any declarations (EM and DR) (FEMA 2019).

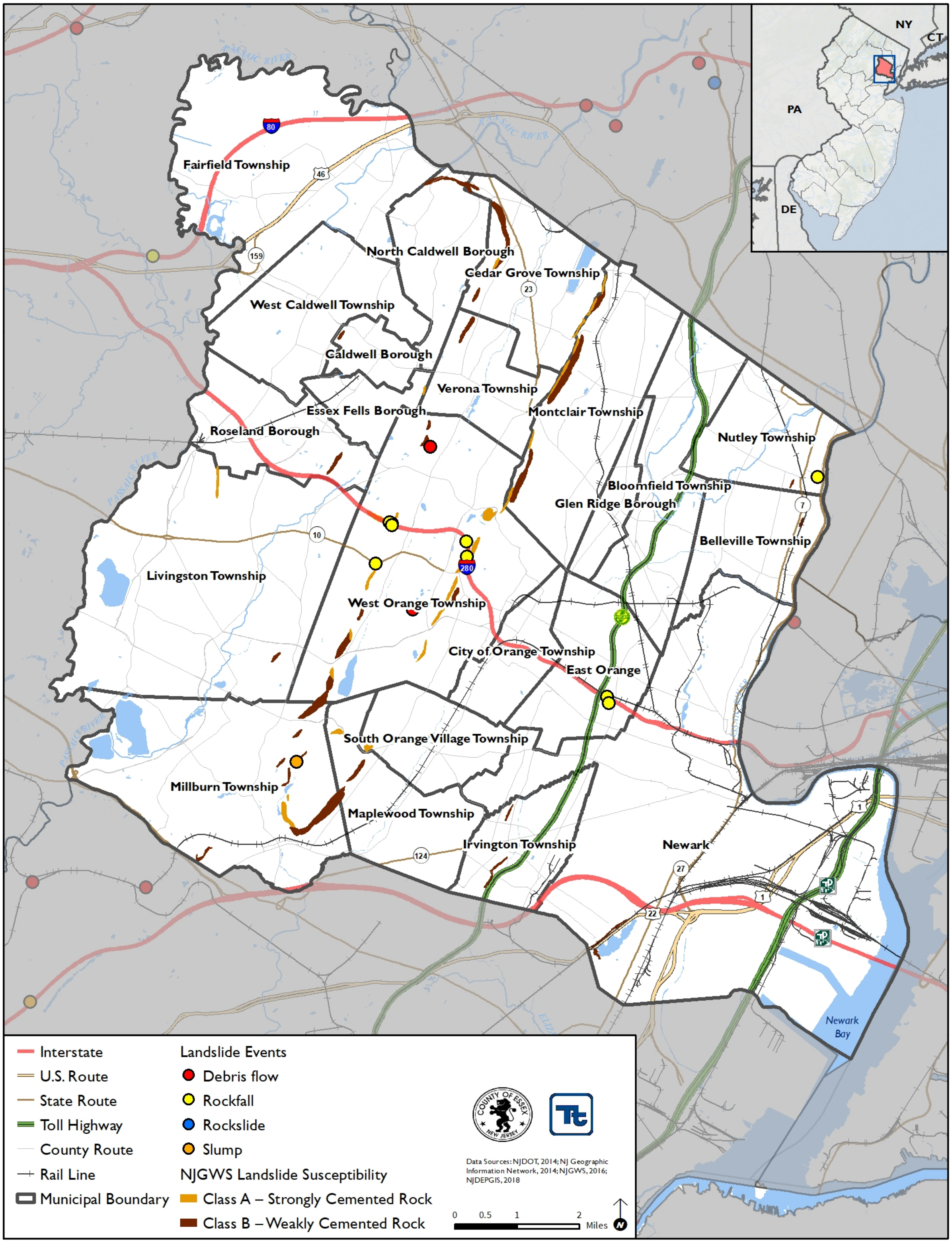
Geological hazard events that have impacted Essex County between 2014 and 2019 are identified in Table 4.3.7-2. With geological hazard documentation for New Jersey and Essex County being so extensive, not all sources have been identified or researched. Therefore, Table 4.3.7-2 may not include all events that have occurred in the County.

Table 4.3.7-2. Geological Hazard Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
April 2014	Weathering	N/A	N/A	Rockfall along Rt. 280 in East Orange off ramp leading to Garden State Parkway, estimated location.
December 6, 2014	Rockfall	N/A	N/A	A 3,000-4,000 lb. boulder rolled down a hill and crashed into a car. The rockfall was attributed to prior heavy rains earlier in the month. The boulder caused about $8,000 worth of damage to a Subaru Forrester.

Source: NJGWS 2017 NOAA-NCEI 2019, NJOEM 2019
N/A Not applicable
NCDC National Climatic Data Center
NJDEP New Jersey Department of Environmental Protection
NOAA National Oceanic and Atmospheric Administration

Figure 4.3.7-5. Landslide Susceptibility Areas and Historic Landslide Events



Probability of Future Occurrences

Based upon risk factors for and past occurrences, it is likely that geological hazards will occur in Essex County in the future. It is estimated that Essex County will continue to experience direct and indirect impacts of geological hazards and its impacts on occasion, with the secondary effects causing potential disruption or damage to communities.

In Section 4.1, the identified hazards of concern for Essex 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 geological hazards in the County is considered 'occasional'.

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, 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.

Expansive Soils

As the climate changes and temperatures increase, soils have the potential to dry out, resulting in expansive soils shrinking and failing. This could lead to a big problem in residential areas where buildings have shallow foundations; the soils will be unable to support the weights of a building. When expansive soils get dry, they begin to repel moisture instead of soaking it up. The water is more likely to run off, creating flash floods. It takes a slow and steady rain, over an extended period of time, to restore expansive clay soils (Gehr 2014).

4.3.7.2 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and/or vulnerable to the identified hazard. For geological hazards, NJGWS landslide susceptibility areas have been identified as the hazard area; due the lack of spatially delineated subsidence hazard areas in the County, a spatial analysis was not conducted. 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 would be an isolated incidence and impact the populations within the immediate area of the incident. Specifically, the population located downslope of the landslide hazard areas are particularly vulnerable to this hazard. 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 4.3.7-3 summarizes the population located in Class A and Class B landslide susceptible areas. The Township of West Orange has the greatest number of populations located in Class A areas with 256 people (less than 1-percent of its total), while the Township of Irvington has the greatest number of populations located in Class B areas with 838 peoples (1.5-percent of its total).

Socially vulnerable populations (e.g. the elderly and low-income populations) are particularly vulnerable to a hazard event. Within Class A areas, there are approximately 78 people over the age of 65 and 16 people below the poverty level. As for populations within Class B areas, there are approximately 334 people over the age 65 and 219 people considered low income populations.

Exhibit 4.3.7-1. Estimated Population Exposure to Landslide Susceptibility Areas

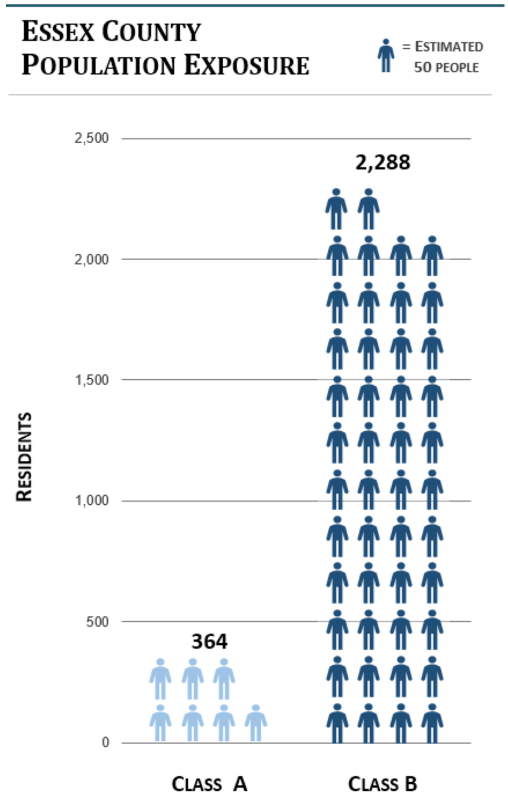


Table 4.3.7-3. Estimated Population Located in the Landslide Hazard Areas

Municipalities	American Community Survey (2013-2017) Population	NJGWS-Defined Landslide Susceptible Areas			
		Class A	% Total	Class B	% Total
Township of Belleville	36,383	0	0.0%	5	0.0%
Township of Bloomfield	48,892	0	0.0%	0	0.0%
Borough of Caldwell	8,032	0	0.0%	43	<1%
Township of Cedar Grove	12,638	25	<1%	114	<1%
City of East Orange	65,151	0	0.0%	0	0.0%
Borough of Essex Fells	2,095	8	0.4%	0	0.0%
Township of Fairfield	7,671	0	0.0%	0	0.0%
Borough of Glen Ridge	7,668	0	0.0%	3	0.0%
Township of Irvington	54,715	0	0.0%	838	1.5%
Township of Livingston	29,955	12	<1%	25	<1%
Township of Maplewood	24,706	0	0.0%	117	0.5%
Township of Millburn	20,387	0	0.0%	314	1.5%
Township of Montclair	38,572	41	<1%	497	1.3%
City of Newark	282,803	0	0.0%	0	0.0%
Borough of North Caldwell	6,637	0	0.0%	57	<1%
Township of Nutley	28,829	0	0.0%	76	<1%
City of Orange Township	30,731	0	0.0%	0	0.0%
Borough of Roseland	5,907	0	0.0%	13	<1%
Township of South Orange Village	16,503	18	<1%	0	0.0%
Township of Verona	13,585	3	0.0%	0	0.0%
Township of West Caldwell	10,932	0	0.0%	0	0.0%
Township of West Orange	47,609	256	<1%	186	<1%
Essex County (Total)	**800,401**	**364**	**<1%**	**2,288**	**<1%**

Sources: American Community Survey 5-year Estimate, 2017; NJGWS, 2016

Note: Class A includes classes AII, AIV, AVI which is strongly cemented rock at varying slope angles. Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles. No Class C soils were identified in Essex County.

NJGWS New Jersey Geological Water Survey

Impact on General Building Stock

In general, the built environment located in the high landslide susceptibility area and the population, structures and infrastructure located downslope are vulnerable to this hazard. Landslides also have the potential of destabilizing the foundation of structures, which may result in monetary losses to businesses and residents. There are 612 buildings with a replacement cost value of $404 million located in these areas countywide. The Township of West Orange has the greatest number of buildings located in Class A areas with 62 buildings (less than 1-percent of its total) with an estimated replacement cost of $52 million, while the Township of Montclair has the greatest number of buildings located in Class B areas with 140 buildings (1.5-percent of its total) with an estimated replacement cost of $91 million. Table 4.3.7-4 summarizes the exposed building stock located in Class A and Class B landslide susceptibility areas by municipality.

Exhibit 4.3.7-2. Estimated Building Exposure to Landslide Susceptibility Areas

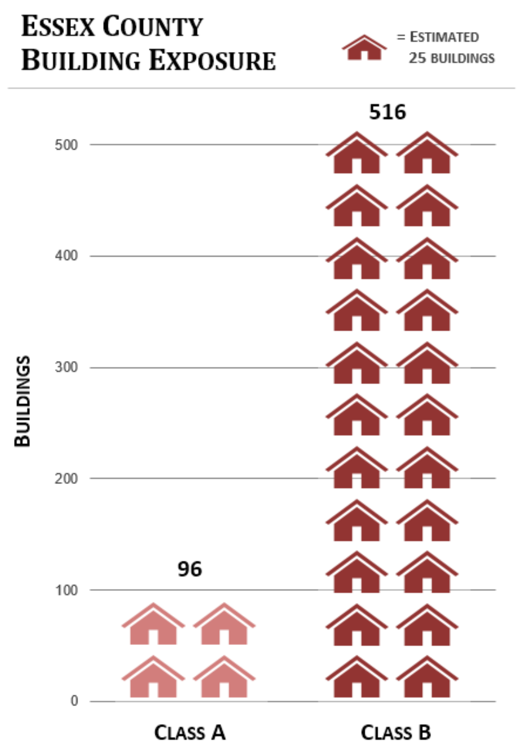


Table 4.3.7-4. Number of Buildings in the Landslide Hazard Area by Municipality

Municipality	Total Number of Buildings	Total Replacement Cost Value (RCV)	Class A				Class B			
			Number of Buildings - Class A	% of Total	RCV - Class A	% of Total	Number of Buildings - Class B	% of Total	RCV - Class B	% of Total
Township of Belleville	7,910	$4,483,250,138	0	0.0%	$0	0.0%	1	<1%	$359,884	<1%
Township of Bloomfield	11,720	$6,021,089,887	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Borough of Caldwell	1,738	$1,183,204,981	0	0.0%	$0	0.0%	8	<1%	$4,937,770	<1%
Township of Cedar Grove	3,944	$3,008,045,785	8	<1%	$9,889,827	<1%	35	<1%	$31,804,607	<1%
City of East Orange	7,908	$6,090,766,912	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Borough of Essex Fells	766	$527,629,662	3	<1%	$1,745,705	<1%	0	0.0%	$0	0.0%
Township of Fairfield	3,121	$6,082,819,367	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Borough of Glen Ridge	2,256	$1,095,474,263	0	0.0%	$0	0.0%	1	<1%	$593,925	<1%
Township of Irvington	7,934	$5,384,838,816	0	0.0%	$0	0.0%	120	1.5%	$40,533,104	<1%
Township of Livingston	9,795	$7,691,376,811	4	<1%	$2,322,170	<1%	9	<1%	$7,155,578	<1%
Township of Maplewood	6,738	$3,575,395,600	0	0.0%	$0	0.0%	33	<1%	$17,862,543	<1%
Township of Millburn	6,437	$5,241,567,136	0	0.0%	$0	0.0%	92	1.4%	$56,360,432	1.1%
Township of Montclair	9,436	$5,845,976,130	12	<1%	$10,037,037	<1%	140	1.5%	$91,235,148	1.6%
City of Newark	43,085	$40,970,549,425	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Borough of North Caldwell	2,095	$1,727,767,442	0	0.0%	$0	0.0%	18	<1%	$22,907,921	1.3%
Township of Nutley	7,945	$3,841,553,722	0	0.0%	$0	0.0%	13	<1%	$4,901,120	<1%
City of Orange Township	3,890	$3,520,865,708	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Borough of Roseland	1,794	$1,955,487,279	0	0.0%	$0	0.0%	4	<1%	$2,150,840	<1%
Township of South Orange Village	4,188	$2,877,374,186	6	<1%	$15,365,495	<1%	0	0.0%	$0	0.0%
Township of Verona	4,113	$2,213,338,613	1	<1%	$501,935	0.0%	0	0.0%	$0	0.0%
Township of West Caldwell	3,730	$3,533,044,820	0	0.0%	$0	0.0%	0	0.0%	$0	0.0%
Township of West Orange	11,845	$8,358,783,858	62	<1%	$52,442,928	<1%	42	<1%	$30,403,393	<1%
Essex County (Total)	**162,388**	**$125,230,200,542**	**96**	**<1%**	**$92,305,098**	**<1%**	**516**	**0.3%**	**$311,206,265**	**0.2%**

Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NJGWS, 2016

Note: NJGWS New Jersey Geological Water Survey

RCV Replacement Cost Value

Class A includes classes AII, AIV, AVI which is strongly cemented rock at varying slope angles. Class B includes classes BIII, BIV, BV, and BVI which includes weakly cemented rock and soil at varying slope angles. No Class C soils were identified in Essex County.

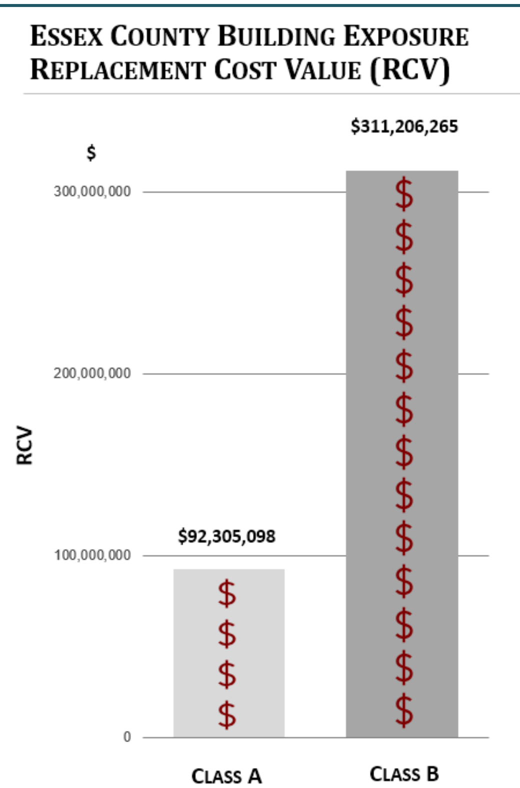
Impact on Critical Facilities

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 Philadelphia and New York City, and a landslide event could prevent travel to and from work.

Several other types of infrastructure may also be exposed to landslides, including water and sewer infrastructure. At this time all critical facilities, infrastructure, and transportation corridors located within the hazard areas are considered vulnerable until more information becomes available. Overall, there are 2 critical facilities located in landslide susceptible areas – both facilities are in the Township of Montclair (1 communication facility and 1 water tank).

Exhibit 4.3.7-3. Estimated RCV Exposure to Landslide Susceptibility Areas



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. Indirect costs, such as clean-up costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity are difficult to measure. Additionally, ground failure threatens transportation corridors, fuel and energy conduits, and communication lines (USGS 2005). Estimated potential damages to general building stock can be quantified as discussed above. For the purposes of this analysis, general building stock damages are discussed further.

Most of the areas that are potentially at risk to the landslide hazard are located along the ridges of the Watchung Mountains in areas that have steep slopes. Many of these areas remain undeveloped. Interstate 280 runs through the center of the County from the northwest corner of the County to the southeastern corner of the County and traverses both the western and eastern ridges of this mountain range. There is risk to potential landslides along this road in these areas; however, engineering standards would have likely mitigated landslide potential.

A landslide or sinkhole/subsidence event will alter the landscape. In addition to changes in topography, vegetation and wildlife habitats may be damaged or destroyed, and soil and sediment runoff will accumulate downslope potentially blocking waterways and roadways and impacting quality of streams and other water bodies. Additional environmental impacts include loss of forest productivity. There are 612 buildings located on steep slopes and account for $404 million, or less than 1-percent of the County's total building replacement cost. These losses would impact Essex County's tax base and the local economy.

I-280 and US-22 are major roadways that are used every day by commuters and provide access to major urban areas within and outside the County. I-280 runs west to east across the County and through some of the most densely populated areas in eastern Essex County, and provides access to major areas of both Morris and Hudson Counties. US-22 provides access to populations from Union County and other western New Jersey communities to the US-1&9 corridor in the City of Newark. Both of these roads traverse the landslide susceptible areas, and a landslide impacting these roadways would cause cascading impacts to populations throughout the region.

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 sloping land increases the rate of runoff, which reduces the rate of groundwater infiltration. This effect is exacerbated when vegetation is unnecessarily stripped from the slope (Essex County Environmental Resource Inventory 2007). Several municipalities within the County have steep slope ordinances to restrict development in these areas.

Each municipality identified areas of recent development and proposed development in their community. Developments that could be located using an address or Parcel ID were geocoded and overlain with the landslide hazard areas to determine vulnerability to flooding. No identified new development is located in a landslide susceptible area. Refer to Section 3 (County Profile), and Volume II Section 9 (Jurisdictional Annexes) for potential new development and landslide hazard areas in Essex County and Figure 4.3.7-6 which illustrates the proposed new development and the landslide hazard areas in Essex County.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time. As discussed above, I-280 and US-22 are exposed to the landslide hazard areas, and an increasing population will result in a greater vulnerability as more people are using these roadways on a daily basis. Refer to Section 4.3.1, Population Trends in the County Profile, includes a discussion on population trends for the county.

Climate Change

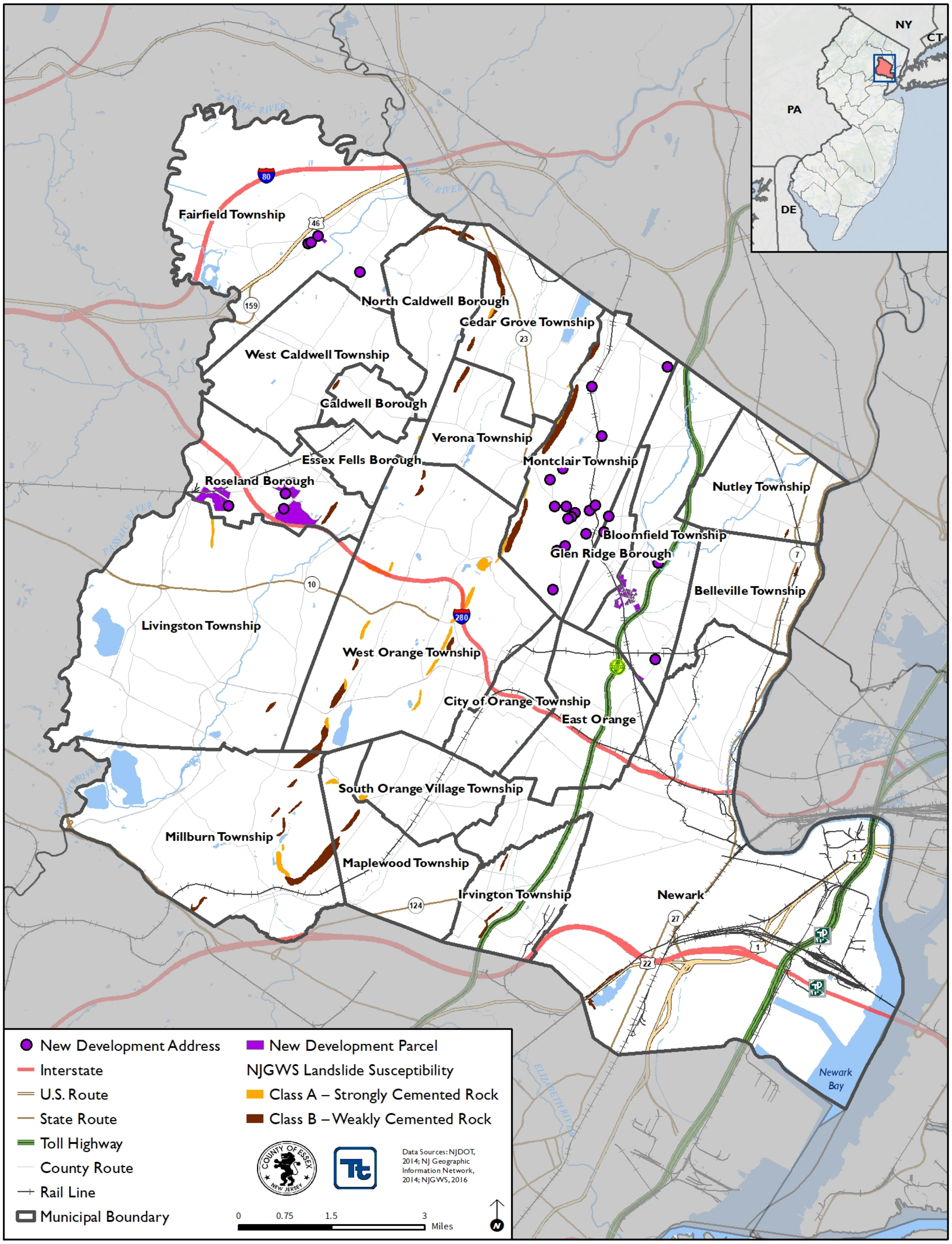
A direct impact of climate change on landslides is difficult to determine. Multiple secondary effects of climate change have the potential to increase the likelihood of landslides. Warming temperatures resulting in wildfires would reduce vegetative cover along steep slopes and destabilize the soils due 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. The projection in the increase of average temperatures may lead to an increase in the frequency of droughts. Sinkhole activity intensifies in some karst areas increases during periods of drought. With an increase in drought periods, the number of sinkholes can increase (Linares et al. 2016). 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.

Change of Vulnerability Since 2015 HMP

The entire County continues to be vulnerable to the landslide hazard. Several differences exist between the 2015 HMP and this update including updated hazard data and asset inventory data. As discussed in Section 4.2 (Methodology and Tools), an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the identified hazards of concern. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level in place of the 2010 U.S. Census blocks. Updated hazard areas were used as well; since the 2015 HMP, the NJGWS has released updated landslide susceptibility data. The updated data was used for the exposure analysis and to update HAZUS-MH's default earthquake data. Overall, the hazard area delineations remained unchanged, so any signification increase in vulnerability would be attributed to population growth and new development.

Figure 4.3.7-6. Potential New Development and Landslide Hazard Areas



4.3.8 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 Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2014 and 2019.

4.3.8.1 Profile

Hazard Description

For the purpose of this HMP update and as deemed appropriated by Essex County, the severe weather hazard includes thunderstorms, lightning, hailstorms, windstorms, and tornadoes which are defined in the sections below. Nor'easters, hurricanes and tropical storms are discussed in Section 4.3.2 Coastal Storm.

Thunderstorms

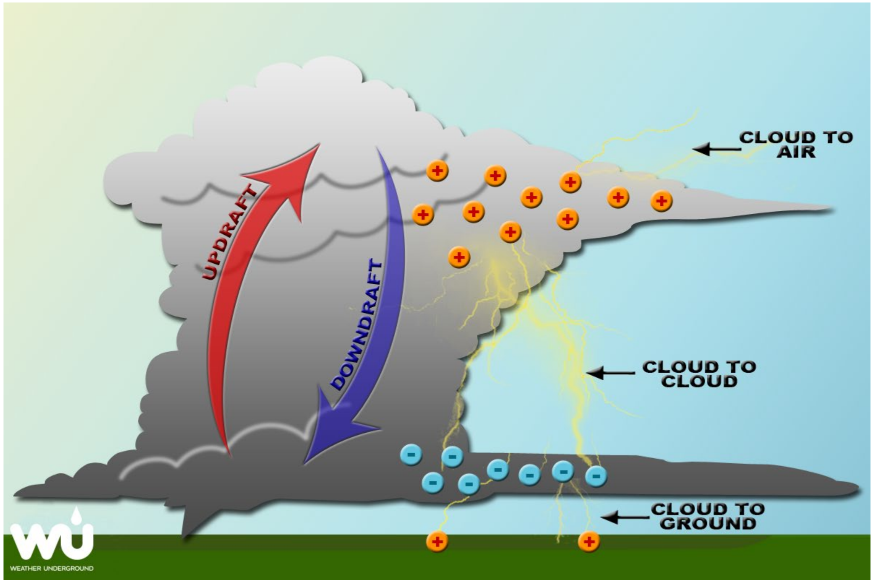
A thunderstorm is a local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder (National Weather Service [NWS] 2009). A thunderstorm forms from a combination of moisture; rapidly rising warm air; and a force capable of lifting air, such as a warm front, cold front, a sea breeze, 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 4.3.8-1 demonstrates the variety of lightning types.

Figure 4.3.8-1. Types of Lightning

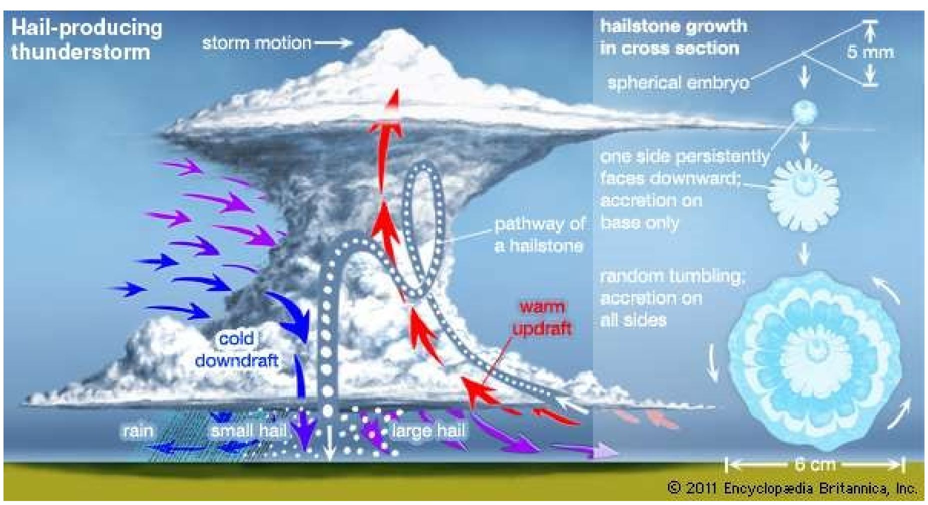


Source: Weather Underground date unknown

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 4.3.8-2 shows how hail is formed within thunderstorms.

Figure 4.3.8-2. 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 (discussed further in this section or in Section 4.3.2 Coastal Storms).

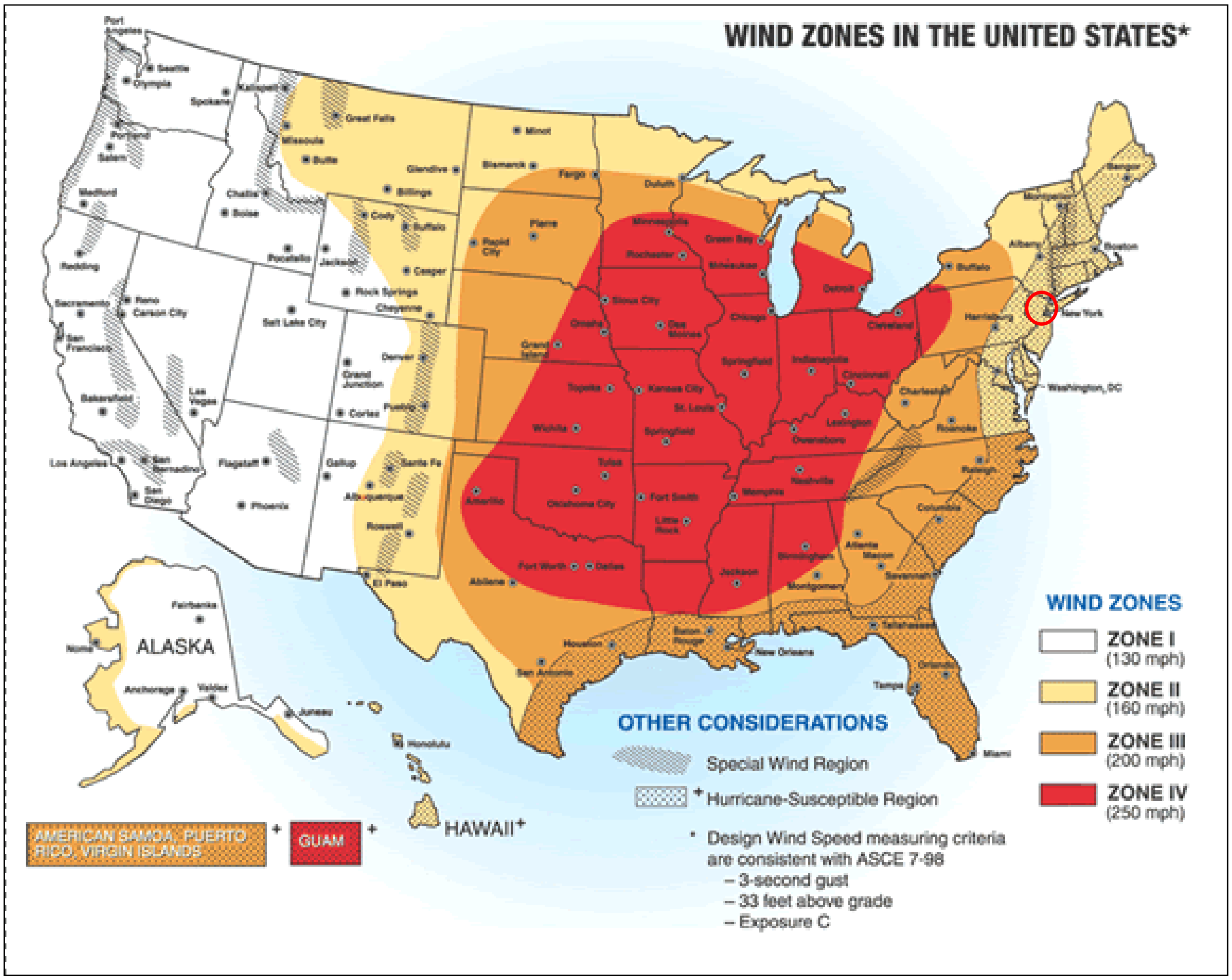
Tornadoes

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).

Location

All of Essex County is exposed to hail, lightning, windstorms and high wind, thunderstorms, and tornadoes and all of the County is subject to high winds from severe weather events. According to the FEMA Winds Zones of the United States map, Essex County is located in Wind Zone II, where wind speeds can reach up to 160 mph and is part of the hurricane susceptible region. Hurricanes are covered in Section 4.3.2 Coastal Storms. Figure 4.3.8-3 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 4.3.8-3. Wind Zones in the United States



Source: *FEMA 2012*
Note: *The red circle indicates the approximate location of Essex County.*

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 Essex County. Historical data presented in Table 4.3.8-1 shows the most powerful severe weather records in Essex County.

Table 4.3.8-1. Severe Storm Extent in Essex County (1950-2019)

Extent of Severe Storms in Essex County	
Largest Hailstone on Record	1.75 inches
Strongest Tornado on Record	F-1
Highest Wind Speed on Record	90 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 4.3.8-4 shows the SPC's severe thunderstorm risk categories.

Figure 4.3.8-4. Severe Thunderstorm Risk Categories

Understanding Severe Thunderstorm Risk Categories

THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	**Isolated severe thunderstorms possible**	**Scattered severe storms possible**	**Numerous severe storms possible**	**Widespread severe storms likely**	**Widespread severe storms expected**
Lightning/flooding threats exist with all thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense
• Winds to 40 mph • Small hail	• Winds 40-60 mph • Hail up to 1" • Low tornado risk	• One or two tornadoes • Reports of strong winds/wind damage • Hail ~1", isolated 2"	• A few tornadoes • Several reports of wind damage • Damaging hail, 1 - 2"	• Strong tornadoes • Widespread wind damage • Destructive hail, 2" +	• Tornado outbreak • Derecho

* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.

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 hail storm is measured by duration, hail size, and geographic extent. Most hail stones from hail storms are made up of variety of sizes. The size of hail is estimated by comparing it to a known object. Table 4.3.8-2 describes the different sizes of hail as compared to real-world objects and lists approximate measurements.

Table 4.3.8-2. Hail Size

Description	Diameter (in inches)	Description	Diameter (in inches)
Pea	0.25	Golf ball	1.75
Marble or mothball	0.50	Hen's egg	2.00
Penny or dime	0.75	Tennis ball	2.5
Nickel	0.88	Baseball	2.75
Quarter	1.00	Tea cup	3.00
Half dollar	1.25	Grapefruit	4.00
Walnut or ping pong ball	1.50	Softball	4.50

Source: NOAA 2012

Windstorms

Table 4.3.8-3 provides the NWS descriptions of winds during wind-producing events.

Table 4.3.8-3. 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 2010

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 2010).

Tornado

The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). Figure 4.3.8-5 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Figure 4.3.8-5. 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).

Previous Occurrences and Losses

Between 1954 and January 2019, Essex County has been included in 18 declarations for severe storm-related events classified as one or a combination of the following disaster types: severe storm, straight-line winds, tornado, or hurricane (FEMA 2019). Table 4.3.8-4 lists these events.

Table 4.3.8-4. Severe Storm-related FEMA Disaster Declarations

Declaration	Event Date	Declaration Date	Event Description
DR-245	June 18, 1968	March 25, 1974	Flood: Heavy Rains & Flooding
DR-310	September 4, 1971	September 4, 1971	Flood: Heavy Rains & Flooding
DR-402	August 7, 1973	August 7, 1973	Flood: Severe Storms & Flooding
DR-477	July 23, 1975	July 23, 1975	Flood: Heavy Rains, High Winds, Hail & Tornadoes
DR-701	March 28-April 8, 1984	April 12, 1984	Flood: Coastal Storms & Flooding
DR-973	December 10-17, 1992	December 18, 1992	Flood: Coastal Storm, High Tides, Heavy Rain, & Flooding
EM-3148	September 16-18, 1999	September 17, 1999	Hurricane: Hurricane Floyd Emergency Declarations
DR-1295	September 16-18, 1999	September 18, 1999	Hurricane: Hurricane Floyd Major Disaster Declarations
DR 1588	April 1-3, 2005	April 19, 2005	Severe Storm(s): Severe Storms and Flooding
DR-1694	April 14-20, 2007	April 26, 2007	Severe Storm(s): Severe Storms and Inland and Coastal Flooding
DR-1897	March 12-April 15, 2010	April 2, 2010	Severe Storm(s): Severe Storms and Flooding
EM-3332	August 26-September 5, 2011	August 27, 2011	Hurricane: Hurricane Irene
DR-4021	August 27-September 5, 2011	August 31, 2011	Hurricane: Hurricane Irene
DR-4048	October 29, 2011	November 30, 2011	Severe Storm(s): Severe Storm
EM-3354	October 26-November 8, 2012	October 28, 2012	Hurricane: Hurricane Sandy
DR-4086	October 26-November 8, 2012	October 31, 2012	Hurricane: Hurricane Sandy
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

In addition, Essex County was included in Agricultural Disaster S4455 for the combined effects of excessive rainfall, moisture, and storm-force winds from Hurricane Florence.

Severe weather events that have impacted Essex County between 2014 and 2019 are identified in Table 4.3.8-5. With severe weather documentation for New Jersey and Essex County being so extensive, not all sources have been identified or researched. Therefore, Table 4.3.8-5 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 4.3.8-5. Severe Weather Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
May 23, 2014	Hail	N/A	N/A	Bloomfield, Orange	A trough of low pressure slowly worked its way through the region, which caused isolated severe thunderstorms that produced large hail and flash flooding in portions of Northeast New Jersey. Quarter size hail was reported just west of Bloomfield. Quarter size hail was reported at the Orange Police Department.
July 2, 2014	Lightning	N/A	N/A	Newark	A strong low level shortwave swung through the Northeast with a trough at the surface. A line of strong thunderstorms formed along the trough and pushed through the area late in the afternoon into the evening. Some of these storms produced heavy rainfall, which resulted in flash flooding in portions of northeast New Jersey. A house on Lindsely Ave. was damaged by a lightning strike in Newark. $10K in property damages were reported.
July 8, 2014	Thunderstorm Wind	N/A	N/A	Fairfield, Caldwell	A line of strong with embedded severe thunderstorms formed along a slow moving cold front as it progressed through the Northeast. Multiple trees were reported down around town in Fairfield. $2K in property damages were reported. Multiple trees were reported down around town in Caldwell. $3K in property damages were reported.
August 31, 2014	Thunderstorm Wind	N/A	N/A	Watsessing	A very humid air mass combined with a passing surface trough to trigger numerous showers and thunderstorms, with embedded severe thunderstorms. Some of these storms produced very heavy rain which led to isolated flash flooding in Essex County. A tree went through the roof of a house on Roosevelt Avenue in Watsessing. $8K in property damages were reported.
November 2, 2014	Strong Wind	N/A	N/A	Eastern Essex County	A strong low pressure system passed south then east of Long Island. At Newark International Airport, a measured wind of 32 mph was reported at 12:40 pm.
December 9, 2014	Strong Wind	N/A	N/A	Eastern Essex County	A coastal storm passed just south and east of the area causing strong winds and heavy rain with isolated flooding in portions of Northeast New Jersey. At Newark International Airport, sustained winds of 35 mph were measured at 1:54 pm, and gusts of 44 mph were measured at 1:39 pm. $10K in property damages were reported.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
February 15, 2015	Strong Wind	N/A	N/A	Eastern Essex County	An area of low pressure deepened as it tracked to the northeast of the local region resulting in strong winds. At Newark International Airport, the ASOS measured sustained winds of 36 mph at 10:43 am. $10K in property damages were reported.
April 22, 2015	Strong Wind	N/A	N/A	Newark	A combination of gradient winds and convection ahead of a cold front resulted in wind gusts from 40 to 50 mph, based on observations, that caused minor damage in Northeast New Jersey. A tree fell on a car parked near the corner of Summer Avenue and Nursery Street in Newark. The wind gust is estimated based on a reported 34 mph gust measured at Newark Airport, around 2 miles away at the same time. $1.5K in property damages were reported.
July 1, 2015	Thunderstorm Wind	N/A	N/A	West Caldwell	A passing warm front triggered isolated severe thunderstorms which impacted Northeastern New Jersey. A tree fell down on Westville Avenue in West Caldwell. $1.5K in property damages were reported.
February 24-25, 2016	Strong Wind	N/A	N/A	Maplewood	Strong winds occurred behind the passage of a warm front, and ahead of a cold front. Emergency management reported downed tree limbs at Parker Avenue and Valley Street in Maplewood at 1041 pm. The roads were closed as a result. $40K in property damages were reported.
July 1, 2016	Thunderstorm Wind	N/A	N/A	South Orange, Fairfield, Caldwell, Cedar Grove	A passing cold front triggered a few severe thunderstorms over northeast New Jersey. Power lines were reported down in South Orange. $0.75K in property damages were reported. There were multiple reports of trees and power lines down throughout Fairfield. $3K in property damages were reported. There were multiple reports of trees and wires down in Caldwell. A large tree was uprooted onto 3 cars and a home in Cedar Grove. $45K in property damages were reported.
July 14, 2016	Thunderstorm Wind	N/A	N/A	Livingston, West Orange, Glen Ridge, Belleville	An approaching trough of low pressure triggered a line of strong to severe storms that moved across Northeast New Jersey. A tree fell down on a house along Mohawk Drive about 1 mile northeast of Livingston. $5K in property damages were reported. A large tree snapped and landed on a car on Maple Street just east of West Orange. $7.5K in property damages were reported. A large tree snapped and fell on a fence between West Orange and Glen Ridge. $2K in property damages were reported. A tree fell on a car along Branch Brook Drive just west of Belleville. $6K in property damages were reported.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
July 25, 2016	Thunderstorm Wind	N/A	N/A	Newark	The combination of a trough of low pressure and a trough aloft produced a line of strong to severe storms that moved over Passaic, Essex and Union Counties. Trees and wires were reported down in Newark. $3K in property damages were reported.
January 23, 2017	Strong Wind	N/A	N/A	Eastern Essex County	A deep area of low pressure passed just south and east of Long Island. A 52 mph gust was measured at Newark International Airport at 154 pm. $10K in property damages were reported.
March 2, 2017	Strong Wind	N/A	N/A	West Orange	Gusty northwest winds occurred behind a strong cold front. The broadcast media reported a downed tree in West Orange at 819 am. The tree was knocked down onto Prospect Ave. southbound between Rock Ave. and Route 280. Nearby, Newark International Airport measured a gust to 56 mph at 746 am. $50K in property damages were reported.
October 24, 2017	Strong Wind	N/A	N/A	Montclair	Strong winds occurred ahead of and behind a cold front. Per social media, a tree was knocked down at 1154 am in Montclair. $10K in property damages were reported.
April 4, 2018	Strong Wind	N/A	N/A	Eastern Essex County	Strong winds occurred ahead of and behind a cold front. The ASOS at Newark International Airport reported a wind gust of 54 mph at 537 pm. $10K in property damages were reported.
May 15, 2018	Thunderstorm Wind	N/A	N/A	Caldwell, West Orange	An approaching cold front triggered numerous severe thunderstorms over northeastern New Jersey. Large trees were reported down in Caldwell. $4K in property damages were reported. Large tree reported down on Maple Street in West Orange. $4K in property damages were reported.
July 3, 2018	Thunderstorm Wind	N/A	N/A	Belleville, Roseville	A pre-frontal trough ahead of an approaching cold front triggered strong to severe thunderstorms across the region. A tree on car with people trapped inside at the intersection of Main Street and Rutgers Street in Belleville. $5K in property damages were reported. A tree fell down on a car at the intersection of Orange Street and 4th Street in Roseville. $5K in property damages were reported.
January 30, 2019	Strong Wind	N/A	N/A	Western Essex County	Strong winds occurred behind low pressure and cold front. The ASOS at Caldwell Airport measured a 30 mph sustained wind at 504 pm. $10K in property damages were reported.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
March 15, 2019	Thunderstorm Wind, Hail	N/A	N/A	Livingston, West Orange	A cold front moved through the region triggering strong to severe thunderstorms across Northeast New Jersey. A tree down on car on Force Hill Road between East Mount Pleasant Avenue and Michele Lane. $6K in property damages were reported. Hail of 07.5 inches in diameter reported in West Orange.

Source: FEMA 2019; NCDC 2019; NWS 2019; SPC 2019; NJ HMP 2012; USGS 2011; NHC 2019; NOAA 2019
DR Disaster Declaration (FEMA)
FEMA Federal Emergency Management Agency
Mph miles per hour
N/A Not Applicable

Probability of Future Occurrences

Essex County is expected to continue experiencing direct and indirect impacts of severe weather annually. These storms may induce secondary hazards such as flooding and utility failure.

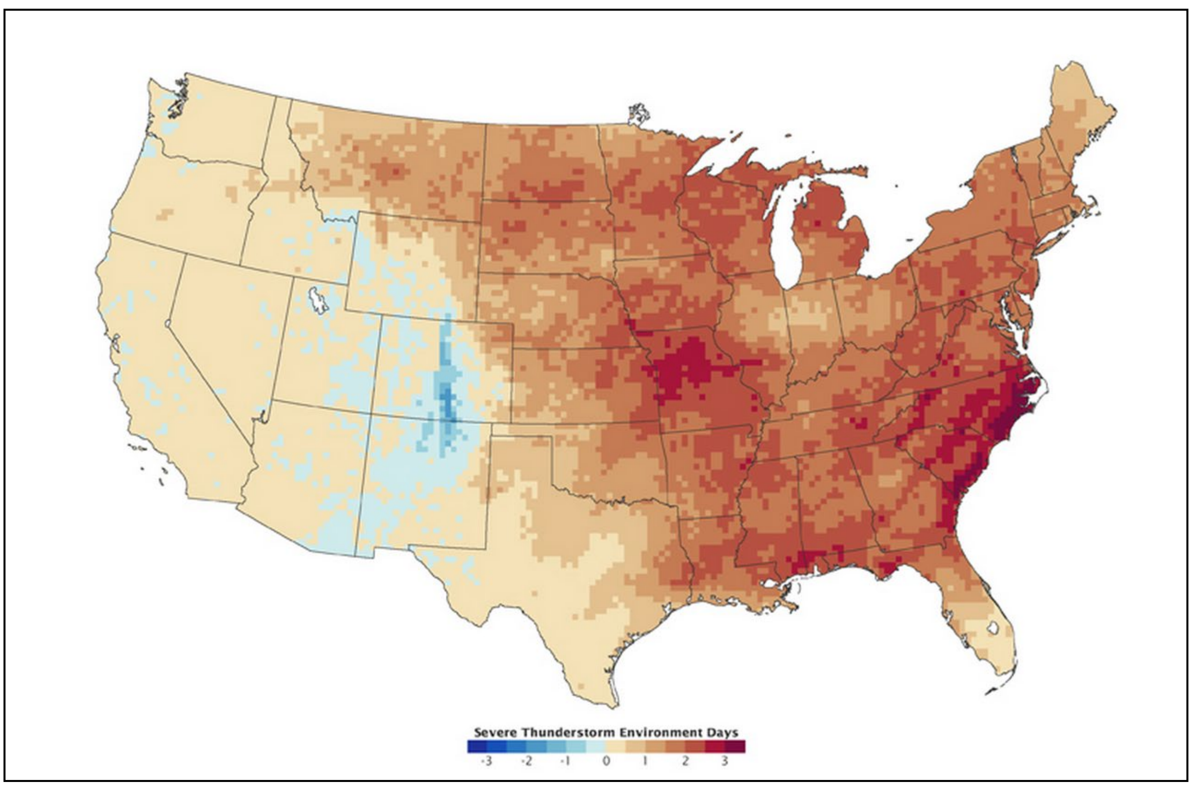
In Section 4.4, the identified hazards of concern for Essex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Planning Committee, the probability of occurrence for severe storms in the County is considered 'frequent'.

Climate Change Impacts

New Jersey have become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). The heaviest 1% of daily rainfalls have increased by approximately 70% between 1958 and 2011 in the Northeast (Horton et al. 2015). Average annual precipitation is projected to increase in the region by four to 11-percent by the 2050s and five to 13-percent by the 2080s (New York City Panel on Climate Change [NPCC] 2015).

As the climate changes, temperatures and the amount of moisture in the air will both increase, thus leading to an increase in the severity of thunderstorms which can lead to derechos and tornadoes. Studies have shown that an increase in greenhouse gases in the atmosphere would significantly increase the number of days that severe thunderstorms occur in the southern and eastern United States (National Aeronautics and Space Administration [NASA] 2005).

Figure 4.3.8-6. Predicted Change in Severe Thunderstorm Environment Days from the 1962-1989 Period to the 2072-2099 Period



Source: Trapp et. al. 2007

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (CATF 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

4.3.8.2 Vulnerability Assessment

A qualitative assessment was conducted to analyze the severe weather hazard for Essex County. Wind-related vulnerability data was generated using a HAZUS-MH v4.2 analysis for the wind hazard. A probabilistic assessment was conducted for the 100- and 500-year MRPs to analyze the severe storm hazard and provide a range of loss estimates. These estimates are detailed in Section 4.3.2 (Coastal Storms).

Impact on Life, Health and Safety

The impact of a severe storms 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 Essex County (800,401) is exposed to this hazard (2013-2017 American Community Survey 5-Year Population Estimate).

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.

As a result of severe storm events, residents can be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds from hurricanes, tropical storms, or tornadoes 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.

Economically disadvantaged populations are more vulnerable because they often evaluate evacuation needs and make decisions based on the economic impact to their family. The population over the age of 65 (102,794) is also vulnerable, can physically have difficulty evacuating, and are more likely to seek or need medical attention, which may not be available due to isolation during a storm event (2013-2017 American Community Survey 5-Year Population Estimate). Section 3 (County Profile) provides for the statistics for these populations for Essex County. Refer to Section 4.3.2 (Coastal Storms) for details regarding wind-related impacts on Essex County's population.

Impact on General Building Stock and Critical Facilities

Damage to buildings depends on several factors, including wind speed, storm duration, path of the storm track or tornado, and distance from the tornado funnel. Depending on the size of the hail and severity of the storm, the County could see damage from hail impacting structures. Lightning can spark wildfires or building fires, especially if structures are not protected by surge protectors on critical electronic, lighting, or information technology systems. While damage to the building stock is possible as a result of lightning and hail, they are difficult to estimate and would not have as wide of an impact as a high wind or tornado event. Refer to Section 4.3.2 (Coastal Storms) for details regarding wind-related impacts on Essex County's building stock and critical facilities.

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 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 until power is restored. Lack of power to emergency facilities, including police, fire, EMS, and hospitals, will inhibit a community's ability to effective respond to an event and maintain the safety of its citizens.

Impact on Economy

As discussed, severe storm events can impact structures and the economy. 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. Refer to the Section 4.3.2 (Coastal Storm and Sea Level Rise) for additional impacts on the economy as a result of severe weather events.

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

As discussed in Section 3 (County Profile), areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by the severe storm hazard because the entire County is exposed and vulnerable. However, due to increased standards and codes, new development may be less vulnerable to the severe storm hazard compared with the aging building stock in the County.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Refer to Section 3 (County Profile) which includes a discussion on population trends for the County. As the population continues to grow, residents will continue to be exposed to the severe weather 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 each of the identified severe storm hazards. Section 5.4.6 (Flood) provides a discussion related to the impact of climate change due to increases in rainfall resulting from severe storms. In addition to the impacts of increasing temperatures and precipitation, sea level rise will increase the County's vulnerability to coastal storms. Increases in mean sea level will lead to subsequent increases in storm surge inundation depths.

Change of Vulnerability Since 2015

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to severe weather events.

4.3.9 Severe Winter Weather

The following section provides the hazard profile and vulnerability assessment for the severe winter storm hazard in Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous occurrences were updated with events that occurred between 2014 and 2019.

4.3.9.1 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 Essex County, winter storms include blizzards, snow storms, Nor'Easters and ice storms. Nor'Easters are also a common type of storm that may occur during winter months within the State of New Jersey; however, given the frequency of these types of storms in the State and their severe potential impact, Nor'Easters are considered by the Planning Committee as a separate hazard and are further discussed in Section 4.3.2 (Coastal Storms) within this plan. Extreme cold temperatures and wind chills are also associated with winter storms; however, based on input from the Planning Committee, these events are further discussed in this Plan in Section 4.3.5 (Extreme Temperatures).

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 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile. These conditions must be predominant over a 3-hour period to be considered a blizzard. 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 with temperatures 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 0 miles. 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 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, Essex County's normal seasonal snowfall is approximately 25-28 inches.

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, Essex County can anticipate 3-4 days with freezing rain per year (Changnon & Karl 2003). Based on data from 1932–2001, the County can anticipate 6-9 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.

The National Oceanic and Atmospheric Administration's (NOAA) 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-NCDC 2018). Table 4.3.9-1 explains the five RSI ranking categories.

Table 4.3.9-1. RSI Ranking Categories

Category	Description
1	Notable
2	Significant
3	Major
4	Crippling
5	Extreme

Source: NOAA-NCDC 2018

Note: RSI = Regional Snowfall Index

NWS operates a widespread network of observation 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 future weather, 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 Essex 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

Between 1954 and March 15, 2019, the Federal Emergency Management Agency (FEMA) included Essex County in six winter storm-related DR or EM declarations classified as one or a combination of the following disaster types: severe winter storm, snowstorm, snow, ice storm, winter storm, and blizzard.

Table 4.3.9-2. Winter Weather Related Disaster (DR) and Emergency (EM) Declarations 1954-2019

Declaration	Event Date	Declaration Date	Event Description
EM-3106	March 13-17, 1993	March 17, 1993	Snow: Severe Blizzard
DR-1088	January 7-12, 1996	January 13, 1996	Snow: Blizzard of 96 (Severe Snow Storm)
EM-3181	February 16-17, 2003	March 20, 2003	Snow: Snow
EM-1954	December 26-27-2010	February 4, 2011	Snow: Severe Winter Storm and Snowstorm
DR-4264	January 22-24, 2016	March 14, 2016	Severe Storm(s): Severe Winter Storm and Snowstorm
DR-4368	March 6-7, 2018	June 8, 2018	Severe Storm(s): Severe Winter Storm and Snowstorm

Source: FEMA 2019

Severe Winter Storm Events

The National Oceanic and Atmospheric Administration (NOAA) National Centers for Environmental Information (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.

Table 4.3.9-3 includes winter storm events and FEMA disaster declarations that occurred between 2014 and 2019.

Table 4.3.9-3. Severe Winter Weather Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
January 18, 2015	Winter Weather	N/A	N/A	Eastern Essex County	Warm air overriding a stationary front along the coast, while a shallow Arctic air mass remained entrenched over land, led to light freezing rain through the day, and also into the evening in the higher interior elevations. Freezing rain continued even as air temperatures warmed above freezing due to very cold ground temperatures. The frozen ground also resulted in flooding in Union County. Freezing rain led to widespread motor vehicle accidents, and numerous falls and injuries. NJ Transit suspended bus service, and police issued closures on many roadways.
January 24, 2015	Winter Weather	N/A	N/A	Eastern Essex County	Low pressure moved out of the northern Gulf of Mexico on the morning of the 23rd, to the Mid Atlantic coast on the morning of the 24th, then rapidly intensified on its way northeast to the Canadian Maritimes the following day. This low brought heavy snow to parts of northeast New Jersey on the 24th. Trained spotters measured an average snowfall of 5 inches. The public measured snowfall of 6 inches in Cedar Grove. A trained spotter measured snowfall of 5.6 inches in Bloomfield. Newark Airport measured 5.1 inches of snow.
January 26, 2015	Winter Storm	N/A	N/A	Eastern Essex County	A potent Alberta Clipper low moved from southwestern Canada on January 24th to the Plains states and Ohio Valley on the 25th. The low then redeveloped off the Mid Atlantic coast on the 26th and rapidly intensified into a strong nor'easter, bringing heavy snow and strong winds to parts of northeast New Jersey just west of New York City. Newark Liberty Airport reported snowfall of 6.5 inches, and north winds gusted up to 33 mph, with blowing and drifting of snow.
February 1, 2015	Heavy Snow	N/A	N/A	Essex County	An area of low pressure tracked east from the Ohio Valley the night of February 1 to just south of Long Island the afternoon of February 2. The close proximity of the low with arctic air to the north resulted in snow at the onset, which transitioned to a wintry mix during the morning hours before going back to snow by early afternoon. Northeast New Jersey received 5 to 12 inches of snowfall and up to a third of an inch of ice. Snowfall ranged from 6 to 8 inches across the county, along with up to two tenths of an inch of ice. The highest amount of 7.8 inches was reported in Cedar Grove, NJ.
March 5, 2015	Heavy Snow	N/A	N/A	Essex County	Rain associated with a wave of low pressure moving along a cold front to the south changed to snow before sunrise on March 5 and became heavy across portions of Northeast New Jersey. Newark Airport reported 6.7 inches of snow.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
January 22-23, 2016	Winter Storm, Blizzard	DR-4264	Yes	Essex County	Low pressure moving across the deep South on Thursday January 21st and Friday January 22nd intensified and moved off the Mid Atlantic coast on Saturday January 23rd, bringing heavy snow and strong winds to northeast New Jersey, and blizzard conditions to the urban corridor and some nearby areas. Governor Chris Christie declared a state of emergency for New Jersey on Friday January 22nd. New Jersey Transit stopped running trains, buses and light rail at 2 AM Saturday January 23rd. Bridges and tunnels from New York City into New Jersey were shut down by mid-afternoon Saturday. Travel in and out of airports lagged through Monday January 25th as airlines pre-emptively cut hundreds of flights. More than 1,000 flights out of area airports were cancelled, and Teterboro Airport were shuttered due to whiteout conditions. At Newark Airport, the storm total snowfall was 24.5 inches, where winds gusted to 39 mph. Newark Airport ASOS observations showed blizzard conditions, with visibility less than one quarter mile in heavy snow and frequent wind gusts over 35 mph through the day and into the early evening on Saturday January 23rd.
February 5, 2016	Winter Weather	N/A	N/A	Western Essex County	Low pressure developing along a cold front moving through the region on Thursday February 4th moved off the southern Mid Atlantic coast on Friday February 5th, bringing locally heavy snow to parts of interior Northeast New Jersey on the fifth. Trained spotters reported a widespread 4 to 5 inch snowfall, with locally up to 6 inches in North Caldwell.
February 9, 2017	Winter Storm	N/A	N/A	Essex County	Low pressure developed along a cold front over the Middle Atlantic early Thursday, February 9th. The low rapidly intensified as it moved off the Delmarva coast in the morning and then to the south and east of Long Island late morning into the afternoon. The low brought heavy snow and strong winds to portions of Northeast New Jersey. Numerous flights were cancelled or delayed at Newark Airport. Trained spotters, CoCoRaHS observers, and the public reported 6 to 8 inches of snowfall.
March 14, 2017	Winter Storm	N/A	N/A	Essex County	Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March 14 bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. The storm cancelled numerous flights at Newark airport with some mass transit services suspended. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow. Trained spotters and the public reported 8 to 13 inches of snow and sleet.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
December 9, 2017	Winter Weather	N/A	N/A	Essex County	Low pressure along a slow moving cold front off the eastern seaboard brought locally heavy snow to portions of northeast New Jersey. A strong upper jet stream enhanced the snow across the Tri-State as the low pressure passed well offshore. Trained Spotters and the public reported 4 to 5 inches of snow.
January 4, 2018	Winter Storm	N/A	N/A	Essex County	The development of the blizzard/winter storm began along the southeast coast on Wednesday January 3, 2018. An amplifying upper level trough spawned the development of low pressure off the coast of Florida. The low pressure rapidly intensified on Wednesday night through Thursday January 4, 2018 as it moved north-northeast along the coast. The low passed just east of the benchmark Thursday afternoon. The central pressure when the storm developed was around 1004 millibars at 1 pm Wednesday. 24 hours later, the central pressure fell to around 950 mb, approximately a 54 millibar drop. The rapid intensification of the storm led to heavy snow, strong winds, and near-blizzard conditions across portions of Northeast New Jersey. Thousands of flights were cancelled at Newark Airport on January 4, 2018. Homes and businesses lost power and there were numerous accidents on area roadways. The public reported 6 inches of snow in West Caldwell. Winds gusts 30 to 40 mph at the Caldwell Airport during the afternoon and evening on January 4, 2018. The FAA Contract Observer at nearby Newark-Liberty Airport reported 8.4 inches of snowfall. Winds also gusted to 44 MPH at 4:38 PM at the airport.
February 7, 2018	Winter Weather	N/A	N/A	Western Essex County	A wave of low pressure developed across the southeastern states and tracked towards the northeast on February 7, 2018. The low brought a mixture of light snow and light freezing rain. The low pressure tracked a long a warm front which lifted across portions of the region helping to change any snow to freezing rain. The Caldwell Airport ASOS reported 0.14 inches of freezing rain. The Public reported 1.5 inches of snow in Cedar Grove.
February 17-18	Winter Weather	N/A	N/A	Essex County	A low pressure developed along a frontal boundary along the southeast coast on the evening of Saturday, February 17, 2018. This low gradually became better organized as it moved up the coast towards the benchmark early Sunday, February 18, 2018. This system brought heavy snow to northern portions of northeast New Jersey. CoCoRahs observers and nearby Newark Liberty Internal Airport reported 3 to 5 inches of snowfall.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
March 7, 2018	Winter Storm	N/A	N/A	Essex County	A strong low pressure system developed along the Middle Atlantic coast during the morning of Wednesday, March 7, 2018. The low tracked along the coast through the early morning hours on Thursday, March 8, 2018. The storm brought heavy wet snow, strong gusty winds, and even some thundersnow across northeast New Jersey. Snowfall rates ranged from 1 to 3 inches per hour at times in the heaviest snow bands. Trained spotters and the public reported 1 to 2 feet of snow. 23.0 inches was reported in North Caldwell and 19.7 inches in Roseland. The heavy wet snow and strong winds also brought down trees and some power lines.
March 21-22, 2018	Heavy Snow	N/A	N/A	Essex County	A large and slow moving low pressure developed along the Middle Atlantic coast on Wednesday, March 21st and moved slowly north and east along the coast through Thursday, March 22nd. Moderate to occasionally heavy snow bands moved across portions of northeast New Jersey. A trained spotter reported 6.6 inches of snow in Bloomfield.
April 2, 2018	Heavy Snow	N/A	N/A	Essex County	Waves of low pressure moved along a stalled frontal boundary across the Middle Atlantic. Moderate to heavy snow fell during the morning commute across northeast New Jersey. Snowfall rates reached 1 inch per hour at times. A daily record snowfall for April 2nd of 5 inches was set at Newark, NJ. Trained spotters, CoCoRaHS, and the public reported 6 to 8 inches of snowfall.
November 15, 2018	Winter Storm	N/A	N/A	Essex County	A wave of low pressure developed along the Middle Atlantic coast during Thursday November 15, 2018. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday November 16, 2018, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). The FAA contract observer at nearby Newark Airport reported 6.4 inches of snow. Trained spotters, social media, and the public reported 4 to 6 inches of snow. Impacts were widely felt across eastern Essex county with major disruption to the evening commute. Trees branches and limbs were downed due to the weight of the heavy wet snow. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
January 30, 2019	Winter Weather	N/A	N/A	Essex County	A strong cold front initiated a broken line of snow squalls to the region. The snow squalls quickly moved across northeast New Jersey in the afternoon and early portion of the evening commute. Traffic was brought to a standstill during the squalls and created life-threatening travel. Snow squalls quickly moved through bringing whiteout conditions, strong winds, and dangerous driving conditions. The public reported 1 inch of snow in 30 minutes in West Orange and Cedar Grove.
March 2, 2019	Winter Weather	N/A	N/A	Essex County	A wave of low pressure brought light accumulating snow to northeast New Jersey early on the morning of Saturday March 2, 2019. The low pressure quickly moved away from the coast after day break bringing an end to the accumulating snow. The public reported 3 to 4 inches of snow.
March 3-4, 2019	Heavy Snow	N/A	N/A	Essex County	Low pressure developed across the southeast on Sunday March 3, 2019 and then tracked off the Middle Atlantic coast early on Monday March 4, 2019. The low moved just inside the 40N/70W benchmark and continued out to sea. The low brought a widespread snowfall to northeast New Jersey with the heaviest accumulations occurring across the interior. Much of the significant snow occurred overnight with improved conditions during the Monday morning commute. Trained spotters, CoCoRaHS, and the public reported 7 to 9 inches of snow.

Source: *NOAA-NCDC 2019; NJOEM 2019; NWS 2019; FEMA 2019*
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*

According to the Storm Events Database, Essex County has been impacted by 37 severe winter storm events between 1950 and January 2019 (Table 4.3.9-4). No events resulted in deaths, property damages, or crop damages. One event resulted in an injury.

Table 4.3.9-4. Severe Winter Storm Events in Essex County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Total Fatalities	Total Injuries	Total Property Damage ($)	Total Crop Damage ($)
Blizzard	2	0	0	$0	$0
Heavy Snow	12	0	1	$0	$0
Ice Storm	1	0	0	$0	$0
Sleet	0	0	0	$0	$0
Winter Storm	12	0	0	$0	$0
Winter Weather	10	0	0	$0	$0
TOTAL	**37**	**0**	**1**	**$0**	**$0**

Note: Not all events that have occurred in Essex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.
Source: NOAA-NCEI 2019

Probability of Future Occurrences

Essex County is estimated to continue experiencing direct and indirect impacts of severe winter storms annually. Table 4.3.9-5 provides the probability of occurrences of severe winter storm events. However, the information used to calculate the probability of occurrences is only based on NOAA-NCEI storm events database results.

Table 4.3.9-5. Severe Winter Storm Events in Essex County 1950 to 2019

Hazard Type	Number of Occurrences Between 1950 and 2019	Rate of Occurrence	Recurrence Interval	Probability of Event Occurring in Any Given Year	% Chance of Event Occurring in Any Given Year
Blizzard	2	0.03	35.0	0.03	2.9
Heavy Snow	12	0.17	5.8	0.17	17.1
Ice Storm	1	0.01	70.0	0.01	1.4
Sleet	0				
Winter Storm	12	12	0.17	5.83	0.17
Winter Weather	10	0.17	5.8	0.17	17.1
Total	**37**	**0.14**	**7.0**	**0.14**	**14.3**

Note: Not all events that have occurred in Essex County are included due to the extent of documentation and the fact that not all sources have been identified or researched.

Source: NOAA-NCEI 2019

In Section 4.4 (Hazard Ranking), the identified hazards of concern for Essex County are ranked using a variety of parameters. The probability of occurrence, or likelihood of the event, is one parameter used for hazard rankings. Based on historical records and input from the Steering Committee and Planning Committee, the probability of occurrence for severe winter storms in the County is considered “frequent”.

Climate Change Impacts

In terms of snowfall and ice storms, 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 (Sustainable Jersey Climate Change Adaptation Task Force 2013).

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013). Due to the increase in temperature, snow cover and sea ice extent are predicted to likely decrease over the next century and the snow season length is very likely to decrease over North America. However, warming of the lower atmosphere could potentially lead to more ice storms by allowing snow to more frequently melt as it falls and then refreeze near or at surface (NPCC 2009).

4.3.9.2 Vulnerability Assessment

All of Essex County is exposed to the severe winter storm hazard; therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 4), are potentially vulnerable to a severe winter storm event. The following discusses Essex County's vulnerability, in a qualitative nature, to the severe winter weather hazard.

Impact on Life, Health, and Safety

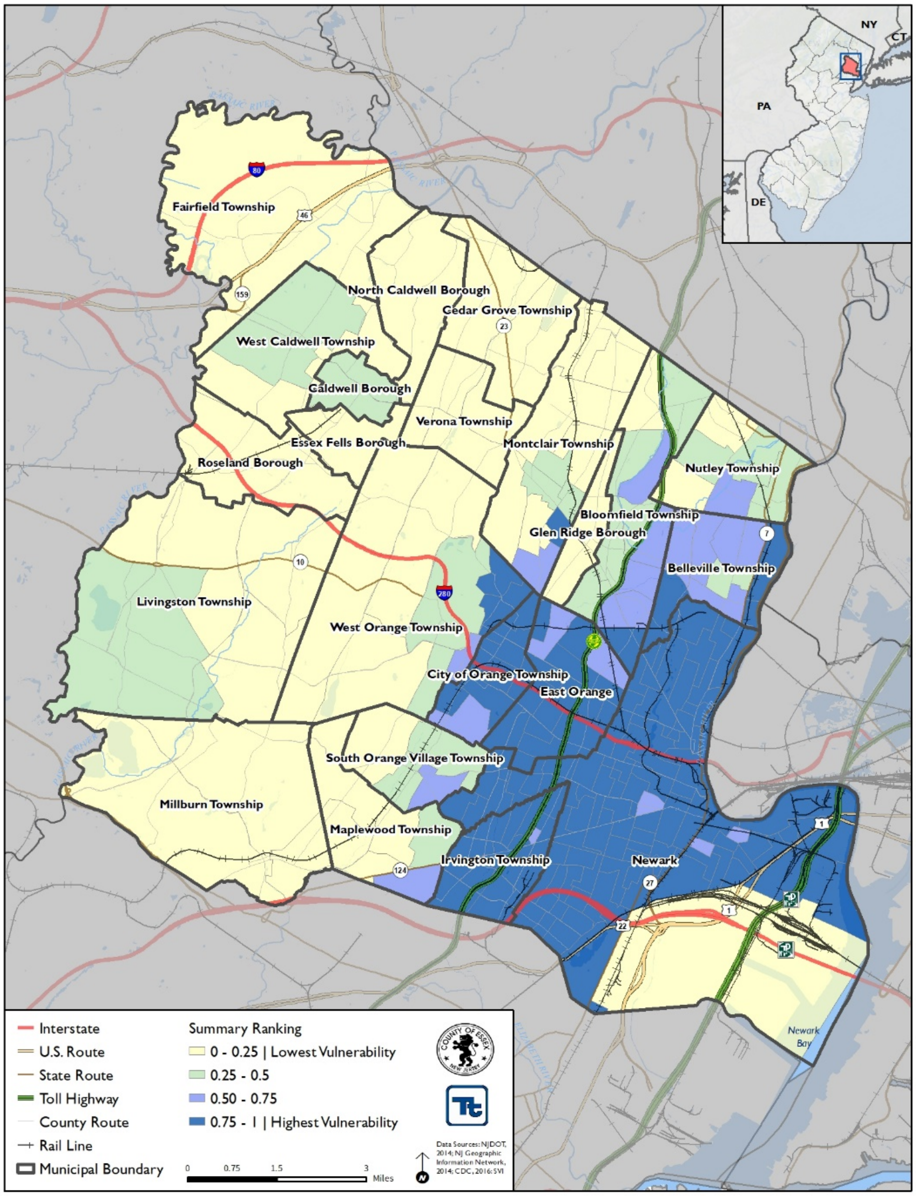
The entire population of Essex County is exposed to severe winter weather events (population of 800,401 people, according to the 2013-2017 American Community Survey population estimates). The homeless and elderly are considered most susceptible to this hazard; the homeless due to their lack of shelter and the elderly due to their increased risk of injuries and death from falls and overexertion or hypothermia from attempts to clear snow and ice.

According to the 2017 ACS 5-Year Population Estimate, 12.8 percent of the population in Essex County is over 65 years in age. Severe winter storm events can reduce the ability of these populations to access emergency services. In Essex County, each municipality has areas of high concentration of elderly population (over 100 persons per square mile) with higher concentrations located in the more urban, densely populated areas of the County. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of populations over 65 in Essex County.

The homeless and residents below the poverty level might 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 Essex County, areas with the highest concentration of population below the poverty level are located in and near the Cities of East Orange and Newark and Townships of Irvington and Orange. Refer to Figure 3-X in Section 3 (County Profile) that displays the densities of low-income populations in Essex County.

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. Census tracts throughout the Cities of East Orange and Newark and the Townships of Irvington and Orange have been ranked in the highest vulnerability category with values between 0.75 and 1.0; Census tract 92 in the City of Newark has the highest social vulnerability with a ranking of 1.0. These Census tracts may be more susceptible to impacts from severe winter weather. Figure 4.3.9-1 below displays the CDC 2016 SVI.

Figure 4.3.9-1. CDC's Social Vulnerability Index 2016



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. 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 (NSSL, 2018).

Impact on General Building Stock

All buildings in Essex County are exposed to the severe winter storm hazard; however, properties in poor condition may be more vulnerable to impacts. 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, the percent damage to structures that could result from severe winter storm conditions is considered. This allows planners and emergency managers to select a range of potential economic impact based on an estimate of the percent of damage to the general building stock. Table 4.3.9-6 summarizes the estimated loss to structures because of 1-, 5-, and 10-percent loss. Given professional knowledge and the currently available information, the potential loss for this hazard is considered to be overestimated because of varying factors (building structure type, age, load distribution, building codes in place). Therefore, this should be used as estimates only for planning purposes with the knowledge that the associated losses for severe winter storm events vary greatly.

Table 4.3.9-6. General Building Stock Exposure and Estimated Losses from Severe Winter Storm Events

County	Total (All Occupancies)	1% Damage Loss Estimate	5% Damage Loss Estimate	10% Damage Loss Estimate
Essex County	$73,368,036,940	$733,680,369	$3,668,401,847	$7,336,803,694

Source: NJOIT, 2018; Microsoft, 2018; Open Street Maps, 2019

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 Section 4.3.6 (Flood). Generally, losses resulting from flooding associated with severe winter storms should be less than that associated with a 1-percent annual chance flood event. In addition, coastal areas are at high risk during winter storm events that involve high winds, as presented in Section 4.3.2 (Coastal Storms) for losses resulting from wind.

Impact on Critical Facilities

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.

Infrastructure at risk for this hazard includes roadways that could be damaged due to salt application 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.

Impact on Economy

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. Impacts on the economy also include commuter difficulties into or out of the area for work or school. The loss of power and closure of roads prevent commuters within the County.

Future Changes that May Impact Vulnerability

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

Areas targeted for future growth and development have been identified across Essex County (refer to Sections 3 and 9). 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 population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Each year a non-profit organization in New Jersey, Monarch Housing Associates, conducts a point-in-time count of homeless populations across the State. On January 22, 2019, 2,235 homeless persons were counted in Essex County (Monarch Housing Associates, 2019). This accounted for 25-percent of the State's total count. The homeless population has been increasing since 2015, at which time 1,723 homeless persons were counted (Kiefer, 2019). If the increase in homeless population trend continues, the County's vulnerability to severe winter weather will continue to increase as well.

Climate Change

As discussed earlier, it is uncertain how climate change will influence extreme winter storm events. 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 Since 2015

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.

4.3.10 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 Essex County.

2020 HMP Update Changes

- Previous occurrences were updated with events that occurred between 2014 and 2019.
- The vulnerability assessment was conducted using updated population, building and critical facility/lifeline spatial data to determine exposure to the wildfire hazard.

4.3.10.1 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.

In the State of New Jersey, each year, an average of 1,500 wildfires damage or destroy 7,000 acres of the state's forests. Wildfires not only damage woodlands but threaten homeowners who live within or adjacent to forest environments. From January 1, 2018, to August 12, 2018, there were 552 wildfires in New Jersey that burned over 1,300 acres. In contrast, during this same period in 2017, the State experienced 588 fires, which burned over 5,024 acres (New Jersey Forest Fire Service [NJFFS] 2018). Details regarding the number of fires in Essex County were not included in these overall statistics.

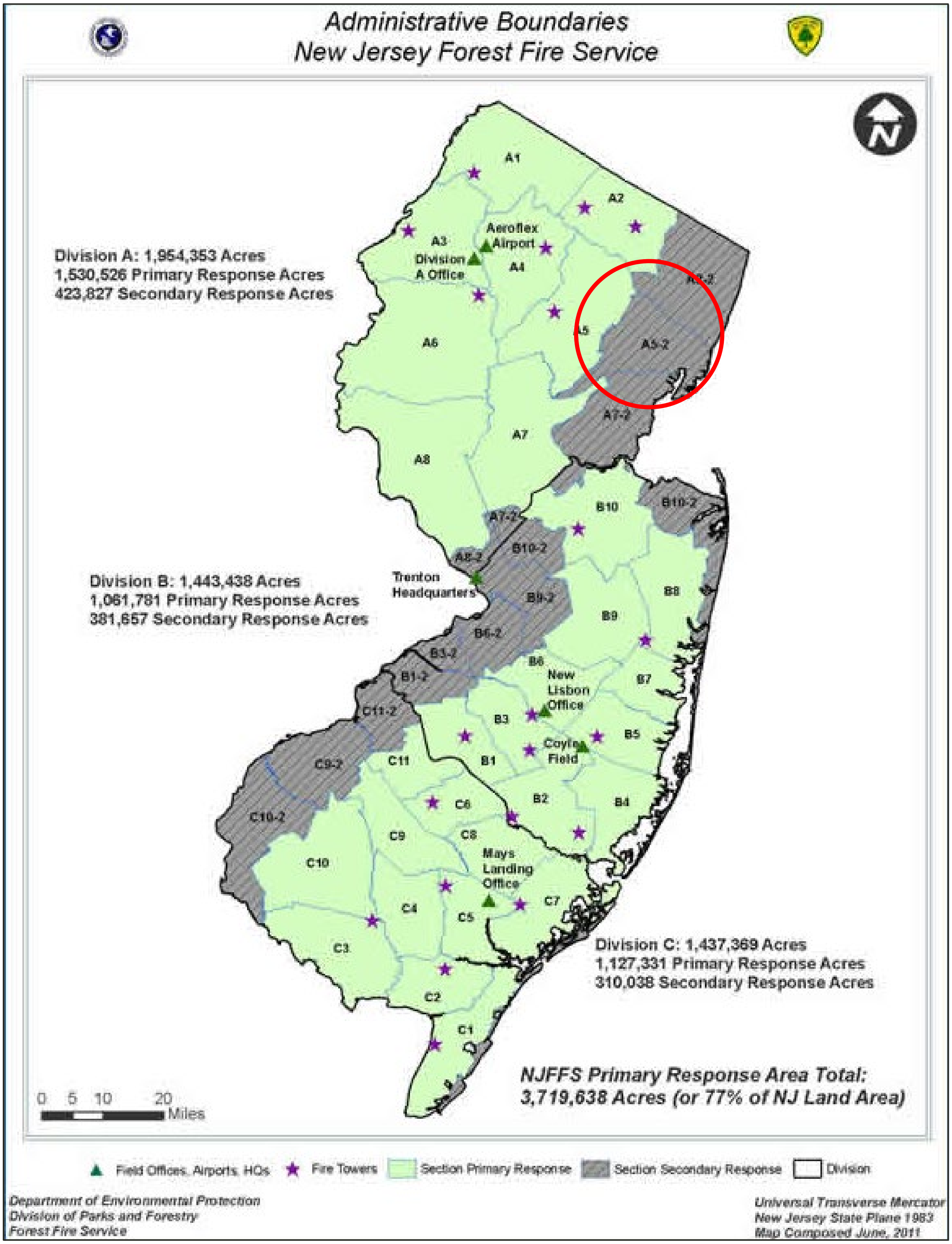
Location

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). Wildfires occur in virtually all of the U.S. The western portion of the U.S. is subject to more frequent wildfires, due to their more arid climate and prevalent conifer and brush fuel types. Wildfires have proven to be the most destructive in California but have become an increasingly frequent and damaging phenomenon nationwide (FEMA, 1997). States with a large amount of wooded, brush, and grassy areas, such as California, Colorado, New Mexico, Montana, Kansas, Mississippi, Louisiana, Georgia, Florida, North and South Carolina, Tennessee, Massachusetts, and the national forests of the western U.S. are at highest risk for wildfires (University of Florida, 1998). In Essex County, wildfires have the potential to occur anywhere in the County.

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 firewarden 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 4.3.10-1 illustrates the NJFFS region divisions within the State. Essex County is located in Division A (Northern NJ).

Figure 4.3.10-1. Fire Divisions of New Jersey



Source: NJDEP 2013
Note: The red circle indicates the location of Essex County. The County is located in Fire Division A.

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. Generally, wildfires in Essex County are more likely to occur in the western and southern portions of the County, as compared to the more urban communities (Essex County HMP 2007). Table 4.3.10-1 indicates the amount of land in each of the wildfire fuel hazard ranking zones for Essex County. Table 4.3.10-2 summarizes the approximate area in the NJFFS risk areas in the County.

Table 4.3.10-1. Area in the Wildfire Fuel Hazard Ranking Zones in Essex County

Hazard Area	Area (Square Miles)
Extreme	0.3
Very High	0.1
High	1.6
Moderate	9.7
Low	29.0

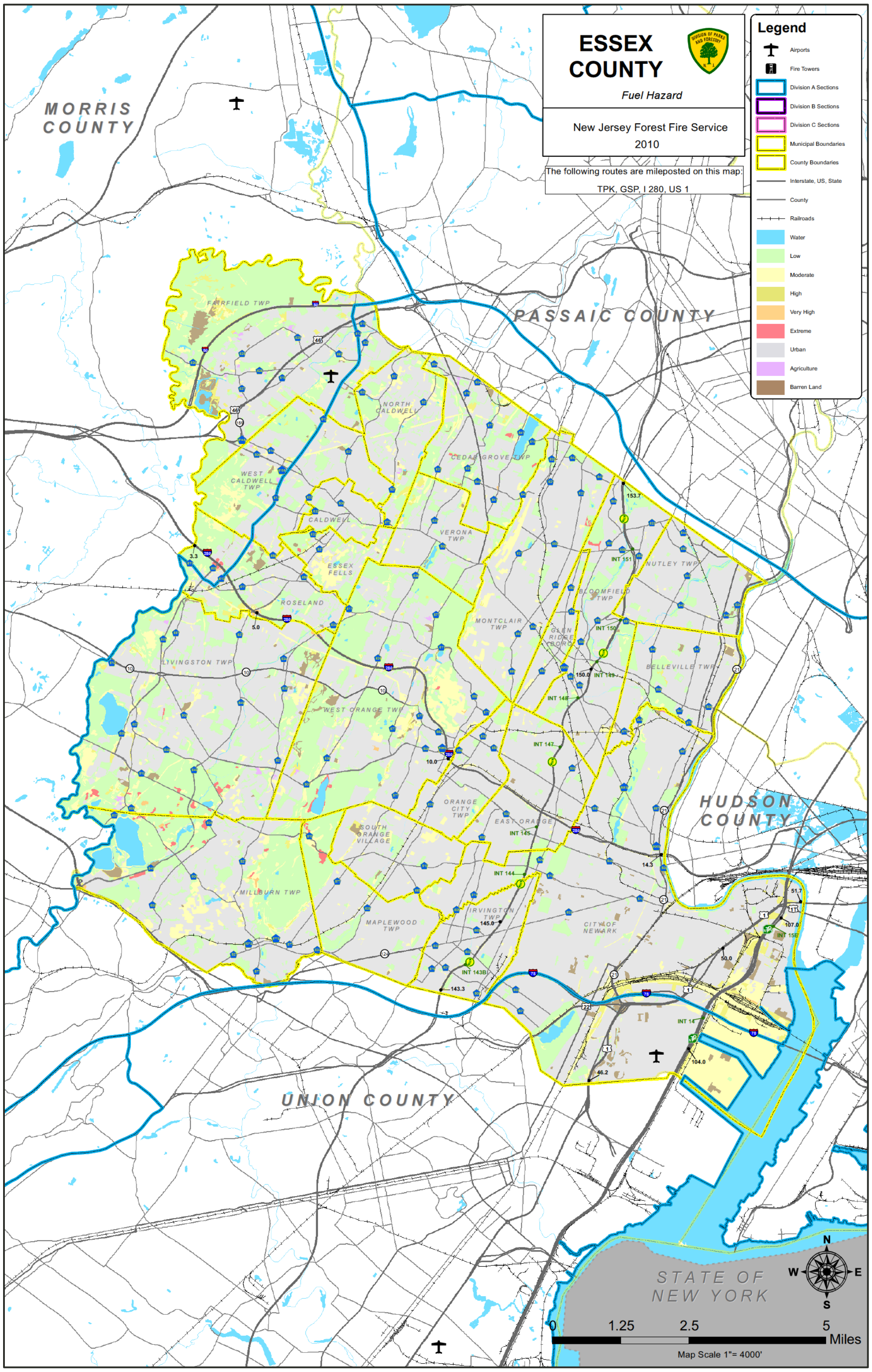
Source: NJFFS 2013

Table 4.3.10-2. Approximate Area in Wildfire Fuel Hazard Ranking Zones in Essex County

Municipality	Total Area (Square Miles)	NJ Forest Service Risk Areas (square miles)			
		Low to Moderate	% in Low to Moderate Hazard Area	High to Extreme	% in High to Extreme Hazard Area
Township of Belleville	3.4	0.52	15.6%	0.02	0.5%
Township of Bloomfield	5.4	1.02	19.0%	0.02	0.4%
Borough of Caldwell	1.2	0.18	15.1%	0.00	0.0%
Township of Cedar Grove	4.4	1.49	34.3%	0.09	2.0%
City of East Orange	3.9	0.28	7.3%	0.00	0.1%
Borough of Essex Fells	1.4	0.75	53.2%	0.03	2.1%
Township of Fairfield	10.3	4.99	48.2%	0.31	3.0%
Borough of Glen Ridge	1.3	0.13	9.9%	0.00	0.0%
Township of Irvington	2.9	0.18	6.1%	0.00	0.2%
Township of Livingston	14.1	5.62	39.8%	0.24	1.7%
Township of Maplewood	3.9	1.08	28.0%	0.04	1.0%
Township of Millburn	9.9	4.26	43.1%	0.16	1.6%
Township of Montclair	6.2	1.13	18.2%	0.03	0.5%
City of Newark	26.2	4.96	18.9%	0.69	2.6%
Borough of North Caldwell	3.1	1.16	37.6%	0.04	1.2%
Township of Nutley	3.4	0.32	9.3%	0.02	0.5%
City of Orange Township	2.2	0.27	12.4%	0.00	0.0%
Borough of Roseland	3.7	1.64	44.5%	0.11	3.0%
Township of South Orange Village	2.8	0.39	13.6%	0.02	0.6%
Township of Verona	2.8	0.76	27.3%	0.05	1.6%
Township of West Caldwell	5.1	2.03	40.1%	0.04	0.7%
Township of West Orange	12.1	5.61	46.3%	0.16	1.3%
Essex County (Total)	129.7	**38.76**	**29.9%**	**2.05**	**1.6%**

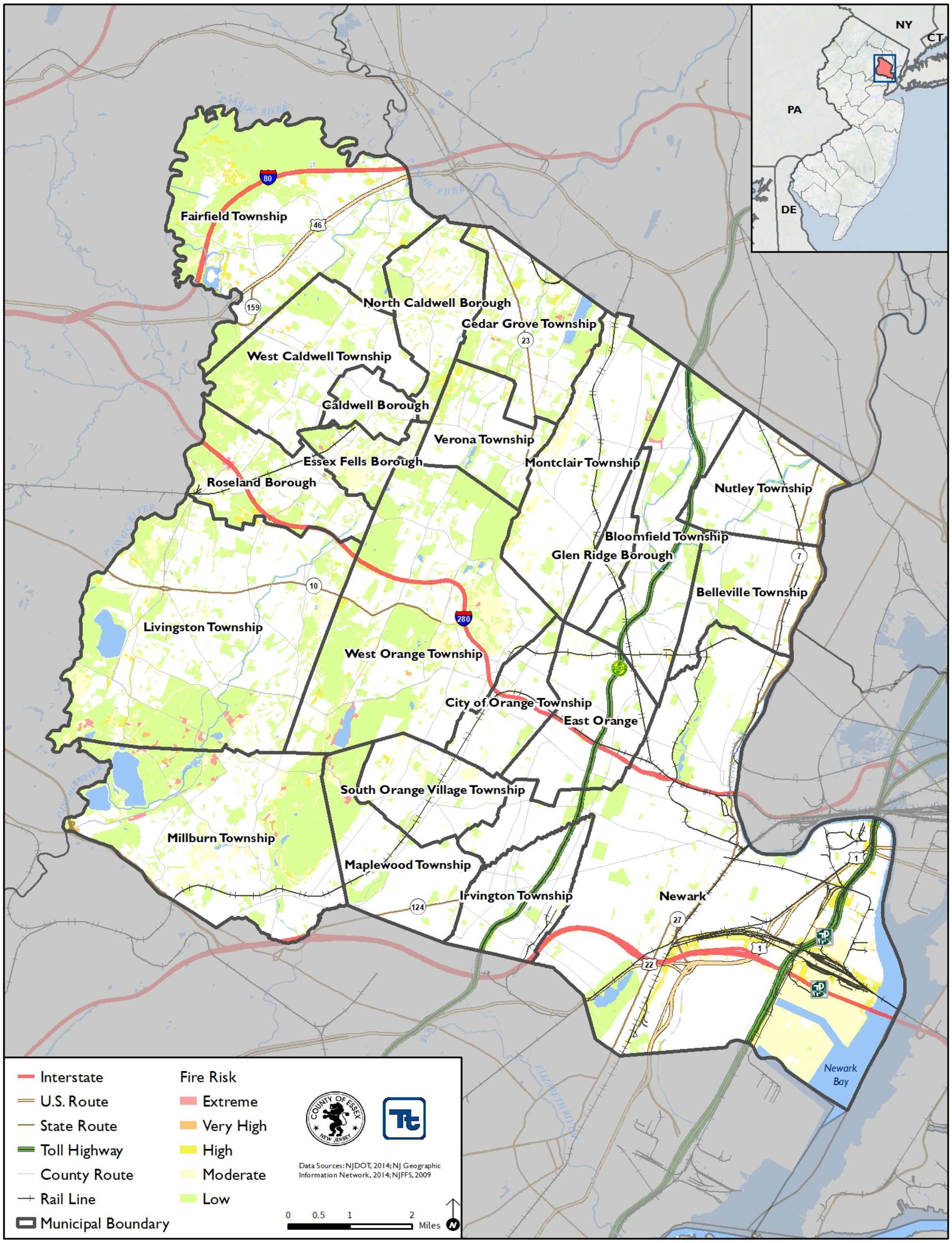
Source: NJFFS 2013

Figure 4.3.10-2. Wildfire Fuel Hazard for Essex County



Source: *New Jersey Forest Fire Service 2010*

Figure 4.3.10-3. Wildfire Risk for Essex County



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:

Table 4.3.10-3. Fire Danger Rating and Color Code

Fire Danger Rating and Color Code	Description
Low (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 (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 (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 (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 bum into heavier fuels.
Extreme (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 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 2018

Previous Occurrences and Losses

Between 1954 and 2019, 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. Essex County was not included in any FMA declarations.

Based on all sources used to research and identify wildfires in the County, there have been no wildfire incidents in Essex County between 2014 and 2019.

Probability of Future Occurrences

Estimating the approximate number of urban fires and wildfires to occur in Essex 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 WUI zone. Based on available data, urban fires and wildfires will continue to present a risk to Essex 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.

In Section 4.4, the identified hazards of concern for Essex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Steering Committee and Planning Committee, the probability of occurrence for wildfire in the County is considered 'frequent'.

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).

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2011). As for precipitation, 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). Average annual precipitation is projected to increase in the region up to 10% by the 2020s and up to 15% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2013).

As stated above, according to the temperature projections for Northern New Jersey, including Essex 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).

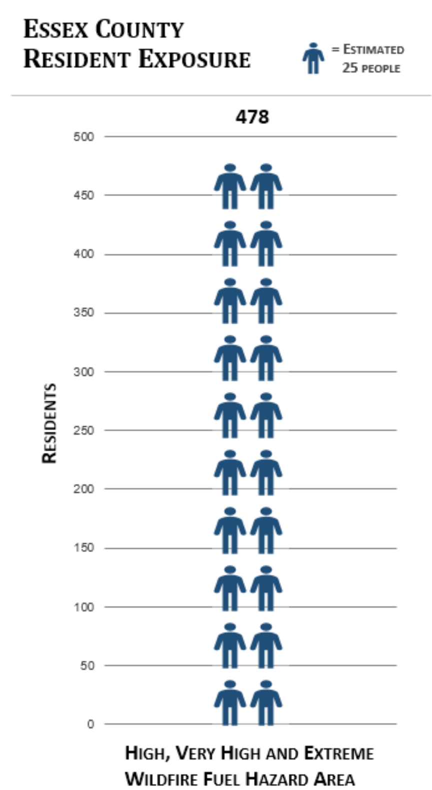
4.3.10.2 Vulnerability Assessment

A spatial analysis was conducted using the NJFFS 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 for additional details on the methodology used to assess wildfire risk.

Impact on Life, Health and Safety

As demonstrated by historic wildfire events in New Jersey and other parts of the country, potential losses include impacts to human health and life of residents and responders, structures, infrastructure and natural resources. In addition, 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 and decrease in tourism. 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 5.4.10-7 summarizes the estimated population exposed by municipality.

Exhibit 4.3.10-1. Estimated Population Exposure



Based on the spatial analysis, an estimated 478 people, or less than 1-percent of the County's population, are located in the high, very high and extreme wildfire hazard areas. Overall, the City of Newark has the greatest number of populations located in the extreme, very high, and high hazard areas (139 people), while the Township of Fairfield has the greatest percentage of its population exposed (79 people – 1% of the municipal population).

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over age 65. 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. In the high/very high/extreme NJFFS fuel hazard boundaries, there are approximately 82 people over the age of 65 and 30 people below the poverty level.

Table 4.3.10-4. Estimated Vulnerable Population

Municipality	American Community Survey (2013-2017) Population	Estimated Population Exposed	
		Extreme, Very High and High	% of Total Exposed
Township of Belleville	36,383	0	0.0%
Township of Bloomfield	48,892	0	0.0%
Borough of Caldwell	8,032	0	0.0%
Township of Cedar Grove	12,638	62	<1%
City of East Orange	65,151	0	0.0%
Borough of Essex Fells	2,095	3	<1%
Township of Fairfield	7,671	79	1.0%
Borough of Glen Ridge	7,668	0	0.0%
Township of Irvington	54,715	0	0.0%
Township of Livingston	29,955	6	<1%
Township of Maplewood	24,706	0	0.0%
Township of Millburn	20,387	9	<1%
Township of Montclair	38,572	39	<1%
City of Newark	282,803	139	<1%
Borough of North Caldwell	6,637	16	<1%
Township of Nutley	28,829	0	0.0%
City of Orange Township	30,731	0	0.0%
Borough of Roseland	5,907	3	<1%
Township of South Orange Village	16,503	33	<1%
Township of Verona	13,585	7	<1%
Township of West Caldwell	10,932	14	<1%
Township of West Orange	47,609	69	<1%
Essex County (Total)	**800,401**	**478**	**<1%**

Sources: American Community Survey 5-year Estimate, 2017; NJFFS, 2009

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 5.4.10-8 summarizes the estimated building stock inventory located in the hazard area by municipality. Less than 1-percent ($221 million) of the County's replacement cost value is located in the extreme/very high/high hazard area. The Township of Fairfield has the greatest number of buildings in the wildfire hazard area (32 structures – less than 1-percent of its total), while the Township of West Orange has the greatest replacement cost value located in the hazard area ($76 million – less than 1-percent of its total).

Table 4.3.10-5. Building Stock Replacement Value Located in Wildfire Fuel Hazard Ranking Zones

Municipality	Number of Buildings	Total Replacement Cost Value (RCV)	Estimated Building Stock Exposed			
			Number of Buildings - Extreme, Very High, and High	% of Total	RCV - Extreme, Very High, and High	% of Total
Township of Belleville	7,910	$4,483,250,138	0	0.0%	$0	0.0%
Township of Bloomfield	11,720	$6,021,089,887	0	0.0%	$0	0.0%
Borough of Caldwell	1,738	$1,183,204,981	0	0.0%	$0	0.0%
Township of Cedar Grove	3,944	$3,008,045,785	19	0.5%	$32,371,269	1.1%
City of East Orange	7,908	$6,090,766,912	0	0.0%	$0	0.0%
Borough of Essex Fells	766	$527,629,662	1	0.1%	$102,270	0.0%
Township of Fairfield	3,121	$6,082,819,367	32	1.0%	$35,586,309	0.6%
Borough of Glen Ridge	2,256	$1,095,474,263	0	0.0%	$0	0.0%
Township of Irvington	7,934	$5,384,838,816	0	0.0%	$0	0.0%
Township of Livingston	9,795	$7,691,376,811	2	0.0%	$2,526,898	0.0%
Township of Maplewood	6,738	$3,575,395,600	0	0.0%	$0	0.0%
Township of Millburn	6,437	$5,241,567,136	3	0.0%	$1,314,971	0.0%
Township of Montclair	9,436	$5,845,976,130	11	0.1%	$10,591,516	0.2%
City of Newark	43,085	$40,970,549,425	13	0.0%	$13,311,804	0.0%
Borough of North Caldwell	2,095	$1,727,767,442	5	0.2%	$5,140,141	0.3%
Township of Nutley	7,945	$3,841,553,722	0	0.0%	$0	0.0%
City of Orange Township	3,890	$3,520,865,708	0	0.0%	$0	0.0%
Borough of Roseland	1,794	$1,955,487,279	1	0.1%	$6,477,522	0.3%
Township of South Orange Village	4,188	$2,877,374,186	11	0.3%	$18,056,328	0.6%
Township of Verona	4,113	$2,213,338,613	2	0.0%	$8,372,455	0.4%
Township of West Caldwell	3,730	$3,533,044,820	5	0.1%	$10,550,659	0.3%
Township of West Orange	11,845	$8,358,783,858	17	0.1%	$76,136,926	0.9%
Essex County	**162,388**	**$125,230,200,542**	**122**	**0.1%**	**$220,539,068**	**0.2%**

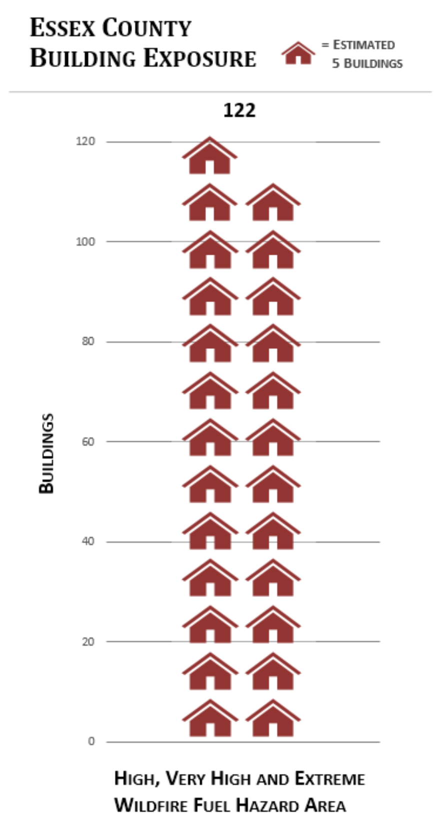
Sources: Microsoft, 2018, Open Street Map, 2019; NJOIT, 2018; NJFFS, 2009

Impact on Critical Facilities

In Essex County, there is one critical facility (school) located in the wildfire hazard area. The school is located in the Township of West Orange in a high fuel hazard area. According to the Township this school is hydrant service to this school.

Roads and bridges in 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. Areas surrounding any dams located in wooded areas or other areas adjacent to the wildfire hazard areas are particularly vulnerable to additional impacts from a wildfire. Wildfires may not directly impact dams, but it can create conditions in which dams can be obstructed or damaged by falling tree debris and cause potential flooding in the area.

Exhibit 4.3.10-2. Estimated Building Exposure



Impact on 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. Wildfires can cost thousands of taxpayer dollars to suppress and control and 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.

Wildfire can also severely impact roads and infrastructure. NJ-27 and NJ-124, which service the southern communities of Essex County are exposed to portions of the wildfire hazard area. This should be considered for evacuation route purposes since it serves as the major north/south corridor in the interior of the County. No major utilities such as power generation facilities are located in the wildfire hazard area.

Due to a lack of data regarding past structural and economic losses specific to Essex County or its municipalities, it is not possible to estimate future losses due to wildfire events currently.

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 in Section 3 (County Profile), areas targeted for future growth and development have been identified across the county. It is anticipated that any new development and new residents in the extreme, very high or high fuel hazard areas will be exposed to the wildfire hazard.

New development could be affected by the wildfire hazard if located in the identified hazard areas and mitigation measures are not considered during design, development and maintenance of the property. Each municipality identified areas of recent development and proposed development in their community. Developments that could be located using an address or Parcel ID were geocoded and overlain with the NJFFS high, very high, and extreme wildfire hazard areas to determine exposure to wildfire. There are 3 recent and proposed developments vulnerable to the wildfire hazard; this represents approximately 1.07 percent of the 28 identified developments. Refer to Section 3 (County Profile), and Volume II Section 9 for potential new development in Essex County; and Figure 5.4.6-13 for a map of proposed new development and the NJFFS boundaries for Essex County.

Projected Changes in Population

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). As population grows, people may expand out towards areas adjacent to or within the wildfire hazard area. The mix of additional structures, ornamental vegetation, and wildland fuels may cause erratic fire behavior, and could potentially increase risk to life, property, and economic welfare in vulnerable areas throughout the County. Refer to Section 3 (County Profile which includes a discussion on population trends for the County.

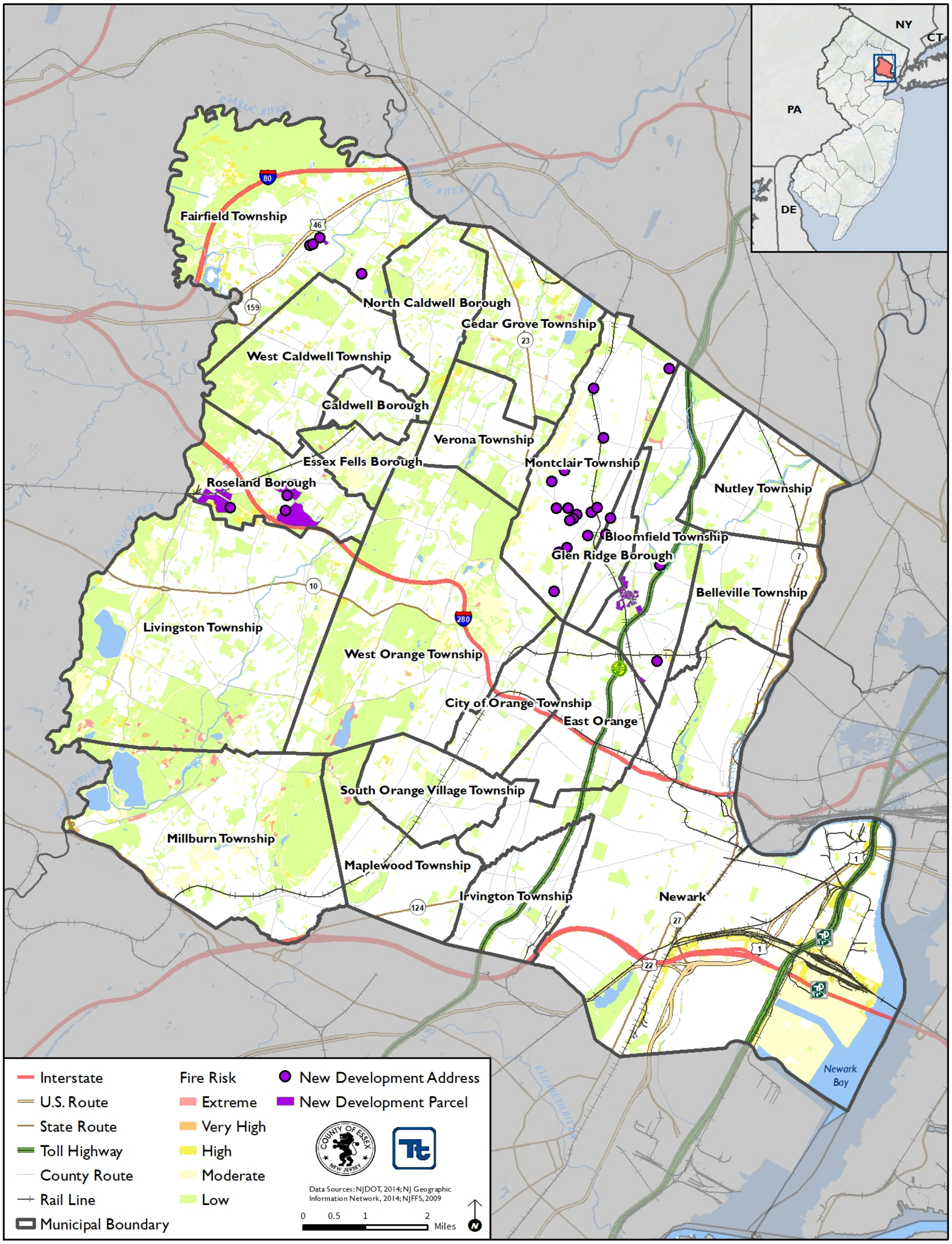
Climate Change

As discussed earlier, temperatures are anticipated to increase, 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 can increase the County's vulnerability. If stronger winds occur near a wildfire and emergency services are unable to initially contain the event, the fast-moving fire can spread to nearby developments. This can directly impact the County's population and built environment in the vicinity of the fire, and also indirectly affect those served by utility infrastructure that can be damaged by a fire.

Change of Vulnerability Since 2015 HMP

The entire County continues to be vulnerable to the wildfire hazard. Several differences exist between the 2015 HMP and this update. For this plan update, an updated general building stock based upon replacement cost value from MODIV tax assessment data and 2019 RS Means, and an updated critical facility inventory were used to assess the County's risk to the hazard areas; further lifelines were identified. In addition, the 2017 American Community Survey population estimates were used and estimated at a structural level as compared to the 2015 plan which evaluated exposure using 2010 U.S. Census blocks. The NJFFS Wildfire Fuel Hazard spatial layer has not been updated since the last HMP. I Changes in exposure are attributed to increases in population and new development.

Figure 4.3.10-4. Wildfire Risk and New Development for Essex County



4.3.11 Civil Disorder

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 civil disorder hazard in Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous events between 2014 and 2019 were researched, with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).

4.3.11.1 Profile

Hazard Description

Civil disorder is a broad term that is typically used by law enforcement to describe one or more forms of unrest caused by a group of people. It involves a disruption of the typical social order that can involve a strike or protest, and it can be peaceful or involve violence (NJOEM 2019). Demonstrations, civil unrest, public disorder, and riots happen for a number of reasons that include economic hardships, social injustices, ethnic differences, objections to word organizations or certain governments, political grievances, and terrorist acts. An event can be triggered by a single cause or a combination of causes (U.S. Army 2005).

Civil disturbances can take the form of small gatherings or large groups blocking or impeding access to a building or disrupting normal activities by generating noise and intimidating people. Demonstrations can range from a peaceful sit-in to a full-scale riot, in which a mob burns or otherwise destroys property and terrorizes individuals. Even in its more passive forms, a group that blocks roadways, sidewalks, or buildings interferes with public order. Often protests intended to be a peaceful demonstration to the public and the government can escalate into general chaos (NJOEM 2019).

There are two types of large gatherings typically associated with civil disturbances: a crowd and a mob. A crowd can be identified as causal, cohesive, expressive, or aggressive (Blumer 1946):

- Casual Crowd: A casual crowd is a group of people who happen to be in the same place at the same time. Violent conduct does not occur.
- Cohesive Crowd: A cohesive crowd consists of members who are involved in some type of unified behavior. Members of this group are involved in some type of common activity, such as worshipping, dancing, or watching a sporting event. Members of these crowds may have intense internal discipline and require substantial provocation to arouse to action.
- Expressive Crowd: An expressive crowd is one held together by a common commitment or purpose. They may not be formally organized and are assembled as an expression of common sentiment or frustration. Members wish to be seen as a formidable influence. One of the best examples of this type is a group assembled to protest.
- Aggressive Crowd: An aggressive crowd is composed of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and will taunt authorities. They may be more impulsive and emotional and require only minimal stimulation to arouse violence. Examples of this type of crowd could include demonstrators and strikers, though not all demonstrators and strikers are aggressive.

A mob can be defined as a large disorderly crowd or throng. Mobs are usually emotional, loud, tumultuous, violent, and lawless. Similar to crowds, mobs have different levels of commitment, and can be classified into the following four categories (Alvarez and Bachman 2007):

- Aggressive Mob: An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity. Examples of aggressive mobs are the inmate mobs in prisons and jails, mobs that act out their frustrations after political defeat, or violent mobs at political protests or rallies.
- Escape Mob: An escape mob is attempting to flee from something such as a fire, bomb, flood, or other catastrophe. Members of escape mobs are generally difficult to control and can be characterized by unreasoning terror.
- Acquisitive Mob: An acquisitive mob is one motivated by a desire to acquire something. Riots caused by other factors often turn into looting sprees. This mob exploits an authority's lack of control in safeguarding property.
- Expressive Mob: An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration. Members experience a release of pent up emotions in highly charged situations.

Civil unrest and disturbances affect the following factions of society:

- The Public: The general population could serve as participants or targets in actions of civil unrest. Wide spread unrest could cause fear amongst the populace and cause them to be absent from school or work activities. During an event, bystanders may be harmed because of the activities of participants.
- Responders: Responses to civil unrest events are generally handled at the local level. In a large event, the resources of a local jurisdiction may be exceeded. In this instance, State resources would be activated to fill the need. During an event, responders may become targets, which could hamper their effectiveness.
- Continuity of Operations, including delivery of services: The outbreak of widespread rioting or looting could have potential impact on the State's ability to provide services and conduct its normal operations. Protesters could occupy government buildings and interrupt the normal functions of government, or targeted attacks on government facilities could interrupt operations entirely.
- Property: Private property often serves as a target in instances of civil unrest. Businesses can be targeted for looting or vandalism. If an event is particularly large, damage could reach millions of dollars and recovery could take years.
- Facilities: Often in acts of civil unrest government facilities become the focal point of protests or targets for vandalism. Damage suffered during an event or the inability of a worker to enter a facility may greatly reduce a facility's effective capacity or close it completely.
- Infrastructure: Similar to government facilities, public and private infrastructure can become targets of civil unrest. Damage to transportation, communications, or utilities infrastructure could further exacerbate the situation.
- Environment: Normally, instance of civil unrest will have a minimal impact on the environment. However, if petroleum or other chemical facilities were a target for vandalism or large-scale fires occurred, the impact on the environment could be significant.
- Economic Condition of the State: Civil unrest could prove economically crippling to the State of New Jersey. Large-scale events are usually accompanied by wide-spread absenteeism and damage to private property.
- Public Confidence in the State's Governance: If an event becomes prolonged or is perceived to be mismanaged, it could greatly decrease public confidence in the governance of the State. If the response is seen to be inadequate, individuals may attempt to protect their property by their own means and further degrade the situation.

Civil disturbances often occur with little to no warning; however, certain events may trigger riots. As demonstrated in the Previous Occurrences and Losses subsection and discussions regarding severity, riots can occur as a result of controversial court rulings, unfair working conditions, or general unrest. Riots can also be triggered as a result of favorable or unfavorable sports outcomes. Thus, generally there will be a certain degree of warning time that a riot may occur; however, achieving certainty that an incident is imminent is not possible.

Civil disorders can result in numerous secondary hazards. Depending on the size and scope of the incident, civil unrest may lead to widespread urban fire, utility failure, transportation interruption, and environmental hazards. There is potential for a mass casualty incident to occur during the course of a civil disorder event should rioters or protestors become violent and clash with law enforcement or opposing groups. This could lead to possible casualties or fatalities. The most significant impact of civil unrest is the secondary hazard of interruption of continuity of government, which can also lead to several of the aforementioned secondary hazards. The extent of secondary hazards will vary significantly based on the extent and nature of the civil unrest.

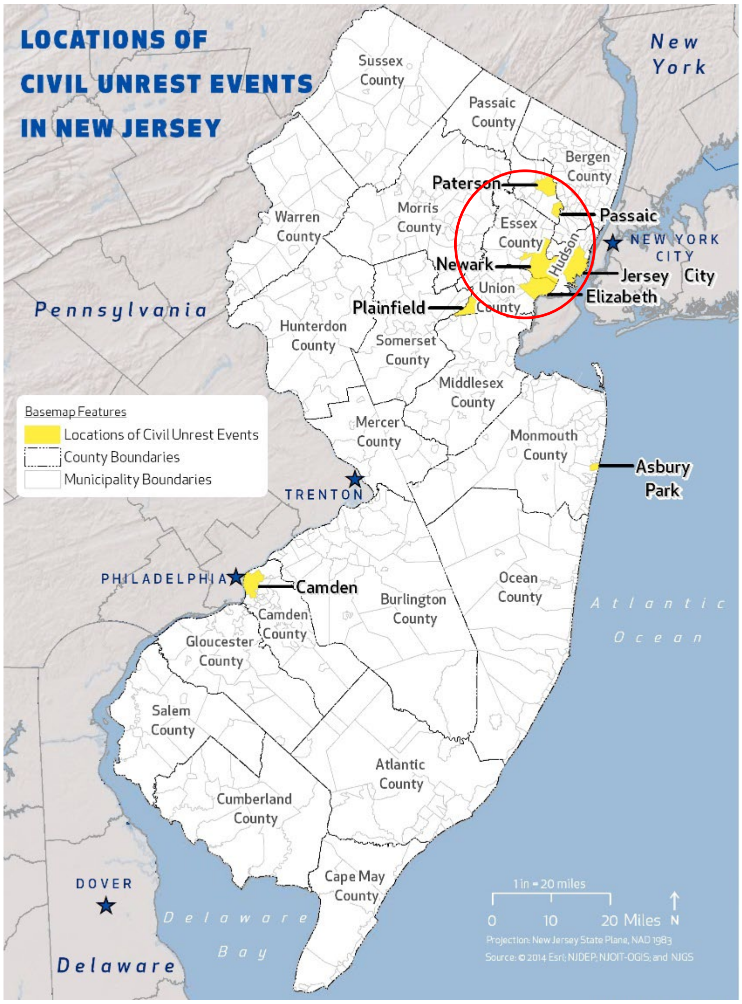
In the State of New Jersey, a municipality in which a civil disorder occurs bears the first and primary responsibility to control the disturbance. Civil unrest that remains uncontrolled warrants local mutual aid from neighboring municipal and/or county resources. If the civil unrest remains beyond the capabilities of local law enforcement agencies alone, limited State Police assistance may be requested. If the restoration of law and order is beyond local, county and state abilities, the Governor may declare a State of Emergency calling on federal support such as the New Jersey National Guard to restore order (NJOEM 2011).

Civil disorder can also be identified as crime, which is classified into four major classifications: violent crime, property crime, public order crime, and hate crime. Violent crimes are physical acts against an individual such as murder, robbery, or assault. Property crimes are acts against the property of others such as burglary, theft, or vandalism. Public order crimes are crimes that have no specific victim, such as prostitution, drugs, or insider trading. Hate crimes can be either violent or property crimes motivated by bias against a particular social group (Essex County HMP 2007).

Location

Government facilities, landmarks, prisons, and universities are common sites where crowds and mobs may gather. The concentration of buildings in and density of northeastern New Jersey, and State government buildings in Trenton may be targets of civil disturbance. New Jersey also has correctional facilities, treatment units, and youth development centers, as well as federal prison facilities and local and private facilities throughout the State that may be targets for civil unrest (NJOEM 2019). Figure 4.3.11-1 illustrates historic civil disorder events in the State since the early 1900's with several that have occurred in Essex County.

Figure 4.3.11-1. Locations of Civil Unrest Events in New Jersey from 1913 to Present



Source: NJOEM 2019
The red circle marks the location of Essex County.

Extent

The magnitude or severity of a civil disorder depends on the nature of the disturbance. They can take form as small gatherings or large groups blocking access to buildings or disrupting normal activities. They can range from peaceful sit-ins to a full-scale riot (NJOEM 2019).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with civil disorders events throughout Essex County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events 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.

Between 1954 and 2019, the State of New Jersey has not been included in any FEMA civil disorder related disasters (DR) or emergencies (EM) (FEMA 2019).

The most significant civil disorder event to occur within the State of New Jersey was the 1967 Newark Riots. The event was fueled by police brutality, political exclusion of African Americans, urban renewal, inadequate housing, unemployment, and poverty. These riots took place between July 12 and July 17, 1967. At the conclusion of 6 days of rioting, 26 people were dead, an estimated 725 people were injured, and close to 1,500 people had been arrested (NJOEM 2019).

No significant civil disorder events that have impacted Essex County between 2014 and 2019 were identified.

Probability of Future Occurrences

While the probability of future civil unrest incidents is difficult to predict, given past occurrences and significance of New Jersey and its communities, civil unrest incidents are possible. As discussed in the Location section above, areas that are important to the State, region, and greater United States may be targets for civil unrest. These areas include universities, landmarks, correctional facilities, major industrial facilities, and others similar in nature. It is also worth noting that while the last major civil disturbance in New Jersey occurred in the 1970s, it is still possible for a future event to occur. Societal trends and emerging social issues should be watched closely as these types of issues have led to instances in the past.

In Section 4.4, the identified hazards of concern for Essex 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 Steering and Planning Committees, the probability of occurrence for civil disorder in the County is considered 'occasional'.

Climate Change Impacts

Because civil unrest is a short-term, human-caused hazard, no climate change impacts are associated with the hazard.

4.3.11.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

Potential losses from civil disorder incidents include human health and life and property resources. Civil disorder incidents can lead to injury and/or death for both the involved persons and the innocent bystanders. If a civil disorder turns violent, they can lead to injury and/or death for personnel responding to the incident. The number of people exposed to a civil disorder depends on the population density and the location of the civil disorder. Increases in population or the hosting of major political, economic or social events could increase the likelihood and severity of a civil disorder incident.

Impact on General Building Stock

The general building stock of Essex County may be damaged or destroyed during a civil disorder incident. Depending on the scale of the incident, damages could range from broken windows to the destruction of major pieces of infrastructure.

Impact on Critical Facilities

Critical facilities may be targets for civil unrest disturbances. Refer to Section 3- County Profile, which summarizes the number and type of critical facilities in Essex County. Disruptions to critical facilities may have cascading secondary effects such as power outages and utility failure. Because these facilities are vulnerable to civil disorders and may be a focal point during a protest, these facilities will need to be protected during incidents.

Impact on Economy

Civil disorder events can have negative economic and social effects on Essex County as a whole. Measuring the economic impact of civil unrest in the County is difficult. Elements that contribute to this are the volatility of the nature of civil disturbances, and the uncertainty of the duration of an incident. Economic conditions could be adversely affected and dependent upon time and length of cleanup and investigation of the incident. Some incidents may target the business sector, impacting the economy of that municipality where the incident is occurring. For the purpose of this assessment, all of Essex County's economy is considered exposed to the effects of civil disorders.

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 and Changes in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by the civil disorder hazard because the entire County is exposed and vulnerable. The limited number of instances of civil unrests within the State has only shown one clear and consistent similarity, which is that each instance occurred in large, densely populated cities. An increase in development and population has the ability to increase the likelihood of a civil disorder incident. Future migration to larger jurisdictions may also increase the likelihood of a civil disorder incident. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). An increased in population within Essex County, particularly in urban areas, could increase the total number of people exposed to civil disorder events.

Climate Change

Because a civil disorder is a short-term, human-caused hazard, no climate change impacts are associated with the hazard.

Change of Vulnerability Since the 2015 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to civil disorder events.

4.3.12 Cyber Attack

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 cyber attack hazard in Essex County.

2020 Plan Update Changes

- All subsections have been updated using best available data.
- Previous events between 2014 and 2019 were researched, with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).

4.3.12.1 Profile

Hazard Description

Cyber terrorism is the use of existing computers and information, particularly over the Internet, to cause physical or financial harm or a severe disruption of infrastructure service. Transportation, public safety, and utility services are all critical, and are highly dependent on information technology. The motive behind such disruptions can be driven by religious, political, or other objectives. Three kinds of attacks that can be conducted on computers include attacks of physical means, electronic means, and attacks using malicious code (NJOEM 2019).

Cyber-attacks differ by motive, attack type and vector, and perpetrator profile. Motives for cyber-attacks can vary, ranging from the pursuit of financial gain to political or social aims. Cyber threats are difficult to identify and comprehend. Types of threats include viruses erasing entire systems, intruders breaking into systems and altering files, intruders using someone's personal computer to attack others, or intruders stealing confidential information. The spectrum of cyber risks is limitless, with threats having a wide-range of effects on the individual, community, organizational, and national threat (FEMA 2013). These risks include:

- Organized cybercrime, state-sponsored hackers, and cyber espionage can pose national security risks to the U.S.
- Transportation, power, and other services may be disrupted by large scale cyber incidents. The extent of the disruption is highly uncertain as it will be determined by many unknown factors such as the target and size of the incident.
- Vulnerability to data breach and loss increases if an organization's network is compromised. Information about a company, its employees, and its customers can be at risk.
- Individually-owned devices such as computers, tablets, mobile phones, and gaming systems that connect to the internet are vulnerable to intrusion. Personal information may be at risk without proper security (FEMA 2013).

Cyber terrorism is the use of existing computers and information, particularly over the Internet, to cause physical or financial harm or a severe disruption of infrastructure service. Transportation, public safety, and utility services are all critical, and are highly dependent on information technology. The motive behind such disruptions can be driven by religious, political, or other objectives. Three kinds of attacks that can be conducted on computers include attacks of physical means, electronic means, and attacks using malicious code (Waldron 2011). Specifically, these types of include:

- Directing conventional kinetic weapons against computer equipment, a computer facility, or transmission lines to create a physical attack that disrupts the reliability of equipment.

- The power of electromagnetic energy, most commonly in the form of an electromagnetic pulse (EMP), can be used to create an electronic attack (EA) directed against computer equipment or data transmissions. By overheating circuitry or jamming communications, an EA disrupts the reliability of equipment and the integrity of data.
- Malicious code can be used to create a cyber-attack, or computer network attack (CNA), directed against computer processing code, instruction logic, or data. The code can generate a stream of malicious network packets that can disrupt data or logic through exploiting vulnerability in computer software, or a weakness in the computer security practices of an organization. This type of cyber-attack can disrupt the reliability of equipment, the integrity of data, and the confidentiality of communications (Wilson and Clay 2007).

Cyber terrorists typically have two broad motivations to carry out an attack. These motivations include:

- Effects-based: Cyber terrorism exists when computer attacks result in effects that are disruptive enough to generate fear comparable to a traditional act of terrorism.
- Intent-based: Cyber terrorism exists when unlawful or politically motivated computer attacks are done to intimidate or coerce a government or people to further a political objective, or to cause grave harm or severe economic damage (Rollins and Clay 2007).

In terms of specific attacks on computers, cyber terrorists have the ability to attack several types of computer systems in a variety of ways. The systems are summarized in Table 4.3.12-1.

Table 4.3.12-1. Computer Systems that can be Attacked

Computer System	Description
All system and network devices BIND weaknesses	The Berkeley Internet Name Domain (BIND) package is the most widely used implementation of Domain Name Service (DNS) by which systems on the Internet are located by name, without having to know specific Internet protocol (IP) addresses. In a typical example of a BIND attack, intruders erase system logs and install tools to gain administrative access. They then compile and install Internet Relay Chat (IRC) utilities and network scanning tools, which are used to scan more than a dozen class-B networks in search of additional systems running vulnerable versions of BIND. In a matter of minutes, they can use the compromised system to attack hundreds of remote systems.
Vulnerable Common Gateway Interface (CGI) programs and application extensions (such as ColdFusion) installed on Web servers (multiple UNIX and Linux systems)	Most Web servers support CGI for data collection and verification. Intruders are known to have exploited vulnerable CGI programs to vandalize Web pages and steal credit cards.
RPC weaknesses (all Web servers)	Remote procedure calls (RPC) allow programs on one computer to execute programs on a second computer. They are widely used to access network services such as shared files in the Network File System (NFS). There is compelling evidence that the vast majority of service attacks launched during 1999 and early 2000 were executed by systems that had been victimized because they had RPC vulnerabilities. In 1998, the broadly successful attack on U.S. military systems during the Solar Sunrise incident also exploited an RPC flaw found on hundreds of Department of Defense systems.

Computer System	Description
RDS security hole in Microsoft IIS (multiple UNIX and Linux systems)	Programming flaws in Microsoft's Internet Information Server (IIS) used to host websites deployed on Microsoft Windows NT and Windows 2000 are employed by malicious users to run remote commands with administrator privileges. Experts who developed the "Top Ten" list of the most exploited internet security flaws believe that exploits of other IIS flaws, such as .HTR files, are at least as common as exploits of Remote Desktop Services (RDS).
Sadmind (Solaris machines only)	Global file sharing and inappropriate information sharing via NetBIOS and Windows NT ports allow file sharing over networks. When improperly configured, they can expose critical system files or give full file system access to hostile parties.
User IDs, especially root/administrator with no or weak passwords (UNIX, Windows, and Macintosh systems)	Some systems come with "demo" or "guest" accounts with no passwords or with widely-known default passwords. Service workers often leave maintenance accounts with no passwords, while some database management systems install administration accounts with default passwords. In addition, busy system administrators often select system passwords that are easily guessable ("love," "money," "wizard" are common) or use a blank password. Many attackers try default passwords and then try to guess passwords before resorting to more sophisticated methods.
IMAP and POP buffer overflow vulnerabilities or incorrect configuration (all systems)	Internet message access protocol (IMAP) and Post Office Protocol (POP) are popular remote access mail protocols, allowing users to access their e-mail accounts. The "open access" nature of these services makes them especially vulnerable to exploitation because openings are frequently left in firewalls to allow for external e-mail access. Attackers who exploit flaws in IMAP or POP often gain instant root- level control.
Default SNMP community strings set to "public" and "private" (multiple UNIX and Linux systems)	The Simple Network Management Protocol (SNMP) is widely used by network administrators to monitor and administer all types of network-connected devices, ranging from routers to printers to computers. SNMP uses an unencrypted "community string" as its only authentication mechanism. Lack of encryption creates one level of security vulnerability, but the default community string used by the vast majority of SNMP devices is "public," with a few clever network equipment vendors changing the string to "private," which presents a greater security risk. Attackers can use this vulnerability in SNMP to reconfigure or shut down devices remotely.

Source: NJOEM 2019

In addition to the motivations for cyber terrorism and the vulnerable systems, cyber-attacks can be further divided by the complexity of the attack. The categories of attacks include:

- Simple-Unstructured: Simple-unstructured attacks are the most common. These are amateurish attacks with relatively minimal consequences.
- Advanced-Structured: Advanced-structured attacks are more sophisticated and consequential and have a greater emphasis on targeting victims prior to an attack, resulting in a more debilitating effect.
- Complex-Coordinated: Complex-coordinated attacks are the most advanced and most troublesome type of attack where success could mean a network shutdown.

Because virtually all critical systems are reliant upon computer systems, the secondary hazards that could result from a cyber terrorism attack could be devastating. For example, many of New Jersey's roadway systems rely on sophisticated traffic control systems that prevent gridlock and accidents daily. Without these systems, the risk of not only auto accidents increases but also hazardous materials in-transit incidents. Additionally, a cyber-attack on a nuclear power plant could have devastating consequences should the plant suffer an intentional catastrophic failure. A cyber-attack could also completely incapacitate the communications infrastructure not only in New Jersey but across the United States, leading to disturbing secondary consequences and hazards. Public Safety Answering Points could be targeted by cyber-attacks, and if affected, there could be significant impacts to public safety response and dispatching of emergency services.

Because the power grid is also largely controlled by computer systems, a widespread power outage is also a possibility. A failure of the power grid would impact individuals reliant on power such as those with medical needs. The number of critical systems reliant on computer systems are numerous, thus disruption of one or more of the systems would cause severe secondary-cascading hazards. Secondary impacts could also affect private structures and systems within them: HVAC systems, life support systems, and security systems. Power outage caused from cyber attacks can also affect individuals who are dependent on medical equipment.

Since cyber security is a fairly new concept, there are limited regulations in place. The United States Department of Homeland Security (DHS) recognizes the threat of a potential cyber-attack and has an established approach meant to safeguard critical infrastructure in cyberspace. DHS coordinates with other agencies and partners to share information on and analysis of cyber threats and vulnerabilities and recognizes cyber security as a main aspect of their risk management strategy (NJOEM 2019).

In Essex County, the Prosecutor's Office formed a Cyber Crimes Unit in December 2010. This was created to investigate child pornography, computer fraud, cyber-stalking, cyber bullying, and the use of the internet and other technology in crimes. The Cyber Crimes Unit works with local, state and federal law enforcement agencies (Essex County Prosecutors Office 2019).

The New Jersey Cybersecurity and Communications Integration Cell (NJCCIC) was established in 2015 in order to address New Jersey's vulnerability to potential occurrences of a cyber-attack. NJCCIC focuses on information sharing, threat analysis and incident reporting with the intent of promoting awareness of the potential threat New Jersey faces to cyber-attack (NJOEM 2019).

Location

Cyber threats to critical infrastructures can be posed by anyone with the capability, technology, opportunity, and intent to do harm. Potential threats can be foreign or domestic, internal or external, State-sponsored or a single rogue element. Terrorists, insiders, disgruntled employees, and hackers are included in this profile. The fact that most of the nation's vital services are delivered by private companies creates a significant challenge in assigning the responsibility for protecting our critical infrastructures from cyber-attacks. Across New Jersey, countless systems rely on computers for day-to-day operations including but not limited to traffic signals, power plants, HVAC systems, as well as systems responsible for ensuing New Jersey's State government can operate. While these are just a few examples of critical systems vulnerable to cyber-attacks, it should be noted that an attack could cripple not only the operations of New Jersey's systems but also the economy (NJOEM 2019).

New Jersey remains a valuable target as it possesses a wealth of critical information infrastructure, much of which is inherently interdependent. New Jersey is strategically located along a heavy transit corridor for people and goods, and is a major node along the fiber path through the northeastern United States, connecting New Jersey to Philadelphia and Washington, D.C. Furthermore, New Jersey is one of the wealthiest states in the country and is home to many Fortune 500 companies. Any disruption to the State's economy could have a drastic impact on the national economy and thus the nation's economic stability (New Jersey Office of Homeland Security and Preparedness [NJ OHSP] 2008).

In Essex County, there are several Fortune 500 companies. Prudential Financial is located in Newark, ranking 2nd in the State for revenue ($59.7 million). Automatic Data Processing in located in Roseland, ranking 9th in the State for revenue ($12.4 million). Lastly, Public Service Enterprise Group is located in Newark and ranks

13th in the State for revenue ($9.1 million) (Choose New Jersey 2019). Any disruption in the County's government could have an impact on the State's economy.

Extent

The magnitude of extent of an incident will vary greatly based on the extent and duration of the impact. Additionally, the extent will vary based upon which specific system is affected by an attack, the warning time, and ability to preempt an attack.

A cyber-attack can affect a variety of sectors with potentially severe consequences. The following areas may be affected by an attack:

- Android: Malicious software designed to exploit the Android operating systems (OS) running on smartphones, tablets, and other devices. Some variants of Android malware have the capability of disabling the device, allowing a malicious actor to remotely control the device, track the user's activity, lock the device, or encrypt or steal personal information transmitted from or stored on the device. As users are increasingly turning to mobile devices for both business and personal use, cyber threat actors are devoting their efforts to developing malware designed to compromise the device software.
- Botnets: A group of internet-connected computers and devices that have been infected by malware that allows a malicious actor to control them remotely. The malicious actor then uses the botnet for nefarious purposes such as sending spam email, stealing data, spreading additional malware infections to other devices, generating illicit advertising revenue through click-fraud, mining cryptocurrencies, or conducting distributed denial-of-service (DDoS) attacks. In the cases where botnets are used to conduct DDoS attacks, these infected devices are used to generate an excessive amount of network traffic designed to overwhelm a website, server, or online service to the point that legitimate users cannot access it.
- Exploit Kits: Toolkits that automate the exploitation of vulnerabilities in popular software applications to maximize successful infections and serve as a platform to deliver malicious payloads such as Trojans, spyware, ransomware, and other malicious software. Most users will encounter EKs from visiting seemingly legitimate, high-traffic websites that either contain links to EKs embedded within malicious advertising (malvertising) or have malicious code hidden directly within the website itself. Malicious URLs linking to EKs are commonly distributed through spam email and spear-phishing campaigns.
- ICS: A collective term for several types of control systems and other equipment used to operate and/or automate industrial processes and includes supervisory control and data acquisition (SCADA) systems – often incorrectly used interchangeably with ICS – and distributed control systems (DCS).
- IOS: Malicious software designed to exploit Apple's iOS operating system running on smartphones, tablets, and other devices. Some variants of iOS malware have the capability of disabling the device, allowing a malicious actor to remotely control the device, track the user's activity, lock the device, or encrypt or steal personal information transmitted from or stored on the device. As users are increasingly turning to mobile devices for both business and personal use, cyber threat actors are increasingly devoting their efforts to developing malware designed to compromise mobile devices, including operating systems, like iOS, and applications, like those available in the App Store. Android devices have historically seen more malware threats than iOS largely due to the open-source operating system; however, malware specifically targeting iOS has increased in the last two years.
- MACOS: Though the majority of known malware targeting operating systems are made to exploit Microsoft Windows, devices running macOS are vulnerable as well. Furthermore, as macOS has become increasingly popular, more malware has been created to target macOS. More macOS malware was discovered in the second quarter of 2017 than in all of 2016.
- Point of Sale (PoS): Malicious software designed to steal credit and debit card data from payment processing systems, known as point-of-sale (PoS) terminals.

- Ransomware: Malicious software (malware) that attempts to extort money from victims by restricting access to a computer system or files. The most prevalent form of this profit-motivated malware is crypto-ransomware, which encrypts files into encoded messages that can only be decrypted (decoded) with a key held by the malicious actor.
- Trojans: A type of malware that, unlike viruses and worms, does not self-replicate. Named after the mythological wooden horse used to sneak Greek warriors through the gates of Troy, trojans are often disguised as legitimate software to avoid detection or trick users into installing the trojan onto their system. Users can be exposed to trojans through numerous vectors, such as clicking on links or opening attachments in phishing emails, other forms of social engineering, malicious advertising (malvertisting), or by visiting compromised websites, known as drive-by downloads. Once a trojan executes, it often downloads other malware onto the system or provides an attacker with a backdoor to gain access and conduct further malicious activity, such as stealing, deleting, or modifying data (NJCCIC 2019).

The extent, nature, and timing of cyber incidents are impossible to predict. There may or may not be any warning. Some cyber incidents take a long time (weeks, months or even years) to be discovered and identified (FEMA 2013). The magnitude of severity of an incident will vary greatly based on the extent and duration of the impact. The extent will also vary based upon which specific system is affected by an attack, the warning time, and the ability to preempt an attack.

A cyber terrorism attack can occur with relatively little or no warning. The New Jersey Office of Homeland and Preparedness is charged with gathering intelligence and monitoring cyber terrorism threats affecting the State. At the federal level, numerous agencies (such as FBI and CIA) are working collaboratively to thwart cyber terrorism attacks. The warning time depends upon the ability of these agencies to recognize that a threat exists and their ability to stop the attack. Even with these agencies on task to monitor cyber threats, a cyber-attack can occur with no warning (NJOEM 2019).

The Multi-State Information Sharing and Analysis Center (MS-ISAC) created the Cyber Alert Level Indicator. It shows the current level of malicious cyber activity and reflects the potential for, or actual damage. There are five cyber alert levels: low, guarded, elevated, high, and severe. Each level is indicated by a color. The following is additional information regarding these levels:

- **Low** – Indicates a low risk. No unusual activity exists beyond the normal concern for known hacking activities, known viruses, or other malicious activity.
- **Guarded** – Indicates a general risk of increased hacking, virus, or other malicious activity. The potential exists for malicious cyber activities, but no known exploits have been identified, or known exploits have been identified but no significant impact has occurred.
- **Elevated** – Indicates a significant risk due to increased hacking, virus, or other malicious activity which compromises systems or diminishes service. At this level, there is known vulnerabilities that are being exploited with a moderate level of damage or disruption, or the potential for significant damage or disruption is high.
- **High** - Indicates a high risk of increased hacking, virus or other malicious cyber activity which targets or compromises core infrastructure, causes multiple service outages, multiple system compromises or compromises critical infrastructure. At this level, vulnerabilities are being exploited with a high level of damage or disruption, or the potential for severe damage or disruption is high.
- **Severe** - Indicates a severe risk of hacking, virus or other malicious activity resulting in wide-spread outages and/or significantly destructive compromises to systems with no known remedy or debilitates one or more critical infrastructure sectors. At this level, vulnerabilities are being exploited with a severe level or wide spread level of damage or disruption of Critical Infrastructure Assets.

Previous Occurrences and Losses

While no major direct cyber-attacks have affected New Jersey or its counties, as mentioned, cyber terrorism is an emerging hazard that can impact the State's computer infrastructure and the systems and services that are provided to the public. Across the United States, concerns over cyber terrorism are growing. Many smaller-scale attacks have occurred in New Jersey. In 2016 New Jersey released the annual statistics on cyber breaches for the first time. The information released details breaches that involve the unauthorized access to personal information, such as a name, social security number, driver's license number, bank account, etc. The state police had 676 data breaches reported to them in 2016, affecting over 116,000 New Jersey account holders (Department of Law and Public Safety, Office of the Attorney General, 2016). Local animal rights extremists have carried out minor cyber-attacks, employing low-level techniques targeting Internet sites and e-mail systems of companies and businesses associated with animal research programs in New Jersey.

There have been no FEMA disaster declarations related to a cyber-attack to date.

Probability of Future Occurrences

Security experts describe the threat of cyber terrorism as eminent and highly likely to occur in any given year in New Jersey (NJOEM 2019). The level of success of an attack and the subsequent damage it can create will vary greatly. With the growing popularity and use of computers, there has been a significant increase in investigations where computers are being utilized for the commission of fraud and identify theft. The probability of a cyber-attack that will affect Essex County is difficult to calculate; however, it is estimated that Essex County will continue to experience direct and indirect impacts of cyber-attacks.

In Section 4.4, the identified hazards of concern for Essex 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 cyber-attacks in the County is considered 'occasional'.

Climate Change Impacts

Because cyber-attacks are human-caused, there are no climate change impacts associated with this hazard.

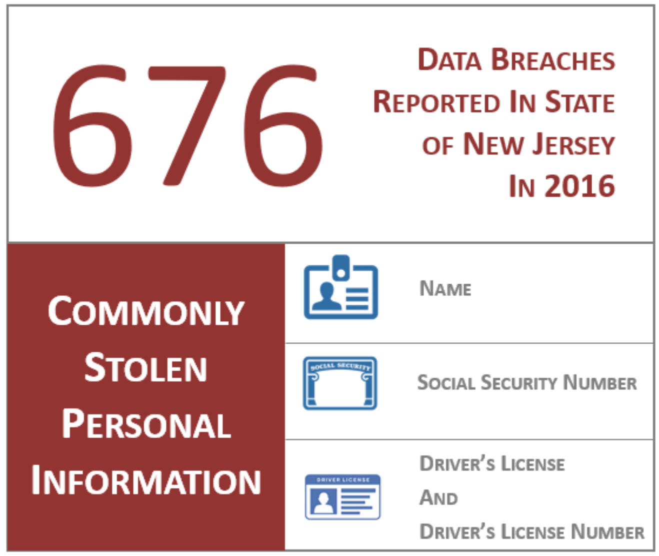
4.3.12.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

Although there is no direct loss of life expected from a cyber-attack, all residents in Essex County are exposed to this hazard. Commonly stolen personal information includes name, social security number, and drivers' license information. Because it is difficult to predict the particular target of cyber terrorism, assessing vulnerability to the hazard is also difficult. All populations who directly use a computer or those receiving services from automated systems are vulnerable to cyber terrorism. Although all individuals in Essex County are vulnerable to an attack, certain types of attacks would impact specific segments of the population.

Exhibit 4.3.12-1. Impacts in New Jersey



Cyber-attacks can have a damaging effect on public trust in systems that are traditionally considered stable and secure. Cyber-attacks can also have extensive economic impacts. Companies and government services can lose large sums of unrecoverable revenue from site down-time and possible compromise of sensitive confidential data.

Cybercrimes against banks and other financial institutions can cost many hundreds of millions of dollars every year. Cyber theft of intellectual property and business-confidential information can cost developed economies billions of dollars—how many billions is an open question. These losses could be considered simply the cost of doing business, or they could be a major new risk for companies and nations as these illicit acquisitions damage global economic competitiveness and undermine technological advantage (McAfee 2013).

The cost of malicious cyber activity involves more than the loss of financial assets or intellectual property. Cybercrimes can cause damage to a company's brand and reputation, consumer losses from fraud, the opportunity costs of service disruption and "cleaning up" after cyber incidents, and the cost of increased spending on cybersecurity (McAfee 2013).

In the United States, the costs of cyber terrorism are estimated somewhere between $24 billion and $120 billion annually. These costs represent approximately 0.2% to 0.8% of the total GDP in the United States (McAfee 2013).

If the cyber-attack targeted the State's power or utility grid, individuals with medical needs would be impacted the greatest. These populations are most vulnerable because many of the life-saving systems they rely on require power. Also, if an attack occurred during months of extreme hot or cold weather, the County's elderly population (those 65 years of age and older) would be vulnerable to the effects of the lack of climate control. These individuals would require shelter or admission to a hospital. Other populations vulnerable to the secondary effects of cyber terrorism are young children.

If a cyber-attack targeted a facility storing or manufacturing hazardous materials, individuals living adjacent to these facilities would be vulnerable to the secondary effects, should the attack successfully cause a critical failure at that facility. Individuals living within 10 miles of a nuclear power plant would be vulnerable should an attack occur at that caused a failure at a facility.

A cyber-attack can have potentially severe consequences. Table 4.3.12-2 summarizes potential impacts on population, facilities, economy and the environment.

Table 4.3.12-2. Cyber Attack Impact Summary

Consideration	Description
General Public	No direct loss of life is expected from an attack. Indirect injuries or deaths may result from secondary effects to critical life-sustaining resources such as energy and water.
Response Personnel	No direct affects to the health and safety of response personnel are expected; however, critical response systems may be affected.
Property, Facilities and Infrastructure	Effects can range from annoyance to complete shutdown of critical infrastructures caused by infiltration of supervisory control and data acquisition (SCADA) systems. Secondary effects could disturb public welfare and property by denying services or providing false readings.
Economic	Because of the heavy reliance on the electronic transfer of economic and commercial information, the economy could be affected by communication difficulties.
Environment	Generally, cyber terrorism has no direct effect on the environment; however, the environment may be affected should a release of a hazardous material occur because of critical infrastructure failure.
Continuity of Operations	Severe effects to continuity of operations could result if a cyber-attack reached critical operational systems or systems that were needed to carry out the operation.
Reputation of the Entity	If exposed vulnerabilities were known and not reduced or eliminated before the attack, the entity would suffer major damage to their reputation for not taking action before the incident.
Delivery of Services	Cyber-attacks may affect delivery of services if the system was infiltrated and directed to malfunction by self-destructing or overloading.
Regulatory and Contractual Operations	Cyber-attacks would have no significant effect on regulatory or contractual obligations, other than the possible elimination of electronic records, which would affect both.

Source: NJOEM 2019

Impact on General Building Stock

A cyber-attack can impact buildings ranging from annoyance to complete shutdown caused by infiltration of supervisory control and data acquisition (SCADA) systems. Secondary effects could disturb public welfare and property by denying services or providing false readings (NJOEM 2019). If a cyber-attack targeted a building storing or manufacturing hazardous materials, individuals living adjacent to these facilities would be vulnerable to the secondary effects, should the attack successfully cause a critical failure at that facility. Should a cyber-attack target fire suppression systems, these structures are likely to be at higher risk for structural fire.

Impact on Critical Facilities

Critical facilities are vulnerable to cyber-attacks based on the significance of the facilities, and the potential to interrupt critical systems in the County. As previously mentioned, many critical facilities are reliant upon computer networks to monitor and control critical functions. This can include utilities, public safety facilities, medical facilities, or government buildings. A cyber-attack could result in catastrophic failure of one of these facilities. The power grid is reliant upon computer systems to distribute power to the State. An attack could disrupt power to millions of New Jersey residents. This is just one example of how critical facilities are vulnerable to cyber-attacks. Given the importance of critical facilities to daily living activities, critical facilities are highly vulnerable to cyber-attacks.

Impact on the Economy

Given the proliferation of electronic commerce and the reliance on electronics, virtually all elements of New Jersey's economy are vulnerable to cyber-attacks. The secondary impacts of a significant attack would be devastating to the economy. For example, an attack that caused the loss of power to hundreds of thousands of businesses during peak holiday shopping months could potentially cost the State millions of dollars in tax revenue if these businesses were closed. Additionally, a disruption in New Jersey's manufacturing, agricultural, or tourism sectors would have devastating impacts on the economy. While it is difficult to quantitatively measure the economic impact of a cyber terrorism attack, it is safe to say that the impact would be great, thus the economy is vulnerable to cyber terrorism attacks.

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 and Change in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by the cyber-attack hazard because the entire County is exposed and vulnerable. Additional development of structures or infrastructure which are reliant on computer systems could increase the County's risk to cyber-attack. Development of more structures using public power grids could also be affected by cyber-attacks and ultimately experience power outage. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time.

Climate Change

Because cyber-attacks are human-caused, no climate change impacts are associated with the hazard.

Change of Vulnerability Since the 2015 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to cyber-attack events.

4.3.13 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 Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous events between 2014 and 2019 were researched, with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).

4.3.13.1 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 Essex 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, La Crosse encephalitis (LCE), and Lyme disease. Influenza will also be discussed due to several outbreaks in the past five years.

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 2018).

La Crosse Encephalitis

La Crosse Encephalitis (LAC) is transmitted to humans by the bite of an infected mosquito. Most cases of LAC occur in the upper Midwestern, mid-Atlantic and southeastern states. Many people infected with LAC have no apparent symptoms. Among people who become ill, initial symptoms include fever, headache, nausea, vomiting, and tiredness. Some of those who become ill develop severe neuroinvasive disease (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.

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).

Measles

Measles is a highly contagious virus that lives in the nose and throat mucus of an infected person. It can spread to others through coughing and sneezing. Also, measles virus can live for up to two hours in an airspace where the infected person coughed or sneezed. If other people breathe the contaminated air or touch the infected surface, then touch their eyes, noses, or mouths, they can become infected. Measles is so contagious that if one person has it, 90% of the people close to that person who are not immune will also become infected (CDC 2017).

Tuberculosis

Tuberculosis (TB) is caused by a bacterium called Mycobacterium tuberculosis. The bacteria usually attack the lungs, but TB bacteria can attack any part of the body such as the kidney, spine, and brain. Not everyone infected with TB bacteria becomes sick. As a result, two TB-related conditions exist: latent TB infection (LTBI) and TB disease. If not treated properly, TB disease can be fatal (CDC 2016).

TB bacteria are spread through the air from one person to another. The TB bacteria are put into the air when a person with TB disease of the lungs or throat coughs, speaks, or sings. People nearby may breathe in these bacteria and become infected (2016).

Symptoms of TB disease depend on where in the body the TB bacteria are growing. TB bacteria usually grow in the lungs (pulmonary TB). TB disease in the lungs may cause symptoms such as a bad cough that lasts three weeks or longer, pain in the chest, and coughing up blood or sputum (phlegm from deep inside the lungs) .Other symptoms of TB disease include weakness or fatigue, weight loss, no appetite, chills, fever, and sweating at night (CDC 2016).

Hepatitis A

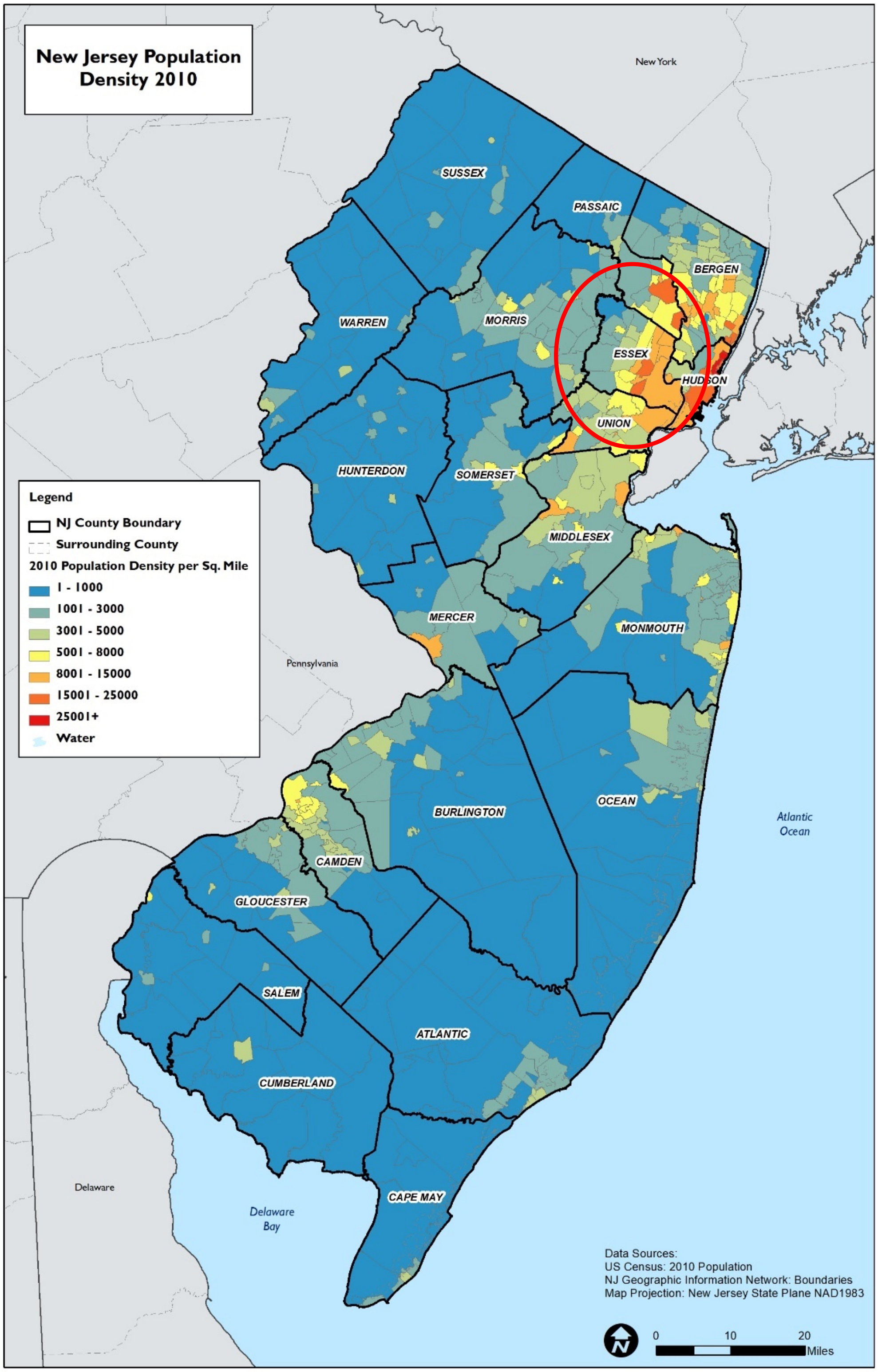
Hepatitis A is a vaccine-preventable, communicable disease of the liver caused by the hepatitis A virus (HAV). It is usually transmitted person-to-person through the fecal-oral route or consumption of contaminated food or water. Hepatitis A is a self-limited disease that does not result in chronic infection. Most adults with hepatitis A have symptoms, including fatigue, low appetite, stomach pain, nausea, and jaundice, that usually resolve within 2 months of infection; most children less than 6 years of age do not have symptoms or have an unrecognized infection. Antibodies produced in response to hepatitis A infection last for life and protect against reinfection. The best way to prevent hepatitis A infection is to get vaccinated (CDC 2019).

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 4.3.13-1 shows population density throughout the State. This figure indicates that Essex County contains many densely populated areas throughout the County. 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.

Essex County's population density and the presence of Newark Liberty International Airport in the County serving as a hub for international travel makes Essex County a logical location to implement efforts to contain the highly infectious Ebola virus.

Figure 4.3.13-1. New Jersey Population Density (United States Census 2010)



Source: United States Census 2010; New Jersey Geographic Information Network (NJGIN)

Extent

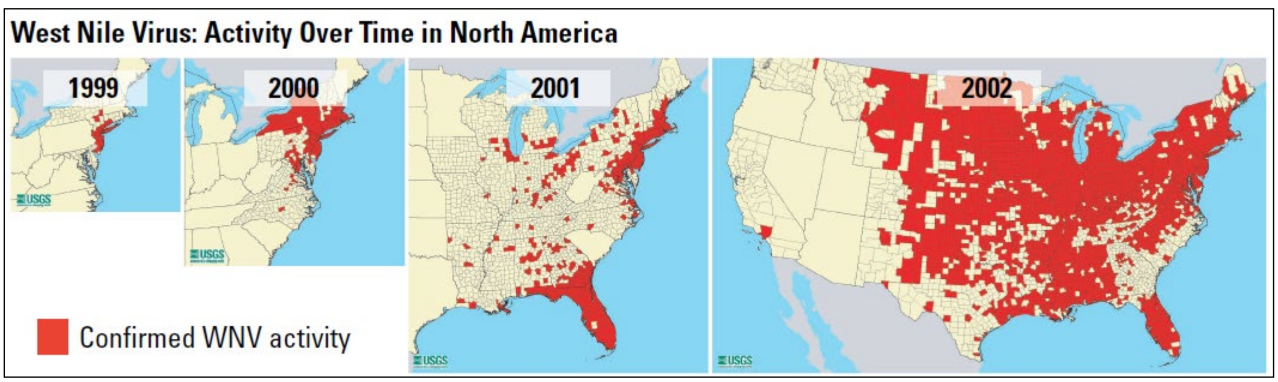
The exact size and extent of an infected population depends on how easily the illness is spread, the mode of transmission, and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in more densely populated areas. The transmission 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 Essex 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. WNV swept from the New York City region in 1999 to almost all of the continental U.S., seven Canadian provinces and throughout Mexico and parts of the Caribbean by 2004 (USGS, 2012). Figure 4.3.13-2 shows the activity of WNV over time in North America, from 1999 to 2002.

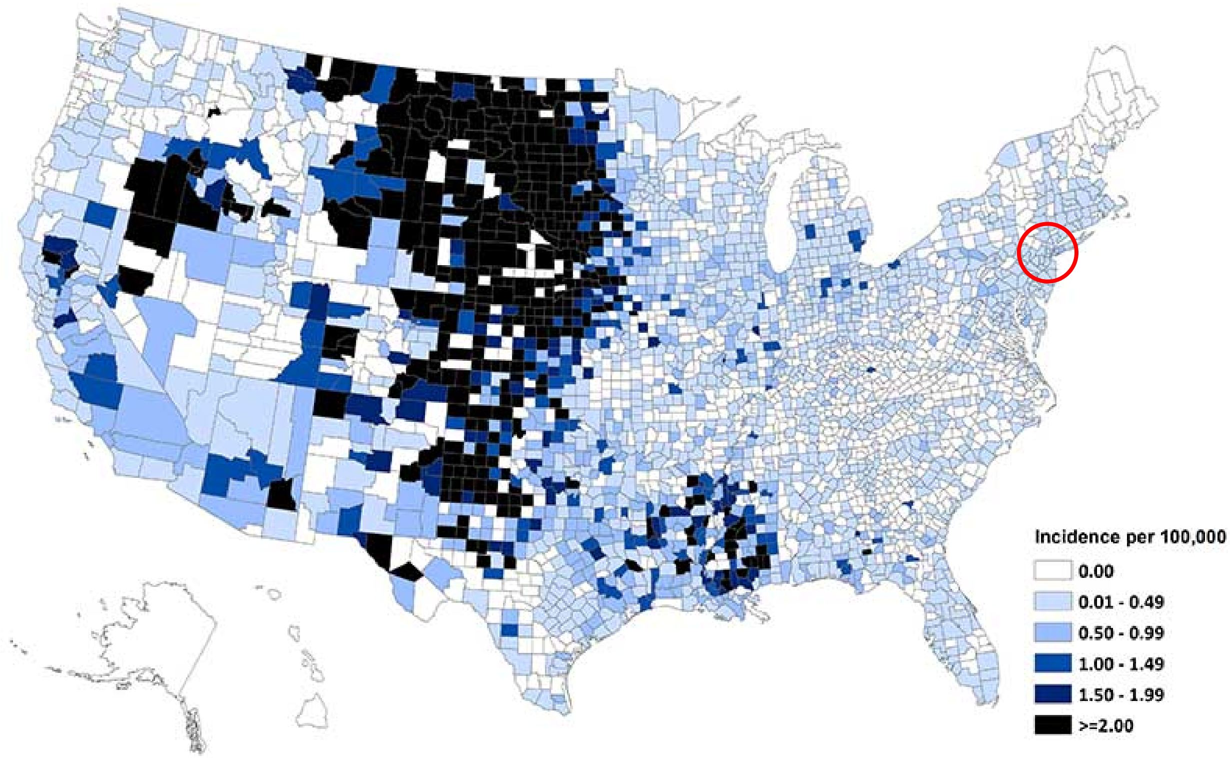
Figure 4.3.13-2. WNV Activity Over Time in the United States



Source: USGS, 2012

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, 2011). Figure 4.3.13-3 illustrates WNV activity in the U.S. from 1999-2018.

Figure 4.3.13-3. 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 Essex County.

Eastern Equine Encephalitis

In the State of New Jersey, there has been one case of EEE from 2009-2018 (CDC 2019.)

St. Louis Encephalitis

In the State of New Jersey, there have been no cases of St. Louis virus neuroinvasive disease from 2009-2018. However, nearby states have reported cases (CDC 2018).

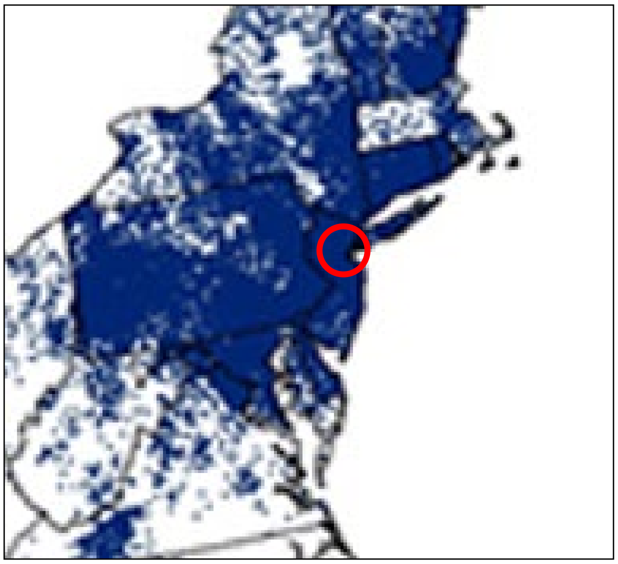
La Crosse Encephalitis

In the State of New Jersey, there have been no cases of La Crosse virus neuroinvasive disease from 2009-2018. 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 2016, there were 437 confirmed cases of Lyme disease in Essex County (NJ DOH 2019). Figure 4.3.13-4 shows the reported cases of Lyme disease in the northeast U.S. for 2017.

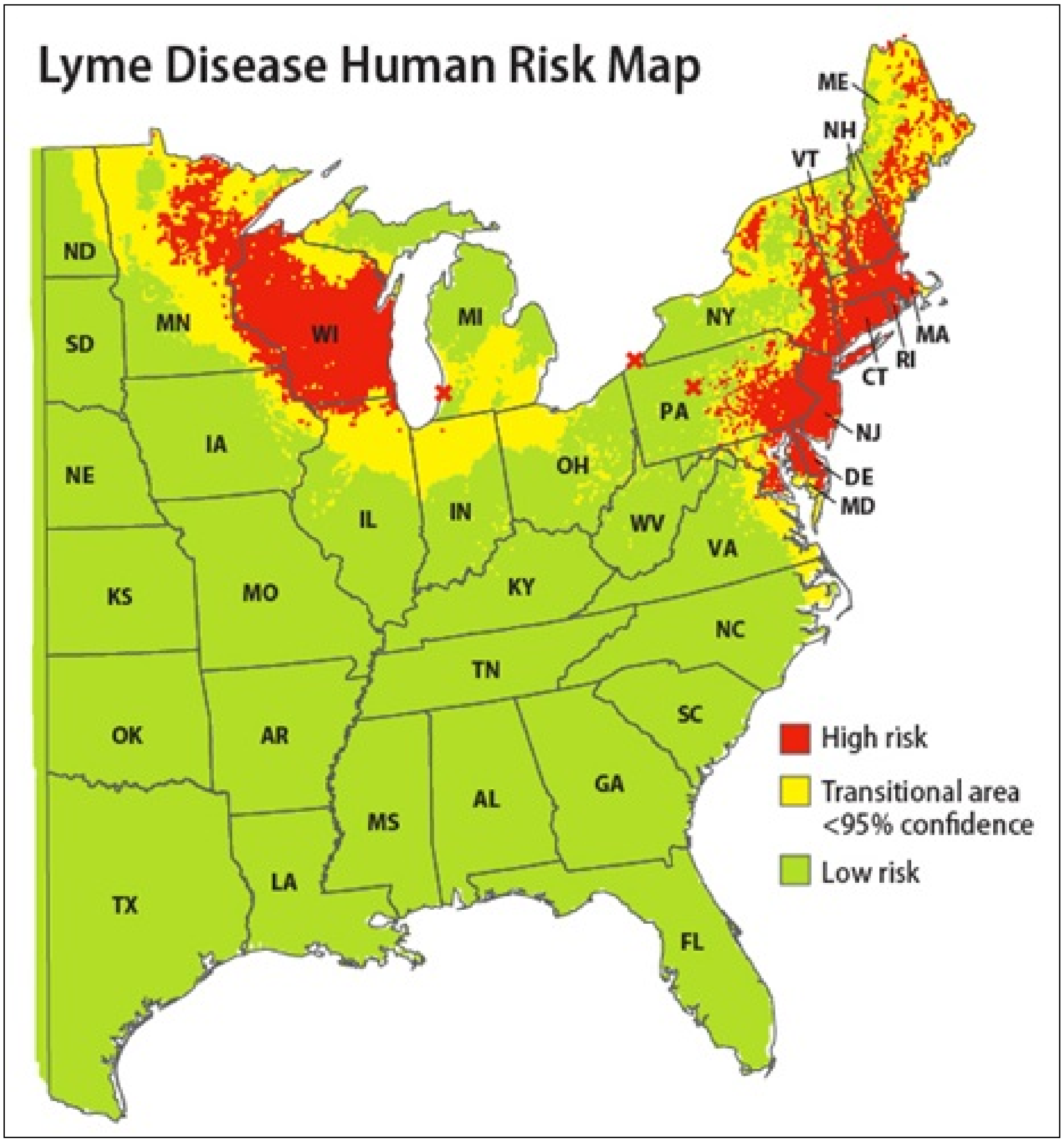
Figure 4.3.13-4. 2017 Reported Cases of Lyme Disease in the Northeast U.S.



Source: *CDC 2019*
Note: *The red circle indicates the approximate location of Essex County.*

Figure 4.3.13-5 shows the risk of Lyme disease in the northeastern U.S. The figure indicates that Essex County is located in a high risk area.

Figure 4.3.13-5. Lyme Disease Human Risk Map in the Northeast U.S.



Source: Yale School of Public Health, 2013

Note (1): All of Essex County located in a high risk area.

The CDC Division of Vector Borne Diseases (DVBD) indicated in 2017 that New Jersey was the state with the second-highest number of confirmed Lyme disease cases, totaling approximately 3,629 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.) (CDC 2018).

Influenza and Ebola

As noted above, 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 Ebola virus is spread to others through direct contact; it is not spread through the air like influenza. The severity and length of the next pandemic cannot be predicted; however, experts expect that its effect on the United States could be severe.

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 2005). The WHO pandemic phases are outlined in Table 4.3.13-1.

Table 4.3.13-1. 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	is 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 4.3.13-2 compares the federal and New Jersey pandemic influenza phases and situations.

Table 4.3.13-2. 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: Homeland Security Council 2006; NJDOH 2012
NJ New Jersey
U.S. United States
WHO World Health Organization

Measles

While there have been numerous confirmed measles cases in the State of New Jersey, there were no confirmed cases of the measles in Essex County from 2014 to 2018 (NJ DOH 2019).

Tuberculosis

From 2014 to 2019, there were 180 morbidity cases of Tuberculosis in Essex County (NJ DOH 2020).

Hepatitis A

From 2014 to 2019, there were 46 confirmed cases of Hepatitis A in Essex County (NJ DOH 2019).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with disease outbreak events throughout New Jersey and Essex County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events 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.

Between 1954 and 2019, the State of New Jersey was included in one disease outbreak-related emergency (EM) declaration, classified as a virus threat (EM-3156, May – November 2000). Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. However, not all counties were included in the disaster declarations. Essex County was included in this declaration (FEMA 2019).

For this 2020 HMP update, known disease outbreak events that have impacted Essex County between 2014 and 2019 are identified in Table 4.3.13-3.

Table 4.3.13-3. Disease Outbreak Events in Essex County, 2014 to 2019

Date(s) of Event	Disease Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
2014	Lyme Disease	N/A	N/A	In 2014, there were confirmed 114 cases of Lyme Disease in Essex County.
2014	West Nile Virus	N/A	N/A	In 2014 there were five WNV infected mosquito pools reported in Essex County.
2014	Hepatitis B	N/A	N/A	In 2014, there were five cases of Hepatitis A in Essex County.
2014	Tuberculosis	N/A	N/A	In 2014, there were 33 confirmed TB morbidity cases in Essex County.
2015	Lyme Disease	N/A	N/A	In 2015, there were confirmed 165 cases of Lyme Disease in Essex County.
2015	West Nile Virus	N/A	N/A	In 2015 there were 12 WNV infected mosquito pools reported in Essex County.
2015	Hepatitis A	N/A	N/A	In 2015, there were five cases of Hepatitis A reported in Essex County.
2015	Tuberculosis	N/A	N/A	In 2015, there were 39 confirmed TB morbidity cases in Essex County.
2016	Lyme Disease	N/A	N/A	In 2016, there were confirmed 158 cases of Lyme Disease in Essex County.
2016	West Nile Virus	N/A	N/A	In 2016 there were two WNV infected mosquito pools reported in Essex County.
2016	Zika Virus	N/A	N/A	In 2016, Essex County had over 20 cases of Zika that were reported to NJDOH.
2016	Hepatitis A	N/A	N/A	In 2016, there were 12 cases of Hepatitis A reported in Essex County.
2016	Tuberculosis	N/A	N/A	In 2016, there were 41 confirmed TB morbidity cases in Essex County.
2017	West Nile Virus	N/A	N/A	In 2017 there were six WNV infected mosquito pools reported in Essex County.
2017	Hepatitis A	N/A	N/A	In 2017, there were 11 cases of Hepatitis A reported in Essex County.
2017	Tuberculosis	N/A	N/A	In 2017, there were 34 confirmed TB morbidity cases in Essex County
2018	West Nile Virus	N/A	N/A	In 2018, there was one WNV human disease case and fourteen WNV infected mosquito pools reported in Essex County.
2018	Hepatitis A	N/A	N/A	In 2018, there were 13 cases of Hepatitis A reported in Essex County.
2018	Tuberculosis	N/A	N/A	In 2018, there were 33 confirmed TB morbidity cases in Essex County.

Source: New Jersey Department of Health 2019; New Jersey Department of Health 2020; Lyme Disease Association 2014; FEMA 2020

N/A Not Available

WNV West Nile Virus

With disease outbreak documentation for New Jersey and Essex County being so extensive, not all sources have been identified or researched. Therefore, Table 4.3.13-3 may not include all events that have occurred in the County.

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 United States and other countries are constantly preparing to respond to pandemic. 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).

In Essex 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. As population density increases in the County, so too will the probability of a disease outbreak event occurring.

All of the critical components necessary to sustain the threat of mosquito-borne disease in Essex 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 Essex County.

Disease-carrying ticks will continue to inhabit the northeast, including Essex 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 Essex County.

In Section 4.4, the identified hazards of concern for Essex 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 Steering and Planning Committees, the probability of occurrence for disease outbreaks in the County is considered 'frequent'.

Climate Change Impacts

Average annual temperatures have increased by 3°F in New Jersey over the past century (NOAA NCEI 2019). Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (CATF 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

New Jersey has become wetter over the past century. Northern New Jersey's 1971-2000 precipitation average was over five inches (12-percent) greater than the average from 1895-1970 (Sustainable Jersey Climate Change Adaptation Task Force [CATF] 2011). The heaviest 1% of daily rainfalls have increased by approximately 70% between 1958 and 2011 in the Northeast (Horton et al. 2015). Average annual precipitation is projected to increase in the region by four to 11-percent by the 2050s and five to 13-percent by the 2080s (New York City Panel on Climate Change [NPCC] 2015). Increased rainfall and heavy rainfalls increase the chances of standing water where mosquitos breed.

The relationship between climate change and increase in infectious diseases is difficult to predict with certainty, there are scientific linkages between the two. As warm habitats that host insects such as mosquitoes increase, more of the population becomes 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).

4.3.13.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

The entire population of Essex 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. 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 to do the closer proximity of population to potentially infected people.

Impact on General Building Stock

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

Impact on Critical Facilities

No critical facilities are anticipated to be affected by disease outbreaks. Hospitals and medical facilities will likely see an increase in patients, but it is unlikely that there will be damages or interruption of services.

Impact on Economy

The impact disease outbreaks have on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with the activities and programs implemented to conduct surveillance and address disease outbreaks have not been quantified in available documentation. Instead, activities and programs implemented by the County to address this hazard are described below, all of which could impact the local economy.

In Essex County, the Department of Public Works has the responsibility for the Mosquito Control Program (Mosquito Division). This Division utilizes an integrated pest management program which provides a balanced approach to controlling mosquitos and reducing the annoyance and threat of disease carried by this insect. The County uses pesticides to control nuisance and vector-carrying mosquitoes (Essex County DPW 2014).

In 2012 a study was conducted on the economic impacts of seasonal influenza by county, titled "Annual economic impacts of seasonal influenza on U.S. counties: Spatial heterogeneity and patterns" (Mao et al). The study estimates over 57,000 annual cases of seasonal influenza in Essex County costing more than $65.5 million in direct and indirect costs.

Future 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 and Change in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across the County. Any areas of growth could be potentially impacted by the disease outbreak hazard because the entire planning area is exposed and vulnerable. Additional development of structures in close proximity to waterbodies or areas with high population density are at an increased risk. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time. Increased population within Essex County will ultimately lead to a higher population exposed

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 are scientific linkages between the two. 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. Climate change accelerates may likely to work synergistically with many of these factors, especially in populations increasingly subject to massive migration and malnutrition (Harmon 2010).

Change of Vulnerability Since the 2015 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to disease outbreak events.

4.3.14 Economic Collapse

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 Economic Collapse hazard in Essex County.

2020 Plan Update Changes

- Economic Collapse is a new hazard for the 2020 Essex County Hazard Mitigation Plan.

4.3.14.1 Profile

Hazard Description

Economic collapse is a breakdown in normal commerce facilitated by actions such as the destabilization of currency and/or hyperinflation, which results in social chaos or civil unrest. The term describes a variety of economic conditions from severe depressions with high unemployment and bankruptcy such as the Depression of the 1930s in the United States, to breakdowns of normal economic conditions such as hyperinflation or the effects of a sharp decline in population that causes an economic downturn. Although a true economic collapse has never occurred in the United States, the Great Depression was the closest that the United States came to suffer a true collapse (NJOEM2019).

Location

An economic collapse, depending on the severity, may impact all of Essex County. Economic collapse would likely affect beyond the geographic boundary of Essex County and could impact a larger region or the United States. Surrounding counties or regions could be impacted by displaced population from Essex County or instances of civil disorder which could potentially occur.

Extent

Economic collapse could have significant impacts on Essex County. The working population of Essex County would be directly impacted by an economic collapse due to reduced or total loss of income. The 2013-2017 American Community Survey 5-Year Estimates indicates approximately 371,793 people are employed age 16 years and older in Essex County (U.S. Census Bureau, 2018). This number may not include the number of people who commute into Essex County from surrounding communities. Significant changes in population may occur if individuals move to find other means of employment or areas with lower cost of living similar to what occurred during the Great Depression (Spector 2012). Businesses may shutdown and go out of business which would lead to a reduction in tax revenue for Essex County.

Secondary impacts from economic collapse could be outbreaks of civil disorder and a general breakdown of law and order in Essex County. Utility companies may go out of business and therefore cause mass power outage. The number of abandoned or blighted properties would increase as a result of population decreases in the County. The quality of housing can contribute to general well-being or cause poor health. Exposure to poor indoor air quality, mold, lead, and rodent and cockroach infestations can lead to asthma and other respiratory illnesses, lead poisoning, learning and behavioral problems, and other serious health issues (de Leon & Schilling 2017). Disease outbreak is also a possible secondary hazard should there be a breakdown in public health and medical services.

Previous Occurrences and Losses

Two previous occurrences of economic collapse in New Jersey include the Great Recession of 2007, and the Great Depression of the 1930s. The Great Depression was the worst-case scenario to date and was the closest that Essex County came to an economic collapse. The Great Depression began from the stock market crash on October 29, 1929 and lasted until the United States entered World War II. This economic depression led to widescale unemployment, decrease in spending, and significant business shutdowns. The Great Recession of 2007 affected the global economy and is the most recent example of a financial crisis affecting New Jersey. The official time period of the recession occurred from December 2007 through June 2009. However, the effects of the recession continue to linger to the present. While the specific triggers of the recession have been debated, a combination of bursting of the United States housing bubble and subsequent foreclosures, subprime lending, mortgage fraud, predatory lending, high private debt limits, and mortgage underwriting are all cited as triggers that contributed to the financial crisis (NJOEM 2019).

To date there have been no previous occurrences of a total economic collapse within Essex County.

Probability of Future Occurrences

The potential for future occurrence of economic collapse is difficult to predict. A number of factors can contribute to an economic collapse occurring including: hyperinflation, stagflation, and a stock market crash (Corporate Finance Institute 2018). Some of these factors are easier to identify trends leading to economic depression or collapse, but it could be a volatile crash similar to the Great Depression with little to no warning. According to the State of New Jersey Hazard Mitigation Plan, the probability of an economic collapse is low, especially in New Jersey.

Climate Change Impacts

Economic collapse is a man-made hazard, which is not directly influenced by meteorological conditions. Climate change will not likely be a contributing factor in the occurrence of economic collapse, but may have an impact on population, and structure facility vulnerability.

4.3.14.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

Because an economic collapse would affect all segments of the population, all Essex County residents are vulnerable to the impact of this hazard. Civil unrest is one of the primary secondary effects of economic collapse. During periods of economic instability, societal conditions may deteriorate, leading to civil unrest. Additionally, during or near economic collapses workers may go on strike, as did the ditch diggers who went on strike in New Jersey during the Great Depression. Another secondary hazard during economic collapse is pandemic. Because many families may become unable to meet basic hygiene needs, diseases historically spread quickly through communities (NJOEM 2019).

Exhibit 4.3.14-1. Potential Impacts

Source: U.S. Census Bureau American Community Survey 2013-2017, 5-year Estimates

Although all of the population would be affected, the very young and elderly would be more vulnerable to the secondary hazard of pandemic than the rest of the population. Also, very young and elderly residents are vulnerable to the effects of malnutrition, which often results during these incidents. Aside from the health effects during economic collapse, lower-income individuals who struggle to cover average costs of living during thriving financial times would be greatly affected by economic collapse and would therefore be more vulnerable (NJOEM 2019).

Economic collapse would likely reduce the quality of life, and livability within Essex County due to goods and services becoming more expensive or unavailable. Access to medical care could become limited due to expense of medical care, or medications. Secondary hazards of blighted structures, civil disorder, disease outbreak, and power outages can all contribute to adverse effects on life, health and safety for the entire population of Essex County.

Impact on General Building Stock and Critical Facilities

Economic collapse may cause structures and critical facilities too expensive to maintain and upkeep and ultimately result in abandonment. Structures and facilities may become blighted due to abandonment, but the effects of blight are isolated in nature and considered a secondary hazard to economic collapse.

Impact on Economy

Critical facilities are also exposed to the effects of economic collapse. Maintaining these facilities and infrastructure systems will be particular challenging when agencies managing these facilities lose operating capital, and thus cannot maintain the facilities. This may lead to critical infrastructure failure.

Should an complete economic occur within Essex County, there would be significant impact to revenue being generated, wages being earned, and money being spent within the County. While specific figures related to an economic collapse of Essex County are not currently available, an estimated direct impact of economic collapse for lost wages within the County is estimated at $13,054,767,609 per year of economic failure. This value was calculated by multiplying the number of employed civilian population, 371,793 persons, by the per capita income of Essex County, $35,133 (U.S. Census Bureau, 2018). Further estimates regarding loss of revenue to the County through taxation or business revenue are difficult to quantify without utilizing wage, revenue generated, and tax revenue statistics for Essex County.

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 and Change in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by the economic collapse hazard because the entire planning area is exposed and vulnerable. Lack of funding or capital to invest in future development within Essex County could also lead to a decrease in future development. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Increased population could potentially lead towards a greater economy within Essex County ultimately leading to greater economic impacts stemming from an economic collapse.

Climate Change

Climate change has few implications related to economic collapse. Changing conditions related to increased flooding and severe weather could cause home values to depreciate which may decrease revenue generated from taxes for local and state entities. Increased flooding or changing conditions in weather will likely raise insurance premiums for properties. Greater variation in temperature would raise heating and cooling costs. Factors such as affordability and livability can contribute to population decline for Essex County causing substantial decreases in government revenue generated by taxes.

Change of Vulnerability Since the 2015 HMP

Economic collapse is a new hazard of concern for the 2020 HMP update.

4.3.15 Hazardous Substances

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 substances hazard in Essex County.

2020 HMP Update Changes

- The U.S. EPA Hazardous Waste Report was used to identify large quantity generators in Essex County. This was updated with 2017 Data for the 2020 HMP.
- All subsections have been updated using best available data.
- Previous events between 2014 and 2019 were researched, with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).

4.3.15.1 Profile

Hazard Description

Hazardous substances are substances 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 approximately39,000 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.

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.

Essex County hazardous materials response program has been in effect since 1999 with Nutley as the sole subcontractor for the County Environmental Health Act (CEHA) program. In 2004, Newark also became a subcontractor for hazardous material response for the CEHA program. Nutley handles all of the low concern and emergency responses within Essex County on a daily basis. The partnership between the Essex County Health Department (ECHD), Nutley and Newark have enabled Essex County to increase response capacity. Further, the County has created a mass decontamination program comprised of 10 Essex County municipal fire departments. The decontamination program includes the New Jersey Department of Health decontamination trailer that is operated by Belleville Fire Department. Because of several grants and other initiatives available much needed emergency equipment was purchased that is utilized for low concern, environmental emergency response and terrorist attacks.

Location

The following provides information regarding the location of hazardous substance incidents.

Hazardous Substances Fixed Site

Many years ago, numerous wastes were dumped on the ground, in rivers, or left out in the open. As a result, thousands of uncontrolled or abandoned contaminated sites were created. These sites included abandoned warehouses, manufacturing facilities, processing plants, and landfills. 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 56 facilities in Essex County, with a majority of them located in the City of Newark (U.S. EPA 2017).

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 Essex County has 75 Superfund sites located throughout the County, with a majority of the sites located in the City of Newark (U.S. EPA 2019).

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).

The NJDEP maintains a list of Known Contaminated Sites of New Jersey (KCSNJ). It is an inventory that includes all sites in the State where contamination is known to exist. The remediation for these sites is currently active or pending in the NJDEP's Site Remediation Program (SRP). As of 2017, there are over 14,000 KCSNJ sites in New Jersey, with 1,592 of those sites in Essex County.

Hazardous Substances In-Transit

Incidents involving hazardous substances in transit can occur anywhere in the State. In Essex County, the major transportation routes include: The Garden State Parkway; I-280; I-80; and I-78. In total, there is approximately 1,767 miles of roadway in the County. Figure 4.3.15-1 shows the major transportation routes in the County.

Hazardous substances incidents may also occur along railways in Essex County. The NJDOT has a vital interest in preserving and improving the rail freight part of its transportation network. Rail shipments allow cost-effective movement of goods with less stress on the State's highway system. Major commodities shipped by rail entail petrochemicals (including plastic pellets), construction materials, food products, raw materials, and finished goods for manufacturers. Of concern for this hazard are rail cars carrying hazardous substances. An accident or release could pose a public safety hazard to the community.

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 4.3.15-2 shows the extent and locations of pipelines throughout the northeastern United States.

Figure 4.3.15-1. Major Transportation in Essex County

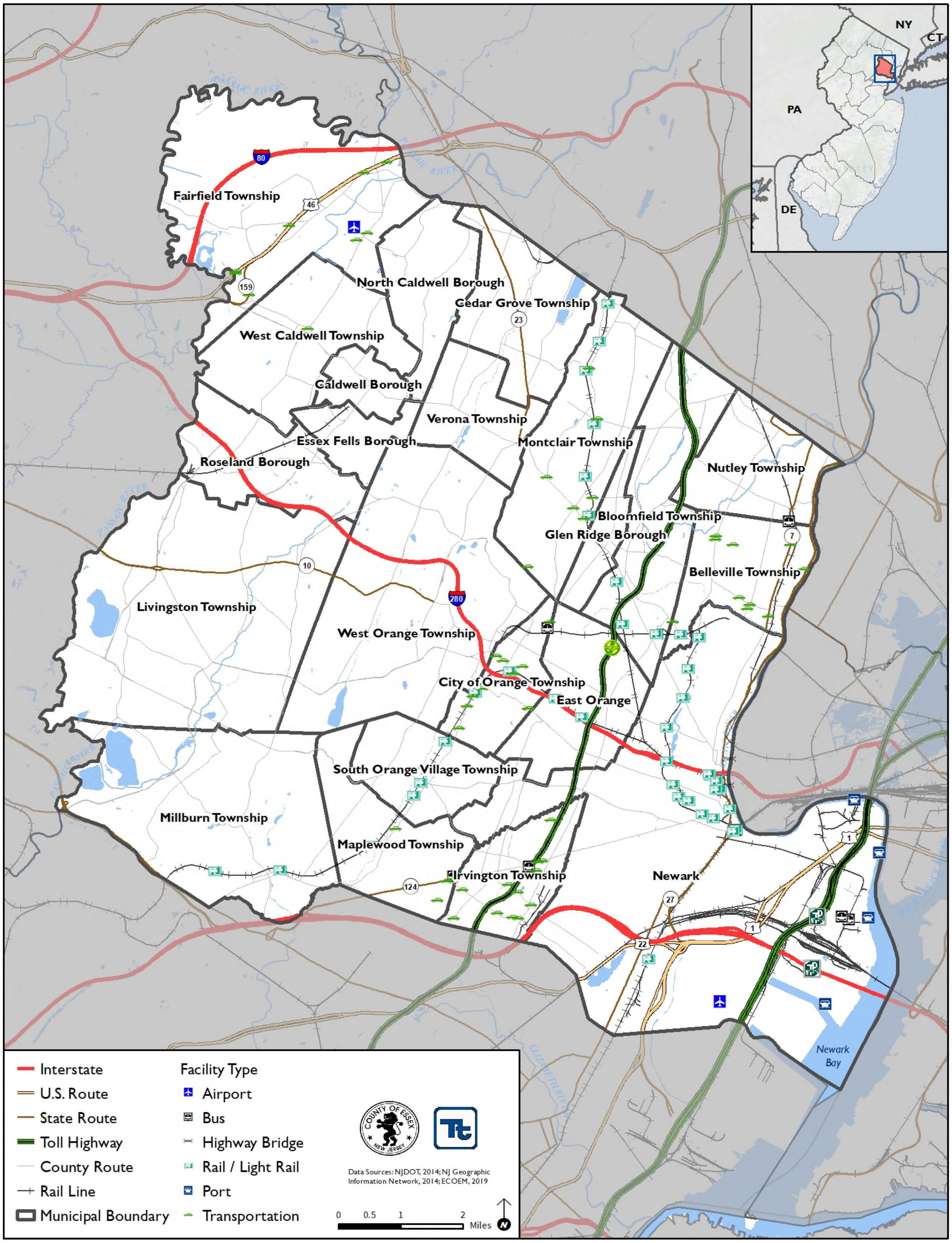
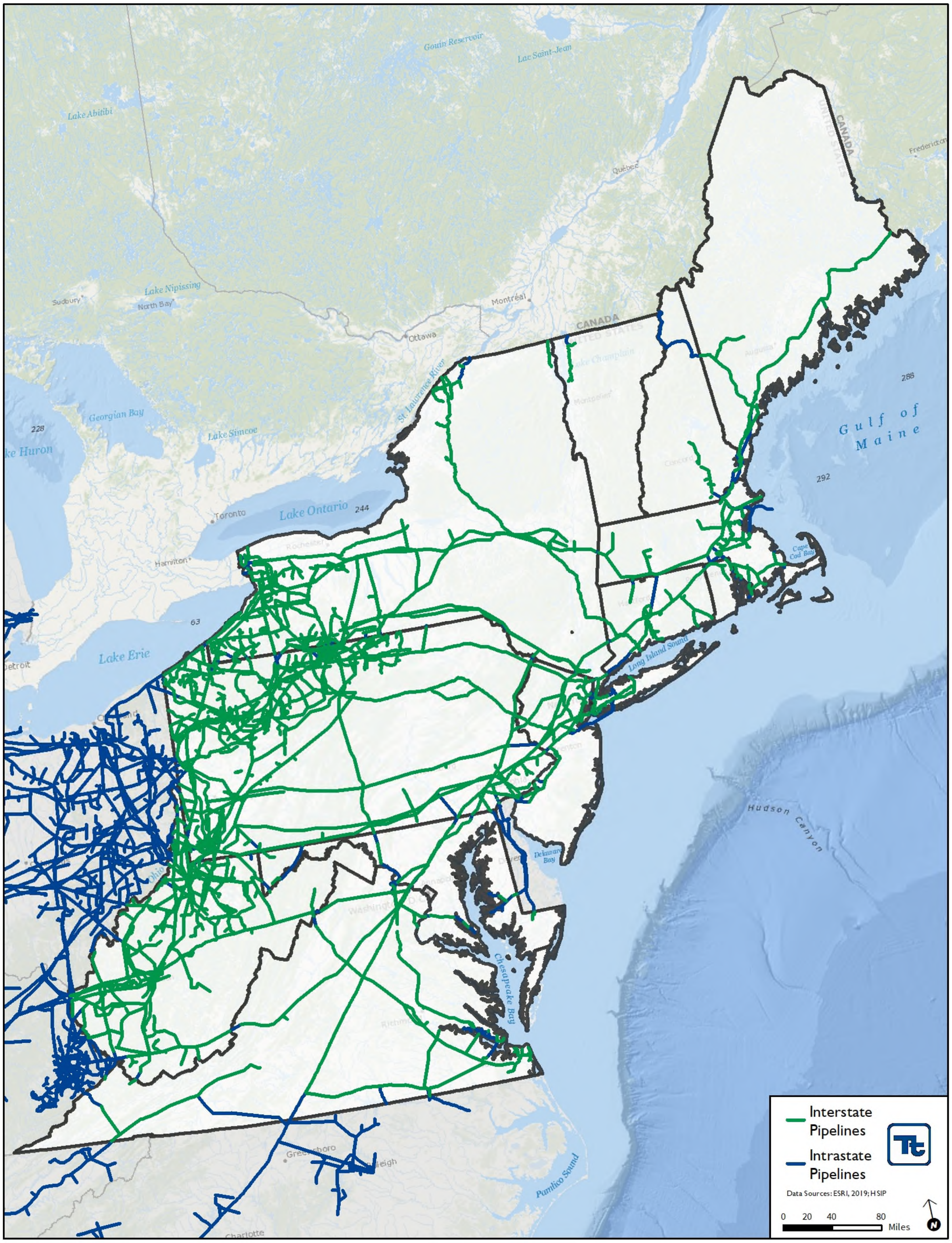


Figure 4.3.15-2. Interstate Natural Gas Pipelines in the Northeast

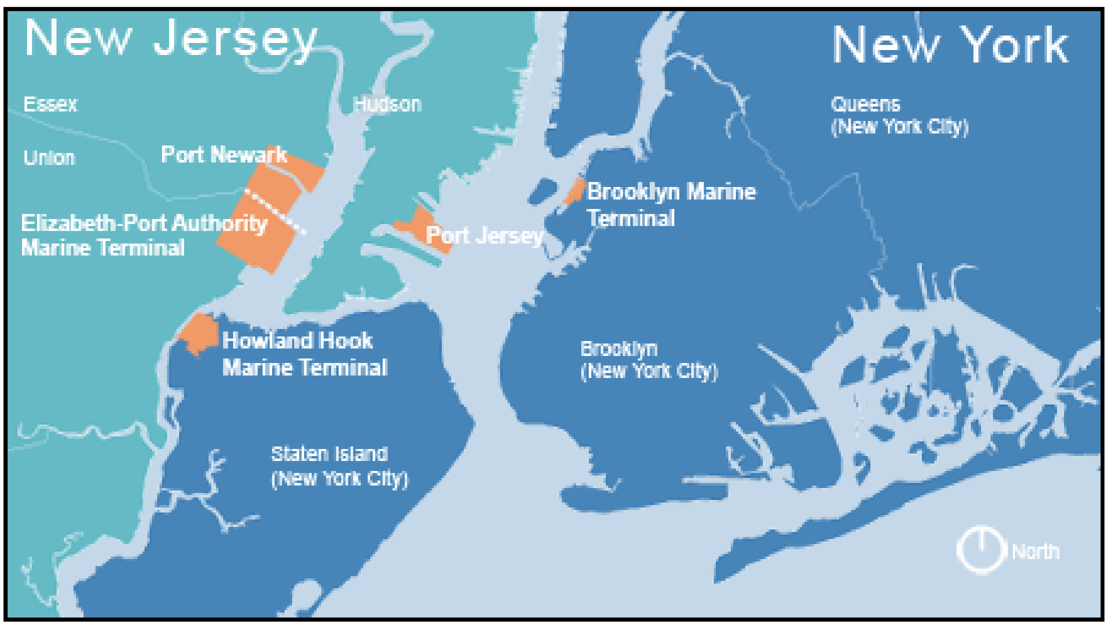


Hazardous Substances Offshore

Offshore hazardous substance incidents have the potential to affect New Jersey because of its vast coastline consisting of rivers, bays, and oceans. New Jersey is a vital link in marine transportation in the Northeast. The State has 14 ports, including the Port of New York and New Jersey, which are a critical link for shipping worldwide. The potential for a hazardous substances incident offshore is possible given the volume of shipping traffic around the State.

New Jersey features the Port of New York and New Jersey system, which includes the New Jersey ports of Port Newark, Elizabeth-Port Authority Marine Terminal, and Port Jersey. The Port of New York and New Jersey is the gateway to one of the most concentrated and affluent consumer markets in the world. It is the largest port on the east coast, and the third-largest port in the nation. In 2016 79,844,000 tons of cargo moved through Port facilities. This included over 6.25 million boxes (PANYNJ Port Planning Summit, 2017). The dollar value of all cargo that moved through the Port exceeded $200 billion (PANYNJ, 2016). The Port ships a variety of goods, many of which are hazardous. Figure 4.3.15-3 shows the location of the Port of New York and New Jersey. Port Newark is located in the City of Newark, Essex County. Port Newark is managed by the Port Authority of New York and New Jersey (PANYNJ). The Port Newark Container Terminal (PNCT) is located in Port Newark and occupies 259 acres. It handles over 600,000 containers each year and is one of the largest infrastructure projects in New Jersey (PNCT 2014).

Figure 4.3.15-3. Port of New York and New Jersey



Source: Port Authority of New York and New Jersey 2013

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).

The severity of offshore hazardous substances incidents will vary based on the amount of hazardous substance spilled, the location of the spill, and the prevailing currents. The effects of an accident can have a devastating impact on the environment. An example of the worst-case scenario was the Deepwater Horizon oil spill in 2010, which affected the gulf and the coastline from Texas to Florida and was one of the worst environmental disasters in the United States.

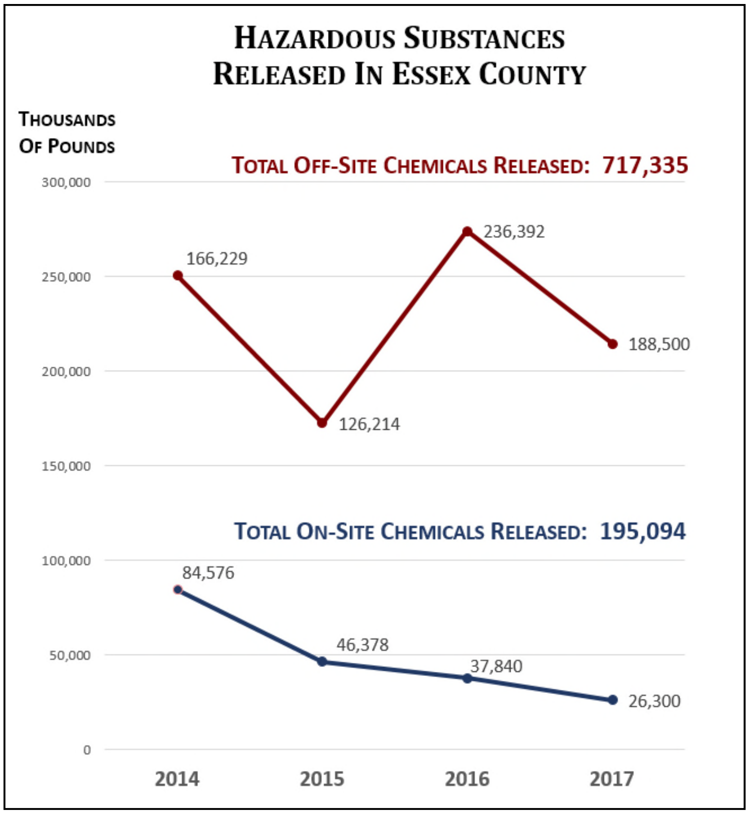
Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with hazardous substance incidents throughout the State of New Jersey and Essex County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events 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.

Between 1954 and 2019, the State of New Jersey was not included in any FEMA declared disasters (DR) or emergencies (EM) related to hazardous substances incidents (FEMA 2019).

The U.S. Department of Transportation (USDOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) provides an incident report database for information on incidents throughout the U.S. According to this database, between 2007 and 2014, there have been 198 incidents in Essex County (61 air; 135 highway; 2 rail) (USDOT 2018). Hazardous substances incidents on-site or in-transit occur frequently across the State and in Essex County. These incidents are typically small, localized events. The U.S. EPA maintains records of the amount of chemicals released at facilities each year. Between 2013 and 2017, Essex County had a total of 246,900 pounds released on-site and a total of 946,800 pounds released off-site (U.S. EPA 2019); refer to Figure 4.3.15-4. Onsite releases refer to emissions made from these respective facilities to the air, discharges to bodies of water, and disposal at the facility to land. Offsite released include various methods of disposal, such as landfills, surface impoundments, and underground injections (U.S. EPA 2019).

Figure 4.3.15-4. Hazardous Substances Released in Essex County, Off-Site and On-Site



Source: EPA TRI Explorer 2019

For the 2020 HMP update, known hazardous substances incidents that have impacted Essex County between 2014 and 2019 are identified in Table 4.3.15-1. Refer to Section (Jurisdictional Annex) 9 for detailed information regarding impacts and losses to each municipality.

Probability of Future Occurrences

Predicting future hazardous substance incidents in Essex 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. Significant events occurring offshore are rather rare in New Jersey and in Essex County. However, with the port systems and waterways in Essex County, the possibility for a significant offshore incident does exist.

In Section 4.4, the identified hazards of concern for Essex 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 Steering and Planning Committees, the probability of occurrence for the release of hazardous substances in the County is considered 'frequent'. 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.

Climate Change Impacts

Hazardous substance incidents are non-natural incidents; therefore, there are no implications for impacts from climate change. Secondary impacts, such as excessive heat on containers may occur, but also can occur during normal fluctuations in temperature.

Table 4.3.15-1. Hazardous Substances Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
2014	Accidents Involving Hazardous Substances	N/A	N/A	In 2014, Essex County experienced 17 air accidents, 49 highway accidents, and one rail accident involving hazardous substances.
May 19, 2014	Hazmat-in transit	N/A	N/A	On 5/19/14 driver was loaded with 7500 gallons of lysergic acid diethylamide and end route to delivery destination in Flemington NJ. While in approach to the traffic circle at Mine ST & Route 12 driver tried to avoid a vehicle that entered his path which resulted in the truck and trailer overturning. Clean up crews started pumping the product in the roadway into a small oil truck (1,650 gallons) and into large storage totes and barrels (950 gallons). 3,901 gallons was salvage and pumped from the trailer into a hired tanker and was delivered to original delivery destination
2014	Chemical Release	N/A	N/A	In 2014, 166,229 pounds of chemicals were released off-site, and 84,576 pounds were released on-site in Essex County.
2015	Accidents Involving Hazardous Substances	N/A	N/A	In 2015, Essex County experienced 23 air accidents, 49 highway accidents, and one rail accident involving hazardous substances.
2015	Chemical Release	N/A	N/A	In 2014, 126,214 pounds of chemicals were released off-site, and 46,378 pounds were released on-site in Essex County.
2016	Accidents Involving Hazardous Substances	N/A	N/A	In 2016, Essex County experienced 21 air accidents, 37 highway accidents, and no rail accident involving hazardous substances.
2016	Chemical Release	N/A	N/A	In 2016, 236,392 pounds of chemicals were released off-site, and 37,480 pounds were released on-site in Essex County.
2017	Chemical Release	N/A	N/A	In 2017, 188.5 thousand pounds of chemicals were released off-site, and 26.3 thousand pounds were released on-site in Essex County.

Source: North American Hazmat Situations and Deployments Map 2014; NJ HMP 2019; EPA TRI Explorer 2019
With hazardous substances incidents for New Jersey and Essex County being so extensive, not all sources have been identified or researched. Therefore, this table may not include all events that have occurred in the County.

4.3.15.2 Vulnerability Assessment

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

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. The general population may be exposed to a hazardous substances release through inhalation, ingestion or dermal exposure. Exposure may be either acute or chronic, depending upon the nature of the substance and extent of release and contamination.

Due to the location of these different hazardous substances and wastes sites in Essex County, the entire County is considered vulnerable to this hazard. When examining fixed sites, the City of Newark has the greatest number of facilities that generate large quantities of hazardous waste and has the greatest number of Superfund sites. Further, Port Newark is located in the City of Newark making it more vulnerable to hazardous substances releases.

Those particularly vulnerable to the effects of hazardous substances incidents are populations located along major transportation 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. Human safety and welfare can become compromised from negative health effects of poisoning or exposure to toxic substances, fires, or explosions.

Impact on General Building Stock

Potential losses to the general building stock caused by a hazardous substance's incident is difficult to quantify. The degree of damages to the general building stock 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.

Impact on Critical Facilities

Potential losses to critical facilities caused by a hazardous substance's 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. Refer to Section 3 (County Profile) which summarizes the number and type of critical facilities in Essex County.

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 Essex County would be affected as well. A significant incident in an urban area may force businesses to close for an extended period of time because on 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 substances incidents have the potential to lead to major transportation route closures to occur in Essex County. If an incident occurred that would require one of the State's major highways to close, the impact on the economy could be significant. Given the scope and importance of New Jersey's transportation routes to the greater northeastern United States, the vulnerability of New Jersey's economy is significant.

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 and Change in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by hazardous substances incidents because the entire County is exposed and vulnerable. An increase in development and population has the ability to increase the likelihood of a hazardous substance incident. Future migration to larger jurisdictions may also increase the likelihood of an incident. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). An increase in the overall population will lead to an increase in the number of people exposed to a hazardous substance release within Essex County.

Climate Change

Because a hazardous substance incident is human-caused hazard, no climate change impacts are associated with the hazard.

Change of Vulnerability Since the 2015 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to hazardous substances incidents.

4.3.16 Terrorism

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 terrorism hazard in Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous events between 2014 and 2019 were researched, with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).

4.3.16.1 Profile

Hazard Description

Terrorism is the use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber-attacks (computer-based attacks); and the use of chemical, biological, nuclear, and radiological weapons (FEMA 2009).

In 1985, the Federal Bureau of Investigation (FBI) and the New Jersey State Police (NJSP) entered into a partnership to combat domestic and international terrorism operations. Since then, a contingent of Counter Terrorism Bureau detectives have been assigned to participate in the Joint Terrorism Task Forces (JTTF) coordinated through the FBI in Newark, New Jersey, New York City, New York and Philadelphia, Pennsylvania (NJSP 2019). The New Jersey Domestic Security Preparedness Act, signed into law on October 4, 2001, created the Domestic Security Preparedness Task Force as the State's cabinet-level body responsible for setting homeland security and counter-terrorism policy after September 11, 2001. The State Police established a Counter Terrorism Bureau (CTB) in 2003 and the New Jersey Regional Operations Intelligence Center (ROIC) was activated in 2005. The New Jersey Joint Terrorism Task Force (JTTF) North Unit, also known as the Newark JTTF, covers most of the State, while the Philadelphia JTTF covers the Camden area. The U.S. attorney chairs an Anti-Terrorism Advisory Council (ATAC) in Newark (Washington Post 2009).

All county prosecutors are required to designate a Counter-Terrorism Coordinator in their respective counties. The Counter-Terrorism Coordinator is the primary link between all law enforcement agencies in the county and the New Jersey Office of Homeland Security and Preparedness (OHSP). The Essex County Counter-Terrorism Coordinator has obtained the necessary clearances in order to receive classified homeland security briefings from the FBI and the U.S. Department of Homeland Security (Essex County Prosecutor's Office 2010).

In addition to the Counter-Terrorism Coordinator, who also serves as the Chief Assistant Prosecutor in charge of the Homicide, Visible Intermodal Prevention and Response (VIPR) and Arson Units, the Homeland Security Unit is staffed by a Risk Mitigation Planner, who performs vulnerability assessments at the numerous critical infrastructures in the County (Essex County Prosecutor's Office 2010).

The Counter-Terrorism Coordinator also oversees the operations of the Essex County Rapid Deployment Team (RDT), consisting of over 100 sworn law enforcement officers from all law enforcement agencies in the County. The RDT serves as "force-multiplier" capable of deploying quickly to assist other law enforcement agencies in matters of civil disorder, crowd control, infrastructure protection, and natural disaster relief (Essex County Prosecutor's Office 2010). Various types of terrorism are discussed in the sections below.

Armed Attacks and Assassinations

Armed attacks include raids and ambushes. Assassinations are the killing of a selected victim, usually by bombings or small arms. Drive-by shootings is a common technique employed by unsophisticated or loosely organized terrorist groups. Historically, terrorists have assassinated specific individuals for psychological effect.

Arson and Firebombing

Incendiary devices are inexpensive and easy to hide. Arson and firebombing are easily conducted by terrorist groups that may not be as well organized, equipped, or trained as a major terrorist organization. An act of arson or firebombing against a utility, hotel, government building, or industrial center portrays an image to the public that the ruling government is incapable of maintaining order.

Bioterrorism

Bioterrorism refers to the intentional release of toxic biological agents to harm and terrorize civilians, in the name of a political or other cause. The United States Centers for Disease Control and Prevention (CDC) has classified the viruses, bacteria, and toxins that could be used in an attack. Category A Biological Diseases are those most likely to do the most damage. They include:

- Anthrax (Bacillus anthracis)
- Botulism (Clostridium botulinum toxin)
- The Plague (Yersinia pestis)
- Smallpox (Variola major)
- Tularemia (Francisella tularensis)
- Hemorrahagic Fever, due to Ebola Virus or Marburg Virus

Bombings and Explosive Attacks

Explosive attack can be defined as an attack in which a bomb and or destructive device is used to destroy, incapacitate, harass, or distract. Bombings are the most common type of terrorist act. Typically, improvised explosive devices are inexpensive and easy to make. Modern devices are smaller and harder to detect and contain very destructive capabilities.   Terrorists such as those responsible for this bombing can use materials that are readily available to the average consumer to construct a bomb.

Cyber Terrorism

Cyber terrorists use information technology to attack civilians and draw attention to the terrorists' cause. This may mean that they use information technology, such as computer systems or telecommunications, as a tool to orchestrate a traditional attack. More often, cyber terrorism refers to an attack on information technology itself in a way that would radically disrupt networked services. For example, cyber terrorists could disable networked emergency systems or hack into networks housing critical financial information. There is wide disagreement over the extent of the existing threat by cyber terrorists. A full discussion of cyber terrorism is presented in Section 4.3.12 (Cyber Attack).

Ecoterrorism

Ecoterrorism is a recently coined term describing violence in the interests of environmentalism. In general, environmental extremists sabotage property to inflict economic damage on industries, businesses, or persons perceived as harming animals or the natural environment. Targets of ecoterrorist attacks have included fur companies, logging companies, and animal research laboratories.

Electromagnetic Pulse (EMP)

An EMP is a high-intensity burst of electromagnetic energy caused by the rapid acceleration of charged particles. In an attack, these particles interact and send electrical systems into chaos in three ways: First, the electromagnetic shock disrupts electronics, such as sensors, communications systems, protective systems, computers, and other similar devices. The second component has a slightly smaller range and is similar in effect to lightning. Although protective measures have long been established for lightning strikes, the potential for damage to critical infrastructure from this component exists because it rapidly follows and com-pounds the first component. The final component is slower than the previous two but has a longer duration. It is a pulse that flows through electricity trans-mission lines-damaging distribution centers and fusing power lines. The combination of the three com-ponents can easily cause irreversible damage to many electronic systems (Heritage Foundation 2008).

Hijackings and Skyjackings

Hijacking is the seizure by force of a surface vehicle, its passengers, and/or its cargo. Skyjacking is the taking of an aircraft, which creates a mobile, hostage barricade situation; provides terrorists with hostages from many nations; and draws heavy media attention. Skyjacking also provides mobility for the terrorists to relocate the aircraft to a country that supports their cause and provides them with a human shield, making retaliation difficult.

Kidnappings and Hostage-Takings

Terrorists use kidnapping and hostage-taking to establish a bargaining position and to elicit publicity. Kidnapping is one of the most difficult acts for a terrorist group to accomplish, but, if a kidnapping is successful, it can gain terrorists money, release of jailed comrades, and publicity for an extended period. Hostage-taking involves the seizure of a facility or location and the taking of hostages present in that facility. Unlike a kidnapping, hostage-taking provokes a confrontation with authorities. It forces authorities to either make dramatic decisions or to comply with the terrorist's demands. It is overt and designed to attract and hold media attention. The terrorists' intended target is the audience affected by the hostage's confinement, not the hostage.

Nuclear Terrorism

Nuclear terrorism refers to a number of different ways nuclear materials might be exploited as a terrorist tactic. These include attacking nuclear facilities, purchasing nuclear weapons, or building nuclear weapons or otherwise finding ways to disperse radioactive materials.

Location

Terrorist attacks can occur anywhere; however, the State of New Jersey is a particularly attractive target of a potential terrorist activity because of its dense population and location relative to major urban areas. The State also houses the busiest commuter rail system in the United States, as well as the headquarters of major corporations in economically vital sectors such as the financial and pharmaceutical industries.

Additional targets in New Jersey include the State's critical infrastructure such as utilities, roadways, bridges, tunnels, hospitals, schools, civic centers, and other high-profile venues such as Met Life Stadium and the Prudential Center (City of Newark). The link between New Jersey Transit and New York City also makes this transportation system a target for terrorists. In Essex County, transportation systems available include large, interconnected rail, roadway, and water transportation networks. Major highways accessible to Essex County includes the Garden State Parkway; New Jersey Turnpike; Interstates 78, 80, and 280; Routes 1-9, 21, 22, 23, 24, and 46; and the Eisenhower Parkway. Public roads have a total mileage of 1,673 miles; total interstate mileage is 27 miles; state highway mileage is 59 miles; county road mileage is 233 miles; and municipal road mileage of 1,330 miles. The County also has three of the nation's major transportation centers, which includes Newark Liberty International Airport, Port Newark, and Penn Station (Essex County 2014).

Jersey City/Newark is one of the 64 urban metropolitan areas that have been designated by the federal government as "high-threat, high-density" with regard to acts of terrorism (Washington Post 2014).

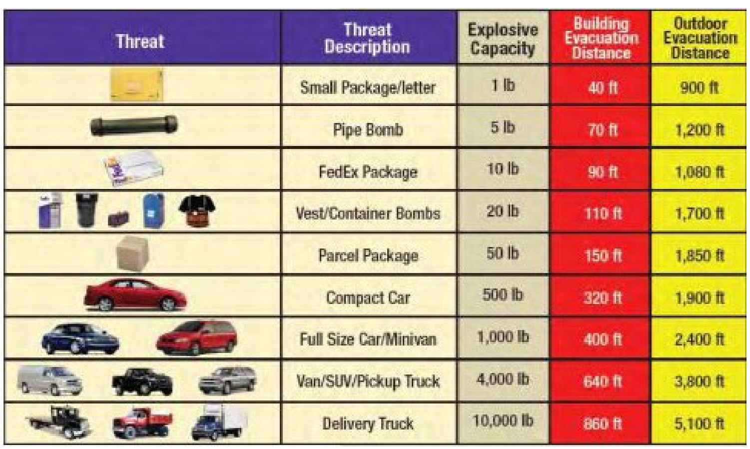
Extent

Any acts of terrorism can occur anywhere at any time of day. The National Terrorism Advisory System (NTAS) communicates information about terrorist threats by providing detailed information to the public, government agencies, first responders, airports and other transportation hubs, and the private sector. When there is a threat, an NTAS Alert will be announced by the Secretary of Homeland Security and will be shared with the public. It may include specific information about the nature of the threat, including the geographic region, mode of transportation, or critical infrastructure potentially affected, as well as steps that individuals and communities can take to protect themselves and help prevent, mitigate or respond to the threat. The alert indicates whether the threat is elevated or imminent. Elevated threats are when there is no specific information about the timing or location. Imminent threats are when it is believed the threat is impending or very soon. The alerts will be posted online and released to the news media for distribution. The United States Department of Homeland Security (DHS) will also distribute alerts through its social media channels (U.S. DHS 2013).

The effect of a terrorism event can vary depending on the type of attack and the magnitude of the event or events. A terrorism event can cause public fear regarding the use of mass transportation or leaving their homes in the event of a biological or nuclear attack. Communication systems, both public and private, can fail because of an overwhelming amount of usage or damage to its infrastructure. Healthcare facilities can become quickly inundated and must be prepared to triage injured patients, handle mass casualties, and conduct decontamination operations.

In terms of explosive attacks, Figure 4.3.16-1 summarizes the capacity of different explosives.

Figure 4.3.16-1. Capacity of Different Explosives



Threat	Threat Description	Explosive Capacity	Building Evacuation Distance	Outdoor Evacuation Distance
	Small Package/letter	1 lb	40 ft	900 ft
	Pipe Bomb	5 lb	70 ft	1,200 ft
	FedEx Package	10 lb	90 ft	1,080 ft
	Vest/Container Bombs	20 lb	110 ft	1,700 ft
	Parcel Package	50 lb	150 ft	1,850 ft
	Compact Car	500 lb	320 ft	1,900 ft
	Full Size Car/Minivan	1,000 lb	400 ft	2,400 ft
	Van/SUV/Pickup Truck	4,000 lb	640 ft	3,800 ft
	Delivery Truck	10,000 lb	860 ft	5,100 ft

Source: NJOEM 2019

There is often very little if any warning time that a terrorist attack is about to occur. It is possible, however, to thwart terrorist attacks through aggressive intelligence monitoring and monitoring of individuals who exhibit radical tendencies. Some terrorist attacks may show warning signs that an incident may occur, such as a suspicious package left unattended. Local, state, and federal officials as well as the general public are responsible for recognizing the warning signs of terrorism incidents and for taking appropriate actions to mitigate against possible attacks. In New Jersey, the coordination, direction, and control of all law enforcement personnel and resources fall under the purview of the Attorney General. Additionally, the New Jersey Office of Homeland Security and Preparedness administers, coordinates, leads, and supervises New Jersey's counter-terrorism efforts.

In New Jersey, the NJOEM, New Jersey Office of Homeland Security and Preparedness (OHSP), and the Regional Operations Intelligence Center (ROIC) have introduced NJ Alert, a mass text and email emergency notification system. During an emergency, NJ Alert assists these agencies in delivering emergency messages to the public through their handheld devices or computers, in addition to the Emergency Alert Systems and Amber Alert (NJOEM 2009).

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with terrorist events throughout the State of New Jersey and Essex County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events 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.

Between 1954 and 2019, FEMA issued a disaster (DR) or emergency (EM) declaration for the State of New Jersey for one terrorism-related, in which Essex County was included.

Previous events between 2014 and 2019 were researched and listed in Table 4.3.16-1. No terrorist events were identified to have occurred within in the County during this timeframe; however, with the County's proximity to New York City, the County has the potential to be impacted by these events.

Table 4.3.16-1. Terrorism Events in New Jersey and Surrounding Area, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Description
September 17-19, 2016	Bombing	N/A	N/A	On the morning of September 17, a pipe bomb exploded in Seaside Park, New Jersey. Later that day, a homemade pressure cooker bomb went off in Manhattan, New York City. A second pressure cooker bomb was discovered four blocks away. Late on September 18, multiple bombs were discovered at the train station in Elizabeth, New Jersey. One of these bombs detonated early next day.

Source: NJ State HMP 2019
N/A Not Applicable; Not Available

Probability of Future Occurrences

While the potential for future terrorism incidents in Essex County is difficult to predict, the combination of past incidents and potential terrorist targets make a terrorism incident possible. Efforts from local, state, and federal officials must be coordinated to prevent future terrorist incidents from occurring. However, despite the best efforts of these entities, the reality is that a terrorist attack may occur in Essex County or the surrounding areas.

In Section 4.4, the identified hazards of concern for Essex 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 Steering Committee and Planning Committee, the probability of occurrence for terrorism events in the County is considered 'occasional'.

Climate Change Impacts

Because terrorism is a human-caused hazard, no climate change impacts are associated with the hazard.

4.3.16.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

For the purposes of this HMP, the entire population in Essex County is exposed to terrorism events. However, because terrorists typically prefer to impact the greatest number of individuals in a given location, it can be inferred that individuals living in highly populated areas, or mass transit systems with a large number of commuters will have a greater exposure to terrorist incidents than those living in rural areas. Refer to Section 3 (County Profile) for a summary of population statistics for the County. Large-scale incidents have the potential to kill or injury many residents in the immediate vicinity of the attack, and they may also affect people located a distance from the initial event.

Impact on General Building Stock

All of the building stock in the County is exposed to the terrorism hazard. Accessibility, design, availability to roof access, driveways underneath buildings, unmonitored areas, and the proximity of structures to transportation routes, underground pipelines, and the potential for a terrorist to strike any structure randomly, makes all buildings in the County exposed and vulnerable to this hazard. Terrorist groups would be likely target structures of significant cultural or financial value. Refer to Section 3 (County Profile) which summarizes the building inventory in Essex County.

Impact on Critical Facilities

Critical facilities are exposed to terrorist attacks, particularly because of the impact that an attack has on these types of facilities. Dams, power stations, and tunnels are all examples of critical infrastructure and facilities that are vulnerable. Additionally, communications systems, first-responder stations, and emergency operations centers are all vulnerable to terrorist attacks. Disrupting one of these facilities or destroying critical infrastructure would have devastating, cascading impacts on Essex County. All critical facilities in the County are exposed to the terrorism hazard.

Impact on Economy

Measuring the economic impact of a terrorist attack on Essex County is difficult. The initial impact can be measured in immediate costs such as costs related to responding to the event, and those associated with the immediate loss of productivity due to closed businesses. Should a terrorist event be of a significant magnitude, there could be ramifications in the financial markets which could affect a greater geographic extent compared to Essex County. The fuller economic impact includes long-term costs such as terrorism mitigation activities and likely heightened anti-terrorism activities.

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 and Change in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by terrorism because the entire County is exposed and vulnerable. At this time, it is difficult to model any impacts terrorism may have on new development within Essex County. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Population change is not expected to have a measurable effect on the overall vulnerability of the county's population over time.

Climate Change

Because terrorism events are human-caused, no climate change impacts are associated with the hazard.

Change of Vulnerability Since 2015 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to terrorism events.

4.3.17 Transportation 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 transportation hazards in Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous events between 2014 and 2019 were researched, with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).

4.3.17.1 Profile

Hazard Description

Essex County is vulnerable to vehicular accidents, aviation accidents, railway accidents, bridge failures, and roadway failures and flood vulnerable roadways.

Essex County is located adjacent to New York City and along the major transportation routes connecting the New York and Philadelphia metropolitan areas. Port Newark is also located in the County. Traffic flow through the County is critical to economic prosperity in the entire region (Essex County HMP 2007). The County possesses an extensive transportation network, including many rail and fixed route bus services, as well as demand responsive, ridesharing, and shuttle services (Essex County Transportation Plan 2013).

The majority of fixed route service in Essex County is provided by New Jersey Transit (NJ Transit) or private carriers. There are 60 bus routes and 5 light rail routes and commuter rail lines. Private carriers mostly serve trips to New York City, although there are at least three privately operate local bus routes. NJ Transit operates commuter rail, light rail, and bus service in Essex County. Commuter rail service is provided on the Morris and Essex Rail Line and on the Boonton Line. Morris and Essex service operates to Hoboken Terminal and New York Penn Station with stops in Essex County at Newark Broad Street and eight other stations on the Morristown Line. Rail service is also provided to Hoboken on the Boonton Line from six stations in northern Essex County (Essex County Transportation Plan 2008, 2013).

NJ Transit provides 53 bus routes and one light rail route in the County; 39 of which serve the City of Newark. Nine others provide service to New York City. The remainder primarily provide local service (NJ Transit System Map 2014).

Transportation systems available in Essex County include large, interconnected rail, roadway, and water transportation networks. Major highways accessible to Essex County includes the Garden State Parkway; New Jersey Turnpike; Interstates 78, 80, and 280; Routes 1-9, 21, 22, 23, 24, and 46; and the Eisenhower Parkway. Public roads have a total mileage of 1,673 miles; total interstate mileage is 27 miles; state highway mileage is 59 miles; county road mileage is 233 miles; and municipal road mileage of 1,330 miles. The County also has three of the nation's major transportation centers, which includes Newark Liberty International Airport, Port Newark, and Penn Station (Essex County 2014). Roadways exposed to the 1-percent annual chance of flooding hazard area include: NJ-7, NJ-10, NJ-21, NJ-23, NJ-24, NJ-27, NJ-124, NJ-159, I-78, I-80 I-95, I-280, US-1, US-22, and US-46 and the Garden State Parkway. All these systems and supporting resources provide services locally, regionally, nationally, and internationally.

Vehicular Accidents

A vehicular accident is a road traffic incident that usually involves one road vehicle colliding with another vehicle or other road user, such as an animal or a stationary roadside object. A vehicular accident may result in injury, property damage or possibly fatalities. Many factors contribute to vehicular accidents, including: equipment failure, poor road conditions, weather, traffic volume, and driver behavior.

Aviation Accidents

According to the International Civil Aviation Organization, an aviation accident is an occurrence with the operation of an aircraft which takes place between the time a person boards the aircraft with the intention of flight to the time the person has disembarked the aircraft. There are three different occurrences that determine an aviation accident: a person is fatally or seriously injured; the aircraft sustains damage or structural failure; or the aircraft is missing or completely inaccessible. An aviation incident is an occurrence, other than an accident, associated with the operation of an aircraft which affects or could affect the safety of operation (International Civil Aviation Organization, 2015).

Railway Failures and Accidents

Freight, commuter, and subway lines are all located in Essex County. These lines may fail due to weakening joints, erosion, and unstable rails that can cause train-car collisions and derailment. Subway breakdowns may occur as a result of aging machinery.

Rail transportation's underground and aboveground rails are vulnerable to weather-related events as well. Flooding from coastal storms and heavy precipitation events can impact underground rails, while strong winds can impact aboveground rails by derailing rail cars. Extreme temperatures can affect railroad tracks by causing the steel to shrink during extreme cold and buckle during extreme heat events (NYC HMP 2014).

An at-grade railroad crossing is an intersection where a public highway, road, street, or private roadway crosses one or more railroad tracks at grade, or at the same ground surface level. These crossings are marked by crossbucks, stop signs, or other signals, and may be identified by a U.S. DOT inventory number (49 CFR 218.93).

Roadway and Bridge Failures

Bridges, tunnels and roads are all make up a part of the transportation network in Essex County. All of which are vulnerable to deterioration from use and climate. The following provides information regarding bridge and roadway failures.

Bridge Failures

Bridge components are subject to cracking, rusting, ground subsidence, and corrosion caused by exposure to water, vibration, ozone, dust, dirt, chemicals in salt products, and gasoline (NYC HMP 2014).Bridge failure generally results in a more severe impact as compared to non-bridge roadway failures. Failure of bridges may also adversely impact the feature it was designed to cross (another roadway, body of water, rail line, etc.). In Essex County, when considering all stream and river crossing, crossing of rail over roadways and vice versa, crossing of roadway over roadway, and pedestrian crossings , there are hundreds of bridges within the County (Essex County HMP 2007).

Roadway Failures

Roadway failures occur frequently and include long-term structural fatigue, overweight traffic, accidents, fuel or hazardous material discharges, or acts of terrorism. During roadway closures, traffic is disrupted and depends on the type of roadway failure (Essex County HMP 2007). Roadways are typically less likely to fail than bridges;

however, subsurface conditions such as sinkholes or collapsed sewers can undermine streets. For example, retaining walls are critical to the structural integrity of roadways and a failure of the wall can close roads and/or cause major traffic disruptions (NYC HMP 2014).

Flood Vulnerable Roadways

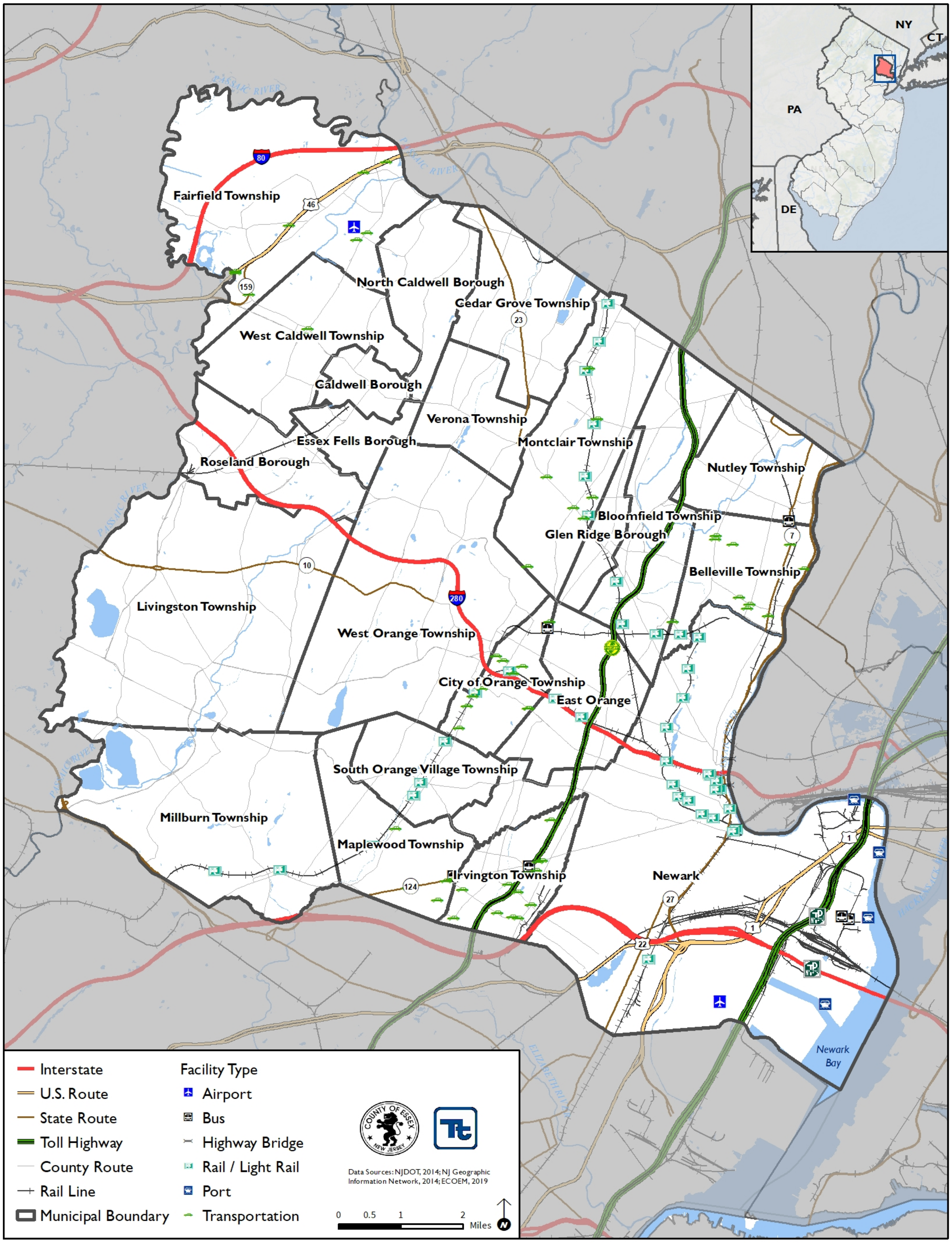
A flood vulnerable roadway is any public road that has a history of being covered by enough water in a manner that the road surface, markings and edges are not visible to the operator of a vehicle, cyclist or a pedestrian. These conditions can be caused by stream/river flooding, poor drainage along roadways or normal surface runoff. Water on the roadway can be either standing or moving and could also leave debris such as gravel, leaves and sticks on the roadway.

Location

Essex County is full of transit infrastructure, especially in the eastern parts of the County. Transit is available in the form of rail, light rail, bus, and paratransit (shuttle). NJ Transit is the primary transit provider in Essex County and operates a bus and rail hub at Newark Penn Station, as well as the Newark Light Rail (subway) that links Penn Station with Broad Street Station and Bloomfield (Essex County Comprehensive Transportation Plan 2013).

Figure 4.3.17-1 illustrates the transportation facilities and major roadways located in Essex County.

Figure 4.3.17-1. Transportation Facilities and Roadways in Essex County



Vehicular Accidents

A vehicular accident can occur on any traveled roadway in Essex County. Areas of particular concern include areas of roads that are difficult to navigate, conducive to accidents, historically accident-prone, adjacent to water bodies, and pass through populated or highly traveled areas.

The County-owned radial roads, including Bloomfield Avenue, Springfield Avenue, Clinton Avenue, and South Orange Avenue, all serve both local and regional travel, including travel to and from New York City. These roads become very congested, especially in areas of high pedestrian activity, which often results the pedestrian mobility and safety and hazardous conditions for bicycles (Essex County Comprehensive Transportation Plan [ECCTP] 2013).

The roadways in Essex County consist of various functional classes and allows for travel between residential areas and the commercial/business establishments throughout the County. Major state roadways include the Garden State Parkway; I-280; I-80; and I-78. In addition to these major roadways, numerous state and county routes are present throughout Essex County as well. In total, there is approximately 1,767 miles of roadway in the County (ECCTP 2013).

Aviation Accidents

With Newark International Airport and Port Newark located within Essex County, the County is a major national transportation hub with an extensive network of rail, highway, air and sea transportation and it is home to one of the world's largest containerized shipping ports (Essex County Division of Planning 2014).

Newark Liberty International Airport is located in the southeast part of the County and is one of the three major airports in the New York metropolitan area. It is operated by the Port Authority of New York & New Jersey (PANYNJ). Additionally, the Port Authority operates the Port Newark-Elizabeth Marine Terminal in Essex County, which is the largest port facility on the east coast and the third largest in the U.S. This port is located on the Newark Bay and serves as the principal container ship facility for goods entering and leaving the New York-New Jersey area (ECCTP 2013).

The Essex County Airport CDW (ECA), also known as Caldwell Airport, is located entirely in the Township of Fairfield and is owned and operated by Essex County Improvement Authority (ECIA). The ECIA is governed by a seven member Board of Commissioners appointed by the County Executive with the consent and approval of the Essex County Board of Chosen Freeholders. The Essex County Airport is a general aviation facility whose campus is located on approximately 278 acres of land. It is located 20 miles west of New York City and 10 miles west of Teterboro Airport. This airport is easily accessible from State Highways 23, 46, 80, 280, and 287. Public transportation to the airport is available via NJ TRANSIT bus service and from the PANYNJ in New York City (ECCTP 2013).

Railway Failures and Accidents

Essex County has approximately 26 miles of railroad track and 21 railroad stations, including Newark Penn Station, which is the hub for Amtrak service. The Port Authority Trans Hudson (PATH) system is a subsidiary of the Port Authority of New York and New Jersey. This heavy rail rapid transit system is the country's 7^{th} largest subway system. It serves as the primary transit link between New York City and urban and suburban communities in New Jersey and handles 250,000 passengers each day (ECCTP 2013).

Amtrak is a federally-owned railroad that provides inter-city passenger service to Newark Penn Station, serving more than 680,000 passengers, and Newark International Airport, serving more than 127,000 passengers. The Northeast Corridor Line runs between Washington D.C. and Boston and services other major east coast cities such as New Haven, New York City, Trenton, Philadelphia, and Baltimore (ECCTP 2013).

There are five NJ TRANSIT commuter lines that travel through Essex County: Northeast Corridor, Raritan Valley Line, Morris and Essex Lines, Montclair-Boonton Line, and North Jersey Coast Line. There are a total of 21 NJ TRANSIT stations located in Essex County. Newark Penn Station is an important multi-modal transportation hub that serves the Northeast Corridor, the Raritan Valley line, PATH, as well as numerous NJ TRANSIT bus routes. These stations have eight tracks, with seven of them on one level and the other track for PATH service on an upper level (ECCTP 2013).

The Conrail Lehigh Line is a main east/west route serving the region and one of the busiest rail lines in the U.S. In the City of Newark, the railroad enters Oak Island yard, the largest classification yard in New Jersey, and then continues across Newark Bay to Jersey City. West of the Oak Island yard, the Lehigh connecting track links the Lehigh Line with the Passaic & Harsimus Line which runs to the intermodal terminals in Kearney and North Bergen (ECCTP 2013).

The Chemical Coast Secondary is a major north/south rail line and serves Port Newark/Elizabeth and the intermodal terminal serving the Port Newark Container Terminal (PNCT) at Portside Yard. A new flyover connection between PNCT and Portside allows direct transfer from ship to rail without having to access city streets. Running north from Oak Island are the Brills Lead and the Bay Shore Lead which serve the intermodal transfer activities in Brills Yard and various industries along Doremus Avenue (ECCTP 2013).

The responsibilities for public crossings at grade are shared between the railroad and the road/highway agency. The railroad is responsible for the crossing surface between the out ends of the railroad ties, for the installation of the crossbuck signs where no signals are present, and for the operation and maintenance of the railroad crossing signals and associated control circuitry. The road or highway agency is responsible for warning and regulatory signs on the approaches to the crossing, for pavement markings and for the street or highway approaches outside the end of the railroad ties (West Virginia Department of Transportation, Date Unknown).

Roadway and Bridge Failures

Bridge Failures

Essex County's transportation network includes operation and maintenance of four swing bridges over the Passaic River, provides maintenance of 131 stationary bridges and 230 culverts. The bridges and culverts represent critical nodes that allow traffic to efficiently navigate the County's diverse topography (ECCTP 2013).

Roadway Failures

See the vehicular accident section for a summary of roadways in Essex County.

Flood Vulnerable Roadways

According to FEMA, flood hazard areas are defined as areas that are shown to be inundated by a flood of a given magnitude on a map. These areas are determined using statistical analyses of records of river flow, storm tides, and rainfall; information obtained through consultation with the community; floodplain topographic surveys; and hydrologic and hydraulic analyses. Flood hazard areas are delineated on FEMA's Flood Insurance Rate Maps (FIRM), which are official maps of a community on which the Federal Insurance and Mitigation Administration has indicated both the Special Flood Hazard Areas (SFHA) and the risk premium zones applicable to the community.

In addition to FIRM, FEMA also provides FISs for entire counties and individual jurisdictions. These studies are narrative reports of countywide flood hazards, including descriptions of the flood areas studied and the engineered methods used, principal flood problems, flood protection measures and graphic profiles of the flood sources. A countywide FIS for Essex County has been completed and discusses the principal flood problems in

Essex County including flood vulnerable roadways (FEMA FIS, 2017). Major roadways exposed to the FEMA delineated Special Flood Hazard Area include: The Garden State Parkway, I-280, I-78, I-80, I-95 (NJ Turnpike), NJ-7, NJ-10, NJ-21, NJ-23, NJ-24, NJ-124, NJ-159, US-1, US-22, and US-46. See the Flood Hazard section (5.4.6) for more information and individual municipal annexes (Section 9) for information on localized problem areas.

Extent

Vehicular Accidents

There is no warning time for vehicular accidents. Contributing factors for these accidents are typically associated with the driver, vehicle and the environment. Factors associated with the driver include: error, speeding, experience, and blood-alcohol level. Factors associated with the vehicle include: type, condition, and center of gravity. Environmental factors include: quality of the infrastructure, weather, and obstacles. The majority of vehicular accidents are attributed to the driver. Vehicular accidents can have severe effects on those directly involved, as well as effects to others not directly involved. Other effects may include: severe traffic delays, lost sales to businesses, delayed commodity shipments, and increased insurance costs (Cova and Conger, 2004).

Aviation Accidents

Approximately 80-percent of all aviation accidents occur shortly before or during take-off and landing. These are usually said to have been caused by human error. Mid-flight accidents are rare but not unheard of. A survey was conducted on 1,843 plane crashes that occurred between 1950 and 2006. The survey showed that of those 1,843 plane crashes, 53-percent were due to pilot (human) error; 21-percent due to mechanical failure; 11-percent due to weather; eight-percent due to other human error (lack of communication, improper maintenance); 6-percent due to sabotage and terrorism; and 1-percent due to other causes (Krasner, 2009).

Aviation accidents are often devastating incidents that may result in serious injuries or fatalities. The Federal Aviation Administration (FAA) and the National Transportation Safety Board (NTSB) are the agencies responsible for monitoring air travel and investigation accidents. Some of the most common causes of aviation accidents occur as a result of the violation of FAA and NTSB regulations. Some other causes of accidents include, but are not limited to:

- Pilot or flight crew errors – Pilot errors are the number one cause of aviation accidents and account for the highest number of fatalities. Pilots have the responsibility to transport passengers safely from one place to another and follow the FAA and NTSB regulations to better ensure passenger safety. If a pilot or flight crew makes an error, an accident may occur.
- Faulty equipment – Faulty aircraft equipment and/or mechanical features are another common cause of an aviation accident.
- Aircraft design flaws – The manufacturer of an aircraft is responsible for an aviation accident if the structural design is flawed and results in an accident.
- Failure to properly fuel or maintain the aircraft – If any regulations and safety standards set by the FAA or NTSB are violated, an accident may occur.
- Negligence of Federal Air Traffic Controllers – The failure of air traffic controllers to properly monitor the airways is another cause of aviation accident (Aviation Law News, Date Unknown).

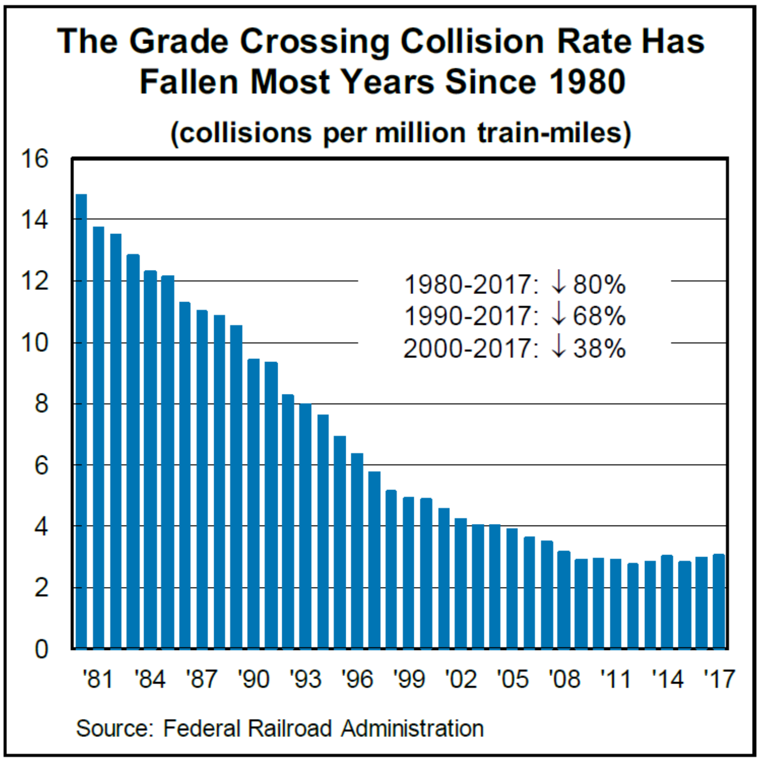
Railway Failures and Accidents

Accidents involving trains and pedestrians, or motor vehicles are severe. For most local road officials, at-grade railroad crossings are the most common exposure to railroads. Such crossings are often a nuisance for both highway and railroad officials. Railroad crossings are a conflict point between two different transportation systems, which have different operating characteristics and different needs (Association of American Railroads, 2012).

As of 2018, there are more than 200,000 at-grade crossings in the U.S (Association of American Railroads 2018). In 2017, there were 10,589 incidents at public highway-rail crossings in the U.S. that resulted in 822 deaths and 8,810 injuries (U.S. Department of Transportation 2018).

Between 1980 and 2017, the number of grade-crossing collisions fell 80% (Figure 4.3.17-2). Injuries associated with collision fell 79% and fatalities fell 67% (Association of American Railroads 2018). According to the Federal Railroad Administration, as of 2019, there are 466 highway-rail crossings in Essex County (Federal Railroad Administration 2019).

Figure 4.3.17-2. Highway/At-Grade Railroad Crossing Collision Rate, 1980 through 2017



Source: Association of American Railroads 2018

Roadway and Bridge Failures

The severity of roadway and bridge failures in Essex County depends on the size and criticality of affected networks, their location, the number of people directly impact, and the secondary impacts to essential services and the economy. A failure's severity can range from localized occurrence to a system-wide incident (New York City HMP 2014).

Flood Vulnerable Roadways

There are heavily trafficked roadways (parkways and secondary roads) used by automobiles and trucks through the County; some of which experience frequent flooding. These roads are used by residents, commuters and for transporting all types of materials, including hazardous materials. Hazardous materials in transit include substances or materials determined to be capable of posing an unreasonable risk to health, safety or property when transported. These routes traverse residential neighborhoods, making the nearby residential population and environment vulnerable. A major accident in each of these transportation systems is possible and could impact the County (minimal to severe). Areas of urban flooding which affect roadways were identified by local municipalities during the planning process including:

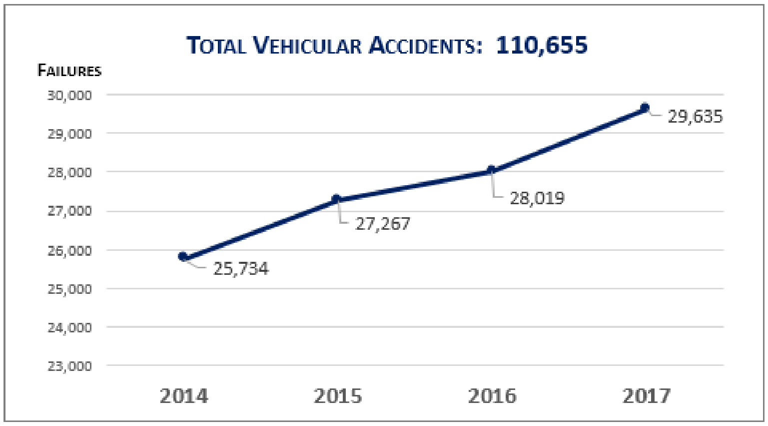
- Bloomfield Avenue in Caldwell Borough
- Bloomfield Avenue and Verona Park in the Township of Verona
- Lindsley Avenue near North Caldwell's Border in the Township of Cedar Grove
- Forest Way in Essex Fells Borough
- Devon Road in Essex Fells Borough
- Horseneck Road in Fairfield Township
- Came Plane Road in Fairfield Township
- Dwight Place in Fairfield Township
- Washington Avenue and Lincoln Drive in Fairfield Township
- Passaic Avenue in Fairfield Township
- Drake's Lane in Irvington Township
- Lennox Avenue in Irvington Township
- Navlon Avenue in Livingston Township
- Naylon Place in Livingston Township

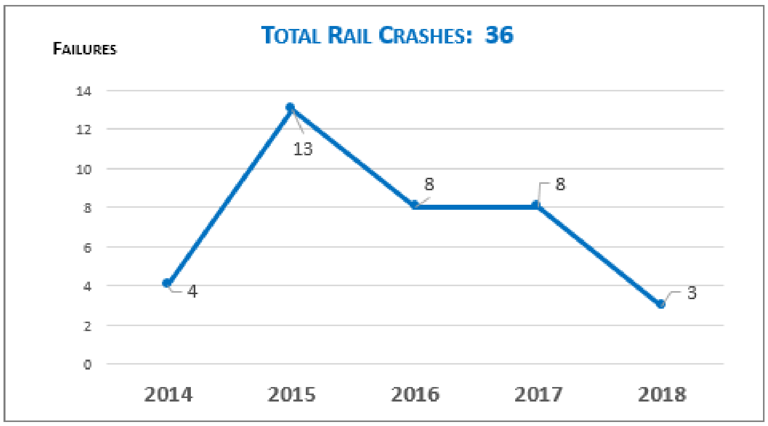
See Section 4.3.6 (Flood) for detailed information on the extent for flood and flood vulnerable roadways. Individual municipal annexes (Section 9) contain additional information on localized problem areas.

Previous Occurrences and Losses

Many sources provided historical information regarding previous occurrences and losses associated with transportation failure events throughout the State and Essex County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events 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. Figure 4.3.17-3 below displays the number of vehicular and rail accidents since 2014 with the best available data accessible. This data shows an increasing number of vehicular accidents occurring annually, but a decrease in the number of rail accidents occurring annually over the last 5 years. Additional information regarding these accidents is available in Table 4.3.17-1.

Figure 4.3.17-3. Transportation Accidents in Essex County





Source: Federal Railroad Administration 2019, NTSB 2019; NJDOT 2018

Table 4.3.17-1 includes railway, automobile, and aviation accidents from 2014 to 2019. The State of New Jersey was not included in any FEMA disaster (DR) or emergency (EM) declarations in regard to transportation failure events.

Table 4.3.17-1. Transportation Failure Incidents in Essex County, 2014 to 2019

Date	Type	Description
2014	Vehicular Accidents	In 2014, as reported by NJDOT, there were 25,734 vehicular accidents in Essex County.
May 15, 2014	Rail Crash	While humping two loaded tank cars into track 46 class, cars rolled out east end and sideswiped a cut of cars out to foul on track 48 class – no derailment.
June 19, 2014	Rail Crash	FO33 was stretched out of track 44 waiting for signal when car TILX 100528 was not stopped by inert retarder on track 50 class and stuck their train. ($300.00 track damage to TRACAK #50).
July 1, 2014	Rail Crash	Loaded tank car OLNX 718092 was bumped out of track 48 by a two car cut of loaded tank cars GATX 33616 AND UTLX 645931, striking train F033 on track #50 causing 11 cars to derail. track damage to track #48 is $480. track damage to track #50 is $370.
August 19, 2014	Rail Crash	Train #1009 derailed wheels 1-3 of lead engine #4008, wheels 1-3-4 of #6556, all wheels of #6542 and1 wheel of #6546 due to a defective concrete tie at MP 11.7 in Montclair.
January 13, 2015	Rail Crash	Crew was humping and car ADMX 28199 sideswiped car ADMX 25120, causing both cars to derail.
January 23, 2015	Rail Crash	While humping track R3, MLMX 256 exited retarder AT 11.85 mph ran out and sideswiped UTLX 674563 on track #2 derailing MLMX 256. track #36 sustained $150.00 in track damages. track #32 sustained $1,860.00 in track damages.
February 11, 2015	Rail Crash	TOAX 880187 on 2 compound track sideswiped the TTGX 986257 on 3 compound track that was left in the foul. 9,550 in equipment damages and $2,800 in track damages.
February 28, 2015	Rail Crash	FO64 was humping cars; the NS 406909 was headed down 18:.02 retarder when the west end of car diverted to 18:03. the next car BGEX 443071 on retarder 18:02 struck the NS 406909. retarder 18:03 sustained $25, 537. 00 in damages. retarder 18:02 was not damaged.
March 14, 2015	Rail Crash	At 12:40 pm on Saturday, March 14, 2015 an eight-car PA-5 train consist was standing on track G in south street yard. Amtrak reported smoke issuing from the train. the power director removed power from tracks G9-10 AND H9-10. transportation division operations examiner M. Biancamano responded to the scene and escorted the Newark fire department to the location of the fire. the Newark car equipment division car inspector responded and extinguished the fire. preliminary inspection revealed that the high voltage cable on the no. 2 side of the no. 2 truck on car 5168 ignited the truck components and started to spread to the undercarriage of the no. 2 end of the car. there were no employee injuries as a result of the fire. material and labor damages to car 5168 are $41,175.
April 20, 2015	Rail Crash	NS train 294H418 shoving west with 7 units and 5 loads into track #4 in Conrail Oak Island yard struck equipment left in the foul of adjacent track resulting in derailment of TTGX 973823.
May 12, 2015	Rail Crash	Train 2166 with locomotive E/2035 in the lead 6 cars and locomotive E/2039 trailing suffered pantograph damage on both power cars. Amtrak’s equipment damage is $17,918.00.
July 17, 2015		FO52 crew was shoving into track 12 and failed to properly protect rear of train and collided with standing cars.

Table 4.3.17-1. Transportation Failure Incidents in Essex County, 2014 to 2019

Date	Type	Description
July 20, 2015	Rail Crash	UP 98513 was humped into track 40 and failed to stop in track. when it exited track 40 it collided with the OI65 crew derailing a total of 4 cars.
August 11, 2015	Rail Crash	On Tuesday, August 11, 2015, at approximately 4:50 AM, an aluminum light pole fell off the new jersey turnpike (i-95) when a truck was involved in a vehicular accident. the pole fell to the path system roadbed, in the vicinity of track H, signal 110x, striking ATC cables and associated equipment.as the cable fell, it bounced off of the messenger wire. The force of the falling pole caused the ATC supporting structures and cable to fall to the ground. when it came to rest, the aluminum pole was obstructing the right-of-way on track h. at 4:55 am the 4:00 am WTC/NWK interval, consist: (W – 5780-5829-5813-5762-5744-5110-5146-5618 - E), was moving west along track h. as it approached the vicinity where the pole fell onto the roadbed, the engineer aboard the train noticed the pole and placed the train into emergency brake. before the train could come to a complete stop, leading car5780 struck the pole. There were no injuries as a result of this incident. there were no damage costs associated with this incident to car equipment, track, and associated components. estimated costs to repair ATC structures and cables is estimated to be $1,300,000. this includes costs for the removal of damaged ATC equipment, and the procurement and installation of ATC equipment.
August 13, 2015	Rail Crash	While humping two sets of cars ran out of the inserts on tracks 18 and track 28 leading to a side swipe and derailment.
August 15, 2015	Aviation Accident	A Cessna T206H lost engine power and crashed soon after takeoff, resulting in one fatality.
September 1, 2015	Rail Crash	NS H80H631 shoving west push/pull with lead unit NS 5613, 4 empties, and trail unit NS 5612 derailed all wheels on trail engine NS 5612 resulting in $24,551 in equipment damages.
September 7, 2015	Rail Crash	Train 664 stopped with a broken pantograph on locomotive E/646 due to fatigue break in auxiliary wire. Amtrak's equipment damage is $20,000.00.
December 8, 2015	Rail Crash	Crew was pulling 8 cars east off track 44 when a covered hopper rolled off track 42 striking the 7th car in train derailing two cars.
2015	Vehicular Accidents	In 2015, as reported by NJDOT, there were 27,267 vehicular accidents in Essex County.
January 30, 2016	Rail Crash	BA50 pulled a 36 car train from east end of oak island track on 1 middle to docks 2, upper bay. While pulling the 26th car, the a end derailed at 1 middle switch resulting in $24,999 in equipment damage, $4,000 track damage.
January 24, 2016	Aviation Accident	Delta Air Lines flight 1409, a McDonnell Douglas MD-88, N908DE, was struck by a Boeing 767, N178DZ, that was under tow by a Delta Airlines ground crew in the vicinity of gate 42 at Newark Liberty International Airport, Newark, New Jersey (EWR). There were no injuries to the 153 passengers and crew members onboard the MD-88 or to the one person aboard the B767 nor to the four ground crew personnel. There was substantial damage to the horizontal stabilizer and elevator of the MD-88.
April 11, 2016	Rail Crash	Train #408 en route east crossed over from track #1 to #2 at green interlocking and pantograph was torn off EMU #1409, #1385 and catenary wire damaged account section insulator failure. $16,932 equipment damage, $4,408 track damage.

Table 4.3.17-1. Transportation Failure Incidents in Essex County, 2014 to 2019

Date	Type	Description
May 25, 2016	Rail Crash	Pantograph on emu #1395 was damaged and bent on the right side while train #308 was en route near MP7.5 in Newark due to section insulator runner failure. $10,500 equipment damage, $1,800 track damage.
June 12, 2016	Rail Crash	FO27 crew shoved the L159-12 after building the train. the FO27 derailed on the southern connection at FRAN as they shoved the train in the clear on track 3. $113,191 in equipment damage, $3,000 track damage.
August 1, 2016	Rail Crash	FO10 derailed cars due to wide gauge resulting in $11,523 equipment damages and $3,500 track damage.
October 21, 2016	Rail Crash	Train #3272 came to rest in a catenary full tension break while train was stopped at a signal. arcing ensued as 1 of the 2 trolley wires forming the break was not touching the pantograph but in very close proximity to it. the resulting heat from the arcing weakened the wire causing it to spark, snag and invert the pantograph as it began to move eastward resulting in $9,000 equipment damage.
November 6, 2016	Rail Crash	FO31 crew were humping cars when the MBLX 28279 sideswiped the SHPX 204819 on track 28. the MBLX was humped into track 26 resulting in $44,981 in equipment damage.
November 12, 2016	Rail Crash	after shoving off a cut of 32 cars on a descending grade only applying 2 hand brakes then cutting away from cars, they began to roll away striking another train on east end of yard resulting in $93,647 in equipment damage, $97,843 track damage.
2016	Vehicular Accidents	In 2016, as reported by NJDOT, there were 28,019 vehicular accidents in Essex County.
January 21, 2017	Aviation Accident	During an initial climb from Essex County Airport, a Hawker Beechcraft Corp G36 was substantially damaged when it impacted trees and terrain after a loss of engine power. The pilot was seriously injured.
March 16, 2017	Rail Crash	NJTR crew MM-90 operated locomotive #4509 in electric mode into non-electrified territory with pantograph still raised in the up position, causing pantograph to be completely extended and flip towards rear of locomotive. NJTRS equipment damage is $12,980.00 and the cause of the incident was attributed to NJTRS crew.
May 3, 2017	Rail Crash	Shoving cars into TRK 7 when the lead switch operated under movement. $20,049 equipment damages. $1,500 track damage.
May 14, 2017	Rail Crash	FO05 derailed 3 cars on track 7 when switch threw under movement. $58,364 equipment damage. $1,200 track damage.
July 27, 2017	Rail Crash	NS19G26 crew was doubling departure lead to 2 middle when they shoved through x-over switch then pulled derailing three cars.
July 30, 2017	Rail Crash	FO61 derailed cars due to wide gauge. $51,676 equipment damages. $90,357 track damages.
August 30, 2017	Rail Crash	two loaded hoppers ran out the east end of track 8 class yard into the side of the FO15 that was pulling out of Track 16 on the low side lead. $30,993 in equipment damages.
October 15, 2017	Rail Crash	Q30115 derailed four cars on Conrail track. Conrail damage is 488.60. $83,228 equipment damages.

Table 4.3.17-1. Transportation Failure Incidents in Essex County, 2014 to 2019

Date	Type	Description
December 10, 2017	Rail Crash	While making a double from the main to 1 middle in oak island yard, the S30110 shoved through the track 12 crossover switch, then derailed 5 cars after pulling to depart. Conrail track damage is estimated at $4000.00.
2017	Vehicular Accidents	In 2017, as reported by NJDOT, there were 29,635 vehicular accidents in Essex County.
January 2, 2018	Rail Crash	FO66 shoving cars into track OI 1 departure when cars separated and rolled through a switch. cars then rolled back and derailed. FO66 shoving cars int$14,507 in equipment damages. $7,500 track damages.
September 29, 2018	Rail Crash	Over speed of GIMX trash cars on hump system. $1,273 in equipment damages.
December 2, 2018	Rail Crash	FO18 Hump crew while pulling out of track 24 found cars derailed. $37,094 in equipment damages. $4,500 track damages.
December 30, 2018	Aviation Accident	At the Caldwell Airport, a Cessna 172 ran off the runway, striking a berm and injuring the pilot.

Source: Federal Railroad Administration 2019, NTSB 2019; NJDOT 2018

With transportation failure documentation for Essex County being so extensive, not all sources have been identified or researched; therefore, not all events may be included in the table.

Probability of Future Occurrences

Transportation hazards are impossible to accurately predict; however, areas prone to these hazards can be located and quantified through analysis of historical records and plotted on a County base map. Certain characteristics that together cause these hazards or increase the vulnerability of these hazards can be outlined and areas that may be prone are identifiable.

In Section 4.4, the identified hazards of concern for Essex County were ranked. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and input from the Steering Committee and Planning Committee, the probability of occurrence for transportations hazards in the County is considered 'frequent'.

Climate Change Impacts

Because transportation failure is a human-caused hazard, no climate change impacts are associated with the hazard. Section 4.3.6 (Flood) discusses climate change impacts associated with flood-vulnerable roadways.

4.3.17.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

Transit-dependent populations in Essex County include those over 65 and older, disabled, low-income, automobile availability, and unemployment. Persons aged 65 and older are often public transit riders because they are either unable or unwilling to drive. Disabled persons are also another group who depend on public transit. Some disabilities prevent people from driving, making them more dependent on public transit or paratransit. Low-income persons often depend on public transportation because they cannot afford other means of transportation (Essex County Transportation Plan 2008). According to the 2013-2017 ACS 5-Year Estimates, the population of Essex County that commutes to work by public transportation was 76,387 persons which represents approximately 9.5% of the County's population (U.S. Census 2018).

Potential losses from transportation hazards include human health and life, property and natural resources. Vehicular accidents, flooded roadways, aviation accidents and accidents involving trains, all may result in injury or death to drivers/passengers on the road, the public in the immediate vicinity and emergency services personnel. The number of people exposed depends on population density, both by day and night, and on the proportions located indoors and outdoors.

Impact on General Building Stock

Potential losses to the general building stock caused by a transportation failure incident are difficult to quantify. The degree of damages depends on the type and scale of incident. Potential losses include inaccessibility, loss of service, and potential structural and content losses of a building.

Impact on Critical Facilities

Many Essex County residents depend on public transportation to get to work, bring their children to child care facilities, hospitals and senior centers, and to reach other key destinations (Essex County Transportation Plan 2008). Loss of roadway use, and public transportation services would affect thousands of commuters, employment, day-to-day operations within the County, and delivery of critical municipal and emergency services. Disruption of one or more of these modes of transportation can lead to the congestion of another, and not only impact the County but the State and region as a whole. Refer to Section 3 (County Profile) which summarizes the number and type of critical facilities in Essex County.

Impact on Economy

Due to insufficient data, a full loss estimate was not completed for the transportation hazard. Disruption of transportation services could lead to lost wages. According to the 2013 Essex County Transportation Plan, 52% of Essex County residents worked within Essex County, which ultimately could lead to substantial losses in productivity. Loss of roadway use, and public transportation services would affect thousands of commuters, employment, day-to-day operations within the County, and delivery of critical municipal and emergency services. Key economic contributors in Essex County include: Port of Newark/Elizabeth and Newark Liberty International Airport. The Port assists the County's major economic engine and provides living-wage employment. The Airport employs nearly 24,000 people and contributes to $19 billion in economic activity to the metropolitan area. Disruption of one or more of these modes of transportation can lead to the congestion of another, and not only impact the County and region as a whole.

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 and Change in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by transportation incidents because the entire County is exposed and vulnerable. An increase in development and population has the ability to increase the likelihood of transportation failure incidents. Future migration to larger jurisdictions may also increase the likelihood of an incident. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan. Additional development or redevelopment throughout the County could change traffic patterns leading to increased demand on various roadways or lead to a heightened risk for traffic accidents due to a higher number of users on the roadway.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). Growth in population within the County is expected to bring an increase in the number of user's driving personal vehicles or utilizing public transportation leading to a higher risk for transportation accident to occur.

Climate Change

Because transportation failure is a human-caused hazard, no climate change impacts are associated with the hazard. See Section 4.3.6 (Flood) for climate change impacts on flooding for flood-vulnerable roadways.

Change of Vulnerability Since the 2015 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to transportation failure incidents.

4.3.18 Utility Interruption

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 power failure hazard in Essex County.

2020 HMP Update Changes

- All subsections have been updated using best available data.
- Previous events between 2014 and 2019 were researched, with a comprehensive list of previous events in Appendix E (Risk Assessment Supplement).
- In the 2015 HMP, this hazard focused on "Power Failure". For the 2020 update, this section was updated to expand the interruption of additional utilities (e.g., potable water and natural gas) due to increased municipal concern.

4.3.18.1 Profile

Hazard Description

Utility interruption is defined as any disruption or loss of a public service which includes, but is not limited to: electrical service, potable water, and natural gas caused by disruption of power transmission caused by accident, sabotage, natural hazards, or equipment failure (also referred to as a utility failure or utility outage). A significant utility interruption is defined as any incident of a long duration, which would require the involvement of the local and/or State emergency management organizations to coordinate provision of food, water, heating, cooling, and shelter.

Widespread power outages can occur without warning or as a result of a natural disaster. Generally warning times will be short in the case of technological failure, such as a fire at a sub-station, traffic accident, human error or terrorist attack. In cases where a power failure is caused by natural hazards, greater warning time is possible. For example, high wind events such as tornados and hurricanes often cause widespread power failure and are often forecasted before they affect a community. Additionally, severe winter weather conditions such as ice storms, blizzards, and snowstorms often cause power failure. Incidents such as these often have plenty of warning time, thus utility response crews can stage resources to prepare for utility failure.

Power failures can cause secondary hazards and have an effect on the health of residents. One potential secondary hazard is chemical accidents that occur after power is restored to industrial facilities. Power interruptions at chemical handling plants are of particular concern because of the potential for a chemical spill during restart (EPA 2001). Chemical spills in turn can have significant health and environmental impacts.

Another secondary hazard that can result from power failure is a loss of communications capability by first responders, which may in turn have negative impacts on public safety. Amateur radio operators may be used to supplement emergency communications during events of power outage. Power outages can also lead to instances of civil disturbance, including looting. Power failure may also lead to an increase in traffic accidents. Traffic accidents may increase because of the lack of traffic control devices such as stoplights and railroad crossing advisory signals. Power outages lasting a long duration will force law enforcement officials to man traffic control points to prevent accidents.

Power failure can have vast secondary impacts on the health of the community. During periods of extreme heat or extreme cold, vulnerable populations such as the elderly and medically frail can be affected and are susceptible to hypothermia or heat stroke. Additionally, power failure can lead to food spoilage, which has negative impacts on public health.

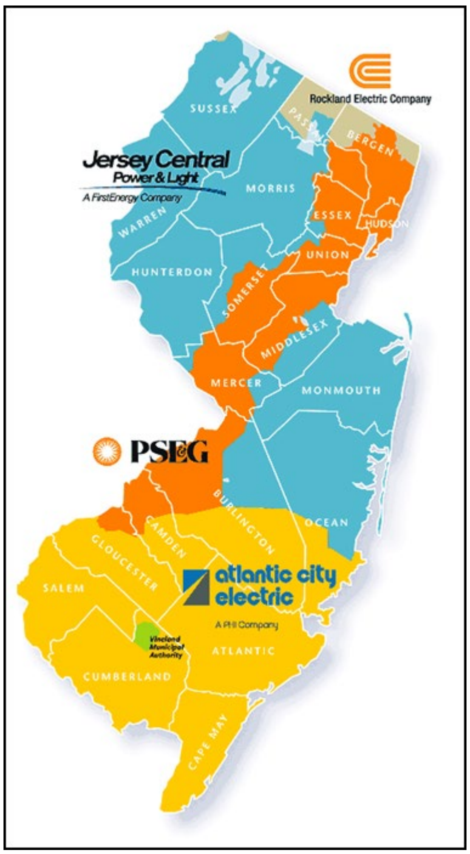
Wastewater and potable water utility interruption may occur as a result of a power failure or due to equipment failure. These critical utilities are essential to community continuity, emergency services and recovery. Their interruption of service may have cascading economic, environmental, and emergency response impacts.

Interruption of water utilities can lead to disruption in daily life for the residents (i.e., loss of potable water) and can have also have serious impacts on firefighting and emergency response capabilities. Failures can occur from natural hazards or due to aging utility infrastructure. After a water main break occurs, Fire Departments in Essex County do not have any water tenders and must rely on tenders from other counties to provide bulk water supply to be used in firefighting operations. Although the County can acquire tenders from other areas of the State, this depletes those areas of the fire protection.

Location

Power failures in New Jersey are usually localized and are usually the result of a natural hazard event involving high winds or ice storms. New Jersey's power systems are overseen by the State of New Jersey Board of Public Utilities. Under New Jersey law, consumers can shop for electric suppliers through a variety of third-party vendors. While the *supply* portion of energy is open to competition, the *delivery* of electricity is limited geographically to the following service providers:

Figure 4.3.18-1. Electric Service Delivery Companies in New Jersey



Source: New Jersey Clean Energy Program 2013

- Atlantic City Electric
- Jersey Central Power and Light (JCP&L)
- Rockland Electric Company
- Public Service Electric and Gas (PSE&G)

These service providers are responsible for maintaining power throughout their respective regions. Figure 4.3.18-1 shows the locations of electric service delivery providers across New Jersey. This figure indicates that PSE&G deliveries electricity to the majority of Essex County, while JCP&L deliveries electricity to the southwestern portion of the County.

Water interruptions can range from localize events to larger scale water outages. Water interruptions can occur from a direct impact from a natural hazard or a failure due to the age of the utility infrastructure. Water supply throughout Essex County is provided through both private and municipally operated water providers.

- North Jersey District Water
- Passaic Valley Water Commission
- Suez Water Company
- New Jersey American Water Co.
- City of Newark Water
- Essex Fells Water Company

Through the November 2019 stakeholders' meetings, Essex County learned that PSE&G has implemented procedures to pre-emptively shut down utility gas distribution should a hurricane or severe weather system be forecasted within their service area. These procedures are intended to reduce sustained damages to utility distribution infrastructure. There can be adverse effects on residents of the area who have utility gas powered generators for their homes. Should the power go out, and utility gas distribution be shutdown, then customers could be completely without power.

Extent

The extent and severity of a utility interruption depends on the cause, location, duration, and time of year. It can range from a small, localized event to a countywide power outage. Impacts from a utility failure can be significant to the County and its residents. Utility interruptions typically occur because of, or in combination with, aging infrastructure, other emergency or disaster incidents, such as severe weather and flooding, and can exacerbate such emergencies. It also depends on the utility distribution system affected.

Power failures lead to the inability to use electric-powered equipment, such as: lighting; heating, ventilation, and air conditioning (HVAC) and necessary equipment; communication equipment (telephones, computers, etc.); fire and security systems; small appliances such as refrigerators, sterilizers, etc.; and medical equipment. This all can lead to food spoilage, loss of heating and cooling, basement flooding due to sump pump failure, and loss of water due to well pump failure.

Utility gas failures can lead to a drastic reduction for residents of Essex County to heat their homes as previously mentioned. Current procedures of shutting off utility gas distribution before severe weather events could also hinder the ability to provide backup power if residents have generators power by utility gas.

Interruptions of water supply can lead to decreased potable water supply and also a decreased firefighting capability. Essex County currently does not have any water tender apparatus for fire suppression, so in the event of a water interruption, outside resources from other agencies and counties must be utilized. There are several areas within Essex County currently that do not have infrastructure in place for fire suppression including: South Mountain Reservation, Hilltop Reservation, Mills Reservation, Eagle Rock Reservation, and along Interstate Highways.

Previous Occurrences and Losses

Many sources provided utility interruption information regarding previous occurrences and losses associated with events that caused outages throughout Essex County. With so many sources reviewed for the purpose of this HMP, loss and impact information for many events 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.

Between 1954 and 2014, FEMA included the State of New Jersey in one power outage-related disaster (DR) or emergency (EM) declaration. Generally, these disasters cover a wide region of the State; therefore, they may have impacted many counties. Essex County was included in this disaster.

For the 2020 HMP update, power outage events were summarized from 2014 to 2019; refer to Table 4.3.18-1.

Table 4.3.18-1. Utility Interruption Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
March 29, 2015	Water Main Break	N/A	N/A	Millburn Township	A water main break occurred within Millburn Township with impacts to commercial and residential properties
July 1, 2016	Thunderstorm Wind	N/A	N/A	South Orange, Fairfield, Caldwell, Cedar Grove	A passing cold front triggered a few severe thunderstorms over northeast New Jersey. Power lines were reported down in South Orange. $0.75K in property damages were reported. There were multiple reports of trees and power lines down throughout Fairfield. $3K in property damages were reported. There were multiple reports of trees and wires down in Caldwell. A large tree was uprooted onto 3 cars and a home in Cedar Grove. $45K in property damages were reported.
March 14, 2017	Winter Storm	N/A	N/A	Essex County	Rapidly deepening low pressure tracked up the eastern seaboard on Tuesday March 14 bringing blizzard conditions to Western Passaic county. Heavy snow and sleet along with strong winds occurred across the rest of Northeast New Jersey. The storm cancelled numerous flights at Newark airport with some mass transit services suspended. Large trees fell onto homes in Bergen county and approximately 4,500 power outages resulted from the strong winds and heavy snow. Trained spotters and the public reported 8 to 13 inches of snow and sleet.
January 4, 2018	Winter Storm	N/A	N/A	Essex County	The development of the blizzard/winter storm began along the southeast coast on Wednesday January 3, 2018. An amplifying upper level trough spawned the development of low pressure off the coast of Florida. The low pressure rapidly intensified on Wednesday night through Thursday January 4, 2018 as it moved north-northeast along the coast. The low passed just east of the benchmark Thursday afternoon. The central pressure when the storm developed was around 1004 millibars at 1 pm Wednesday. 24 hours later, the central pressure fell to around 950 mb, approximately a 54 millibar drop. The rapid intensification of the storm led to heavy snow, strong winds, and near-blizzard conditions across portions of Northeast New Jersey. Thousands of flights were cancelled at Newark Airport on January 4, 2018. Homes and businesses lost power and there were numerous accidents on area roadways. The public reported 6 inches of snow in West Caldwell. Winds gusts 30 to 40 mph at the Caldwell Airport during the afternoon and evening on January 4, 2018. The FAA Contract Observer at nearby Newark-

Table 4.3.18-1. Utility Interruption Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
					Liberty Airport reported 8.4 inches of snowfall. Winds also gusted to 44 MPH at 4:38 PM at the airport.
March 7, 2018	Winter Storm	N/A	N/A	Essex County	A strong low pressure system developed along the Middle Atlantic coast during the morning of Wednesday, March 7, 2018. The low tracked along the coast through the early morning hours on Thursday, March 8, 2018. The storm brought heavy wet snow, strong gusty winds, and even some thundersnow across northeast New Jersey. Snowfall rates ranged from 1 to 3 inches per hour at times in the heaviest snow bands. Trained spotters and the public reported 1 to 2 feet of snow. 23.0 inches was reported in North Caldwell and 19.7 inches in Roseland. The heavy wet snow and strong winds also brought down trees and some power lines.
November 15, 2018	Winter Storm	N/A	N/A	Essex County	A wave of low pressure developed along the Middle Atlantic coast during Thursday November 15, 2018. The low was associated with a closed upper level trough across the Midwest. As the trough translated eastward into Friday November 16, 2018, the low pressure moved up the northeast coast. The antecedent air mass ahead of the low was cold and dry for the middle of November with temperatures during the morning and afternoon of November in the upper 20s and low 30s. The moisture associated with the trough and low pressure was able to produce moderate to heavy bands of snow as the precipitation began across the entire Tri-State area due to the cold air in place. Once the low drew warmer air from the south, the precipitation gradually changed to a wintry mix and then plain rain, especially for the New York City metro and Long Island. The moderate to heavy wet snowfall significantly impacted the evening rush hour with 1-2 inch per hour snowfall rates. Hundreds of trees, tree limbs, and branches were brought down by the weight of the snow, which caused many power outages. Numerous accidents were reported, and many motorists were stranded on roads until the early morning hours the next day. There were over 1,000 flights cancelled at the New York City metro airports (Kennedy, La Guardia, and Newark). The FAA contract observer at nearby Newark Airport reported 6.4 inches of snow. Trained spotters, social media, and the public reported 4 to 6 inches of snow. Impacts were widely felt across eastern Essex county with major disruption to the evening commute. Trees branches

Table 4.3.18-1. Utility Interruption Events in Essex County, 2014 to 2019

Date(s) of Event	Event Type	FEMA Declaration Number (if applicable)	Essex County Designated?	Location	Description
					and limbs were downed due to the weight of the heavy wet snow. Nearby Newark airport reported 1-2 inch per hour snowfall rates at times during the evening commute.
March 2-3, 2019	Water Interruption	N/A	N/A	Cedar Grove Township	North Jersey District Supply made overnight repairs to a 72" transmission line which required the water supply to be shut down. The Township made preparations by flooding water tanks and having plans in place to interconnect to the Township of Little Falls and the Borough of North Caldwell's water system. A 5000 Gallon Tanker was brought in and on standby for fire suppression.

Source: NOAA-NCEI 2019; FEMA 2019

Note: With documentation for New Jersey and Essex County being so extensive, not all sources have been identified or researched; therefore, Table 4.3.18-1 may not include all events that have occurred throughout the County.

Probability of Future Occurrences

While the probability of future utility interruption incidents in Essex County is difficult to predict, the historic record indicates that significant failures have occurred as a result of high winds, lightning, severe weather, winter weather, technological failures, and age of utility infrastructure. As infrastructure ages beyond its intended lifespan, it is likely to become less reliable leading to a higher likelihood of failure Data were not readily available on the frequency of smaller utility interruptions across the County; however, it is reasonable to assume that utility failure events of shorter duration will continue to occur in the future. In addition, future changes in climate may also impact the frequency and probability of future utility failure occurrences.

In Section 4.4, the identified hazards of concern for Essex 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 Steering Committee and Planning Committee, the probability of occurrence for utility interruptions in the County is considered ‘frequent’.

Climate Change Impacts

Several implications for climate change are related to the utility interruption hazard. 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.

The New Jersey Climate Adaptation Alliance is a network of policymakers, public and private-sector practitioners, academics, non-governmental organizations (NGO), and business leaders aligned to build climate change preparedness in the state of New Jersey. The Alliance is facilitated by Rutgers University, which provides science and technical support, facilitates the Alliance’s operations and advances its recommendations. A document titled *Change in New Jersey: Trends and Projections* was developed to identify recommendations for State and local public policy that will be designed to enhance climate change preparedness and resilience in New Jersey (Rutgers 2013).

Temperatures in the Northeast United States have increased 1.5 degrees Fahrenheit (°F) on average since 1900. Most of this warming has occurred since 1970. The State of New Jersey, for example, has observed an increase in average annual temperatures of 1.2°F between the period of 1971-2000 and the most recent decade of 2001-2010 (ONJSC, 2011). Winter temperatures across the Northeast have seen an increase in average temperature of 4 °F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). By the 2020s, the average annual temperature in New Jersey is projected to increase by 1.5°F to 3°F above the statewide baseline (1971 to 2000), which was 52.7°F. By 2050, the temperature is projected to increase 3°F to 5°F (Sustainable Jersey Climate Change Adaptation Task Force 2013).

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. Southern New Jersey became two inches (5%) wetter late in the 20th century (Office of New Jersey State Climatologist). Average annual precipitation is projected to increase in the region by 5% by the 2020s and up to 10% by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2009). In addition, heavy precipitation events have increased in the past 20 years.

Climatologists predict an increase in the number and intensity of severe weather events. More storms with higher winds will increase the chance that the power infrastructure will be impacted. Extreme temperatures are predicted to increase as well. During the hot summer months, the potential for power overload will increase as demand for power increases. Additionally, climatologists predict an increase in precipitation, which may lead to more winter weather thus causing additional power failures.

4.3.18.2 Vulnerability Assessment

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

Impact on Life, Health and Safety

The entire population in Essex County is vulnerable to utility interruption events. Refer to Section 3 (County Profile) for a summary of population statistics for the County.

Utility failure is particularly problematic for homes that are heated with electricity. Widespread power outages during the winter months can directly impact vulnerable populations such as the elderly and medically frail. According to the 2013 – 2017 American Community Survey, 213,021 (76.0%) homes across Essex County are heated with utility gas, 21,836 (7.8%) homes are heated with fuel oil and kerosene; and 37,940 (13.5%) are heated by electricity. JCP&L and PSE&G currently maintain databases for homes/facilities with individuals that need power supplied for medical reasons. Utility interruption events have potential health impacts including injury and death. Other issues from power outages include food safety from lack of refrigeration and carbon monoxide poisoning from misuse of generators.

Individuals with medical needs are vulnerable to power failures, because medical equipment such as oxygen concentrators requires electricity to operate. The elderly and low-income populations of Essex County are also vulnerable to the effects of power failure, as power failure has the potential to expose them to extreme heat or extreme cold. During power failure events, water purification systems may not be functioning. Further, populations on private wells will not have access to potable water. Many power outage events are caused by storm events that can lead to flooding. Without electricity, residents would be unable to pump water from their basements potentially causing structural and content damage to their homes.

Individuals powering their homes with generators are subjected to carbon monoxide poisoning if proper ventilation procedures are not followed. Improperly connected portable generators are capable of 'back feeding' power lines which may cause injury or death to utility works attempting to restore power and may damage house wiring and/or generators (NJOEM 2019).

As noted above, interruptions of water supply can lead to decreased potable water supply and a decreased firefighting capability. There are several areas within Essex County currently that do not have infrastructure in place for fire suppression increasing the vulnerability of these residents to the wildfire hazard: South Mountain Reservation, Hilltop Reservation, Mills Reservation, Eagle Rock Reservation, and along Interstate Highways. Interruption of potable water distribution also has a considerable impact on the firefighting capabilities of many fire departments within Essex County. Essex County's fire departments rely on the pressurized water system that supplies the fire hydrant connections for fire suppression. Most of the firefighting apparatus in the County relies on these fire department connections for adequate fire suppression. Should frequent or widespread water interruption occur, there will be an increased risk for structural fire and wildfire occurrence within the County.

Water systems and thus distribution 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 General Building Stock

All of the building stock in the County is exposed to the utility interruption hazard. Refer to Section 3 (County Profile) which summarizes the building inventory in Essex County. Impacts sustained from utility interruption are likely to be secondary impacts. Should potable water distribution be reduced or not available, then structures could be at increased risk for structural fire since current fire suppression is dependent accessing water supply from hydrants.

Impact on Critical Facilities

All critical facilities in the County are exposed to the utility interruption hazard. It is essential that critical facilities remain operational during natural hazard events. Backup power is recommended for critical facilities and infrastructure. Loss of power can have serious impacts on the health and welfare of residents, continuity of business, and the ability of public safety agencies to respond to emergencies. Interruption of utility gas or water distribution could also reduce the effectiveness of critical facilities to operate at full capacity.

Impact on Economy

During a utility interruption event, the County may experience losses because of an interruption of critical services. Further, increased costs such as providing shelters, and costs related to cooling and heating centers may be incurred. Extended power outages will require officials to shelter victims who require heat and power for activities of daily living.

A prolonged power failure in Essex County may impact the County's economy. The County possesses an extensive transportation network, including many rail and fixed route bus services, as well as demand responsive, ridesharing, and shuttle services (Essex County Transportation Plan 2008). Transportation systems available in Essex County include large, interconnected rail, roadway, and water transportation networks. Major highways accessible to Essex County includes the Garden State Parkway; New Jersey Turnpike; Interstates 78, 80, and 280; Routes 1-9, 21, 22, 23, 24, and 46; and the Eisenhower Parkway. Public roads have a total mileage of 1,673 miles; total interstate mileage is 27 miles; state highway mileage is 59 miles; county road mileage is 233 miles; and municipal road mileage of 1,330 miles. The County also has three of the nation's major transportation centers, which includes Newark Liberty International Airport, Port Newark, and Penn Station (Essex County 2014). All these systems and supporting resources provide services locally, regionally, nationally, and internationally. Disruption in any of these services would mean that many workers, residents, and travelers would not be able to go where needed.

Power interruptions can cause economic impacts stemming from lost income, spoiled food and other goods, costs to the owners/operators of the utility facilities, and costs to government and community service groups. FEMA's benefit-cost analysis methodology measures the loss of electrical service on a per-person-per-day-of-lost-service basis for the service area affected.

Interruption of utility gas or potable water distribution could also cause significant economic impacts such as: additional costs for bringing in water tenders to maintain fire suppression capabilities; opening additional warming centers should electric and utility gas utility be interrupted to residential areas; and distribution of potable water for public consumption. There could be significant costs associated with reimbursing fire departments from other counties within New Jersey to travel, staff, and maintain water tenders within Essex County during the duration of a water outage event.

Potential modeling of economic impacts from utility interruption would be calculating interruption of service costs which is derived from a standard value per person per day multiplied out by the number of customers served. This would help to provide an estimate of the impact of the interrupted utility service but may not be representative of the complete economic impact of a prolonged utility interruption.

The FEMA BCA Toolkit version 5.3 uses the following standard values per person per day:

- Electric: $148.00
- Potable Water: $105.00
- Wastewater: $49.00

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 and Change in Population

As discussed in Sections 3 and 9, areas targeted for future growth and development have been identified across Essex County. Any areas of growth could be potentially impacted by the utility interruption hazard because the entire County is exposed and vulnerable. Please refer to the specific areas of development indicated in tabular form and/or on the hazard maps included in the jurisdictional annexes in Volume II, Section 9 of this plan.

According to population projections from the State of New Jersey Department of Labor and Workforce Development, Essex County will experience an increase in population through 2034 (approximately 40,000 people between 2017 and 2034). An increase in population within Essex County could potentially lead to a higher likelihood of utility failure due to an increased demand on aging infrastructure. If utility infrastructure is not maintained and enhanced to accommodate for future demands, then there is a higher likelihood for more frequent utility interruptions. Increased frequency of utility interruptions will lead to an increased risk for socially vulnerable populations and also a heighted risk for structural and wildfire because of the current reliance of fire hydrants for fire suppression in Essex County.

Climate Change

Several implications for climate change are related to the power failure hazard. 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 in New Jersey: Trends and Projections describes changes in temperature, precipitation, and sea level rise. Each section of the report summarizes observed recent changes in climate in New Jersey. Observations are based on recorded climate data collected by the ONJSC and other institutions, and on other reports summarizing climate change in the northeastern United States. Each section also presents a synthesis of the most current projections for future climate changes based on climate science modeling and techniques. The projections reflect potential average climate over a span of future years (2020, 2050, and 2080). The projections in the report illustrate the potential climate changes that could impact the northeastern United States based on future emissions scenarios (A2, A1B, and B1 – high, medium, and low scenarios). Each emissions scenario would result in a range of potential climate outcomes in the State (Rutgers 2013).

Climatologists predict an increase in the number and intensity of severe weather events. More storms with higher winds will increase the chance that the power infrastructure will be impacted. Extreme temperatures are predicted to increase as well. During the hot summer months, the potential for power overload will increase as demand for power increases. Additionally, climatologists predict an increase in precipitation, which may lead to more winter weather thus causing additional power failures and utility interruptions.

Change of Vulnerability Since the 2015 HMP

Overall, the County's vulnerability has not changed, and the entire County will continue to be exposed and vulnerable to the utility interruption events.

4.4 HAZARD RANKING

2020 HMP Changes

- The 2020 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 'unlikely', and modifications to the remaining categories so that 'frequent' aligned with an event that has an annual probability.
- The following Countywide hazards of concern's ranking changed from 2015 to 2020:
  - Disease outbreak changed from a high (2015) to a medium (2020) because impacts to population was adjusted to a medium
  - Hazardous substances and transportation failure changed from a high (2015) to a medium (2020) because impacts to property and buildings is more often in an isolated geographic region

A comprehensive range of hazards that pose a significant risk to Essex 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 Essex 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

The methodology used to rank the hazards of concern for Essex County is described below. Estimates of risk for the County were developed using methodologies promoted by FEMA's hazard mitigation planning guidance, generated by FEMA's HAZUS-MH risk assessment tool, and input from Essex 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 the potential vulnerability 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 and each municipality.
- **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 'low' for adaptive capacity means the jurisdiction does not have the capability to effectively respond, which increases vulnerability; whereas 'high' 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 Essex 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 4.4.1 through 4.18. The benchmark values in the methodology are similar to confidence levels outlined in the National Climate Assessment 2017.

The relative hazard risk score was calculated for each hazard using the following formula. Table 4.4-1 summarizes the categories, benchmark values, and weights used to calculate the risk factor for each hazard.

Example Hazard Ranking Equation

Hazard Ranking = [Probability of Occurrence x .30] + [(Impact on Population x 3) + (Impact on Property x 2) + (Impact on Economy x 1) x .30] + [Adaptive Capacity x .30] + [Climate Change x .10]

Using the weighting applied, the highest possible risk factor value is 6.75. 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

<table>
<tr><th colspan="2">Category</th><th>Level / Category</th><th>Degree of Risk / Benchmark Value</th><th>Numeric Value</th><th>Weighted Value</th></tr>
<tr><td colspan="2" rowspan="4">Probability of Occurrence</td><td>Unlikely</td><td>A hazard event is not likely to occur or is unlikely to occur with less than a 1% annual chance probability.</td><td>0</td><td rowspan="4">30%</td></tr>
<tr><td>Rare</td><td>Between 1 and 10% annual probability of a hazard event occurring.</td><td>1</td></tr>
<tr><td>Occasional</td><td>Between 10 and 100% annual probability of a hazard event occurring.</td><td>2</td></tr>
<tr><td>Frequent</td><td>100% annual probability; a hazard event may occur multiple times per year.</td><td>3</td></tr>
<tr><td rowspan="9">Impact (Sum of all 3)</td><td rowspan="3">Population (Numeric Value x 3)</td><td>Low</td><td>14% or less of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.</td><td>1</td><td rowspan="9">30%</td></tr>
<tr><td>Medium</td><td>15% to 29% of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.</td><td>2</td></tr>
<tr><td>High</td><td>30% or more of your population is exposed to a hazard with potential for measurable life safety impact, due to its extent and location.</td><td>3</td></tr>
<tr><td rowspan="3">Property (Numeric Value x 2)</td><td>Low</td><td>Property exposure is 14% or less of the total number of structures for your community.</td><td>1</td></tr>
<tr><td>Medium</td><td>Property exposure is 15% to 29% of the total number of structures for your community.</td><td>2</td></tr>
<tr><td>High</td><td>Property exposure is 30% or more of the total number of structures for your community.</td><td>3</td></tr>
<tr><td rowspan="3">Economy (Numeric Value x 1)</td><td>Low</td><td>Loss estimate is 9% or less of the total replacement cost for your community.</td><td>1</td></tr>
<tr><td>Medium</td><td>Loss estimate is 10% to 19% of the total replacement cost for your community.</td><td>2</td></tr>
<tr><td>High</td><td>Loss estimate is 20% or more of the total replacement cost for your community.</td><td>3</td></tr>
<tr><td colspan="2" rowspan="3">Adaptive Capacity</td><td>Low</td><td>Weak/outdated/inconsistent plans, policies, codes/ordinances in place; no redundancies; limited to no deployable resources; limited capabilities to respond; long recovery.</td><td>3</td><td rowspan="3">30%</td></tr>
<tr><td>Medium</td><td>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.</td><td>2</td></tr>
<tr><td>High</td><td>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.</td><td>1</td></tr>
<tr><td colspan="2" rowspan="3">Climate Change</td><td>Low</td><td>No local data is available; modeling projections are uncertain on whether there is increased future risk; confidence level is low (inconclusive evidence).</td><td>1</td><td rowspan="3">10%</td></tr>
<tr><td>Medium</td><td>Studies and modeling projections indicate a potential for exacerbated conditions due to climate change; confidence level is medium to high (suggestive to moderate evidence).</td><td>2</td></tr>
<tr><td>High</td><td>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).</td><td>3</td></tr>
</table>

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 4.3.18 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	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Countywide Impacts			
		Population [d]	Buildings/Critical Facilities and Lifelines	Economy[a]	
Coastal Erosion and Sea Level Rise	Coastal Erosion: CEHA Sea Level Rise: NOAA +1ft and +3ft rise	Coastal Erosion: 270 people impacted +1ft Rise: 28 people displaced +3ft Rise: 251 people displaced	Coastal Erosion (# located in CEHA): ▪ 42 buildings ▪ 5 critical facilities ▪ 0 lifelines +1ft Rise (# lost): ▪ 8 buildings ▪ 5 critical facilities ▪ 0 lifelines +3ft Rise (# lost): ▪ 43 buildings ▪ 6 critical facilities ▪ 0 lifelines	Coastal Erosion ($ building RCV located in CEHA): ▪ $42.3 Million +1ft Rise (($ RCV lost): ▪ $18.7 Million +3ft Rise (($ RCV lost): ▪ $68.4 Million	High
Coastal Storm	100-year MRP (Tropical Storm-Category 1)	Entire County population exposed 14,885 residents located in Category 1 storm surge inundation area	2,192 buildings ($6.3 Billion RCV) located in Category 1 storm surge inundation area	$69 Million building RCV damage due to wind	High

Hazard	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Countywide Impacts			
		Population [d]	Buildings/Critical Facilities and Lifelines	Economy[a]	
Drought	Drought event	Entire County population exposed; impacts to health and safety of individuals are estimated to be minimal.	Critical facility functionality may be impacted (e.g., water source for fire services); overall impacts to structures are low.	Industries that rely on water for business could be impacted the most; 22 farms in County; Increased demand for water and electricity can result in shortages and higher costs for these resources.	Low
Earthquake	100-Year Mean Return Period Event	Entire population exposed 1 displaced household 122,291 residents located on earthquake-vulnerable soils	Located on Vulnerable Soils (NEHRP Soils D&E; high liquefaction susceptibility): ▪ $33.8 billion building RCV ▪ 220 critical facilities ▪ 73 lifelines	▪ $1.2 Million RCV building damages ▪ >1,000 tons of building debris ▪ $515,000 income loss	High
Extreme Temperature	Extreme temperature event (heat or cold)	Entire County population exposed; Vulnerable populations: elderly, youth, individuals with chronic medical conditions; low income	Critical facility functionality may be impacted if without backup power source	22 farms in County; 11 farm operators report farming as primary occupation	Low
Flood	100-Year Mean Return Period Event	32,128 residents living in the SFHA	Located in the SFHA: ▪ 6,481 buildings ▪ 82 critical facilities ▪ 24 lifelines	>$2 Billion in estimated RCV loss	High
Geological	High Landslide Susceptibility Areas	2,652 residents located in Class A and B susceptibility areas (<1% of population)	• 612 buildings located in Class A and B susceptibility areas • 2 critical facilities • 2 lifelines	$403 Million building RCV located in Class A and B susceptibility areas	Moderate
Severe Weather	Severe Weather Event	Entire population exposed	All buildings exposed	Event-dependent	Low
Severe Winter Weather	Severe Winter Weather Event	Entire population exposed	All buildings exposed	Event-dependent	Low
Wildfire	Wildfire Fuel Hazard areas (High, Very High, Extreme)	478 residents located in high, very high, and extreme wildfire hazard area (<1% of population)	• 122 buildings located in wildfire hazard area • 1 critical facility • 0 lifelines	$221 million building RCV located in wildfire hazard area	Moderate
Civil Disorder	Civil disorder event	The degree of impact to the population depends on the scale of the incident.	The degree asset impacts depend on the scale of the incident. Assets in the immediate vicinity will be impacted.	The degree of economic impact depends on the scale of the incident.	Low

Hazard	Category					Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Countywide Impacts				
		Population [d]	Buildings/Critical Facilities and Lifelines	Economy [a]		
		Population in the immediate vicinity will be impacted.				
Cyber Attack	Cyber-attack event	The degree of impact to the population depends on the scale of the incident.	Physical damages due to a cyber-attack may be limited; loss of utilities/communication would have Countywide impacts and could result in loss of emergency services.	The degree of economic impact depends on the scale of the incident. This can range but can be great depending upon the sector impacted.		Low
Disease Outbreak	West Nile Virus, Eastern Equine Encephalitis, St. Louis Encephalitis, La Crosse Encephalitis, Lyme Disease, Influenza, Ebola Virus	Entire population exposed; The degree of impact to the population depends on the scale of the incident	Loss of services; Potential temporary closure of ports of entry impacting import/export of goods and vital resources; Overcrowding of local medical clinics and hospitals depending on severity	Impacts to food supply and water supply; Costs of activities and programs implemented to address outbreaks and prevent spread.		Low
Economic Collapse	Recessions, Depressions, Interruption of normal economic conditions	The degree of impact to the population depends on the scale of the incident.	Physical damages due to economic collapse may be limited; structures and facilities that cannot afford the maintenance to remain open may become abandoned/rundown	The degree of damages depends on the scale of the incident. The hazard could cause massive impacts Countywide through loss of jobs, businesses, and tax revenue.		Low
Hazardous Substances [b]	Essex County (3rd largest port in the U.S.) Major highways/rail Pipelines 10 NPL Sites in County: • Fairfield: 2 • Glen Ridge: 1 (Deleted) • Montclair/West Orange: 1 (Deleted) • Newark: 4 • Orange: 1 • West Orange/ Orange: 1	Population impacted will depend on the type of material and scale of the incident. May include population within small radii of site.	The degree asset impacts depend on the scale of the incident. Assets in the immediate vicinity will be impacted.	The degree of economic impact depends on the scale of the incident.		Low
Utility Interruption	Disruption of power caused by accident, sabotage, natural hazards, or equipment failure.	The degree of impact to the population depends on the scale of the incident.	The degree of damages to asset depends on the scale of the incident; Physical impacts to structures may occur if utilities are keeping critical functions online (i.e. sump	The degree of economic impact depends on the scale of the incident.		Low

Hazard	Category				Certainty Factor
	Hazard Scenario/ Area Evaluated	Estimated Countywide Impacts			
		Population [d]	Buildings/Critical Facilities and Lifelines	Economy [a]	
			pumps); Loss of communication would impact emergency services.		
Terrorism	Terrorist Attack	The degree of impact to the population depends on the scale of the incident; Population in the immediate vicinity will be impacted.	The degree of physical damages depends on the scale of the incident. Assets in the immediate vicinity will be most impacted.	The degree of economic impact depends on the scale of the incident. This can range.	Low
Transportation Failure	Vehicular accidents, Aviation Accidents, Railway Accidents	The degree of impact to the population depends on the scale of the incident; Population in the immediate vicinity will be impacted.	The degree of physical damages depends on the scale of the incident. Assets in the immediate vicinity will be most impacted.	The degree of damages depends on the scale of the incident; Assets in the immediate vicinity will be most impacted.	Low

Notes:
Building values are based on structure replacement cost for sea level rise losses do not include land value.
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.

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.
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 4.2 to 4.18 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	
Coastal Erosion and Sea Level Rise	↑	↑	↑	Highly Likely
Coastal Storm	↑	↑	↑	Highly Likely
Drought	—	—	↑	Likely
Earthquake	—	—	—	Uncertain
Extreme Temperature	↑	↑	↑	Highly Likely
Flood	↑	↑	↑	Highly Likely
Geological Hazards	—	—	—	Uncertain
Severe Weather	↑	↑	↑	Highly Likely
Severe Winter Weather	—	↓	↓	Likely

Hazard	Projected Change			Confidence in Changing Future Conditions [a]
	Location	Extent/ Intensity	Frequency/ Duration	
Wildfire	↑	↑	↑	Likely
Civil Disorder	—	—	—	No Change
Cyber Attack	—	—	—	No Change
Disease Outbreak	—	↑	↑	Uncertain
Economic Collapse	—	—	—	No Change
Hazardous Substances	—	—	—	Uncertain
Utility Interruption	↑	↑	↑	Likely
Terrorism	—	—	—	No Change
Transportation Failure	↑	↑	↑	Likely

Notes:
Arrow direction indicates a projected increase or decrease based on literature review as described in Sections 4.3.1 through 4.3.18
— *Straight line indicates uncertain and/or no change known at this time.*

a Similar to confidence levels outlined in the National Climate Assessment 2017

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 hazard ranking was determined for each hazard of concern. The hazard ranking is detailed in the subsequent tables that present the step-wise process for the ranking. The countywide risk 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 hazards; and 4) to consider changing future conditions (i.e., climate change) in Essex County. As previously stated, estimates of risk for Essex County were developed using methodologies promoted by FEMA's hazard mitigation planning guidance, generated by FEMA's HAZUS-MH risk assessment tool and input from the County and participating municipalities. To estimate adaptive capacity, all municipalities were assigned a Medium, with the exception for the CRS-participating communities; they were assigned a high capacity for the flood hazard. During the review of the calculated hazard ranking at the September 2019 risk assessment meeting and at individual jurisdictional annex meetings, each municipality had the option to adjust the calculated rankings to incorporate perceived adaptive capacity of the community with respect to the relevant hazard.

Refer to Table 4.4-4 for the calculated hazard ranking for each hazards and associated category in the hazard ranking equation. Refer to Table 4.4-5 for the calculated hazard ranking for each municipality. Again, these tables represents the calculated hazard ranking using the results from the risk assessment. Therefore these results may not align with Table 4.4-6, the final Essex County hazard ranking, and the hazard ranking tables and final ranking results presented in each jurisdictional annex (Section 9).

Table 4.4-6. Calculated Ranking for Hazards of Concern for Essex County

Hazard of Concern	Probability		Impact										Adaptive Capacity	Climate Change
			Population			Property			Economy					
	Impact	Numeric Value	Impact	Numeric Value	Weighted Value (x3)	Impact	Numeric Value	Weighted Value (x2)	Impact	Numeric Value	Weighted Value (x1)	Total Impact Value)		
Coastal Erosion and Sea Level Rise	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 2	7	2	3
Coastal Storm	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 2	7	2	3
Drought	Occasional	2	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	2	3
Earthquake	Occasional	2	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	9	2	3
Extreme Temperature	Frequent	3	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	2
Flood	Frequent	3	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 2	7	2	3
Geological Hazards	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	3
Severe Weather	Frequent	3	High	3	3 x 3 = 9	High	3	3 x 2 = 6	Low	1	1 x 1 = 1	16	2	2
Severe Winter Weather	Frequent	3	High	3	3 x 3 = 9	High	3	3 x 2 = 6	Low	1	1 x 1 = 1	16	1	1
Wildfire	Frequent	3	Low	1	1 x 3 = 3	Medium	1	2 x 2 = 4	Low	1	1 x 1 = 1	6	2	3
Civil Disorder	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	1
Cyber Attack	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	1
Disease Outbreak	Frequent	3	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	1
Economic Collapse	Occasional	2	Medium	2	2 x 3 = 6	Low	1	1 x 2 = 2	Medium	2	2 x 1 = 1	10	2	1
Hazardous Substances	Frequent	3	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	1
Utility Interruption	Frequent	3	High	3	3 x 3 = 9	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	12	2	1
Terrorism	Occasional	2	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	1
Transportation Failure	Frequent	3	Low	1	1 x 3 = 3	Low	1	1 x 2 = 2	Low	1	1 x 1 = 1	6	2	1

Table 4.4-7. Calculated Hazard Ranking for each Municipality

Essex County Municipality	Hazard Ranking																	
	Coastal Erosion/SLR	Coastal Storm	Drought	Earthquake	Ext. Temp	Flood	Geologic	Severe Weather	Severe Winter Weather	Wildfire	Civil Disorder	Cyber Attack	Disease Outbreak	Economic Collapse	Hazardous Substance	Utility	Terrorism	Transportation Failure
Township of Belleville	L	M	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Bloomfield	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Borough of Caldwell	L	L	M	H	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Cedar Grove	L	L	M	M	M	L	L	H	H	L	L	L	L	M	L	H	L	L
City of East Orange	L	L	M	L	H	L	L	H	H	L	L	L	L	M	L	H	L	L
Borough of Essex Fells	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Fairfield	L	L	M	H	M	H	L	H	H	L	L	L	L	M	L	H	L	L
Borough of Glen Ridge	L	L	M	L	L	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Irvington	L	L	M	L	H	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Livingston	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Maplewood	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Millburn	L	L	M	M	L	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Montclair	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
City of Newark	L	H	M	M	H	M	L	H	H	L	L	L	L	M	L	H	L	L
Borough of North Caldwell	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Nutley	L	M	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
City of Orange Township	L	L	M	L	H	L	L	H	H	L	L	L	L	M	L	H	L	L
Borough of Roseland	L	L	M	M	M	L	L	H	H	L	L	L	L	M	L	H	L	L

Essex County Municipality	Hazard Ranking																	
	Coastal Erosion/SLR	Coastal Storm	Drought	Earthquake	Ext. Temp	Flood	Geologic	Severe Weather	Severe Winter Weather	Wildfire	Civil Disorder	Cyber Attack	Disease Outbreak	Economic Collapse	Hazardous Substance	Utility	Terrorism	Transportation Failure
Township of South Orange Village	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of Verona	L	L	M	M	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of West Caldwell	L	L	M	H	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Township of West Orange	L	L	M	L	M	L	L	H	H	L	L	L	L	M	L	H	L	L
Essex County	L	L	M	M	M	M	L	H	H	L	M	M	M	M	M	H	L	M

L = Low; M = Medium; H = H.

Only Nutley, Belleville and Newark are impacted by coastal waters and may experience erosion of land; however, all municipalities indicated a low.

This table represents the calculated hazard ranking using the results from the risk assessment. Therefore, these results may not align with Table 4.4-6 and the hazard ranking tables in each jurisdictional annex.

Table 4.4-6 presents the total calculations for each hazard ranking value for the hazards of concern. The rankings were categorized and assigned a color as follows: Low = Values less than or equal to 3.8 (green); Medium = Values between 3.9 and 4.9 (yellow); H = Values greater than or equal to 5.0 (red). This hazard ranking reflects any adjustments made by the Planning Partnership at the September 2019 risk assessment meeting. At this meeting, the County's calculated hazard ranking for wildfire was low and changed to a medium; the County's calculated hazard ranking for terrorism was low and changed to a H.

Table 4.4-8. Total Hazard Ranking Values for the Hazards of Concern for Essex County

Hazard of Concern	Probability x 30%	Total Impact x 30%	Adaptive Capacity x 30%	Changing Future Conditions x 10%	Total Hazard Ranking Value
Coastal Erosion and Sea Level Rise	0.6	2.1	0.6	0.3	**3.6**
Coastal Storm	0.6	2.1	0.6	0.3	**3.6**
Drought	0.6	2.7	0.6	0.3	**4.2**
Earthquake	0.6	2.7	0.6	0.3	**4.2**
Extreme Temperature	0.9	1.8	0.6	0.2	**4.4**
Flood	0.9	2.1	0.6	0.3	**3.9**
Geological Hazards	0.6	1.8	0.6	0.3	**3.3**
Severe Weather	0.9	4.8	0.6	0.2	**6.5**
Severe Winter Weather	0.9	4.8	0.3	0.2	**6.2**
Wildfire	0.9	2.4t	0.6	0.3	**4.2**
Civil Disorder	0.6	2.7	0.6	0.1	**4.0**
Cyber Attack	0.6	2.7	0.6	0.1	**4.0**
Disease Outbreak	0.9	2.7	0.6	0.1	**4.3**
Economic Collapse	0.6	3	0.6	0.1	**4.3**
Hazardous Substances	0.9	2.7	0.6	0.1	**4.3**
Utility Interruption	0.9	3.6	0.6	0.1	**5.2**
Terrorism	0.6	2.1	0.6	0.1	**5.2**
Transportation Failure	0.9	2.7	0.6	0.1	**4.3**

Low = Values less than or equal to 3.8; Medium = Values between 3.9 and 4.9; H = 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 H hazard and is addressed in the County mitigation strategy accordingly. Jurisdictional ranking results are presented in each local annex in Section 9 (Jurisdictional Annexes) of this plan.

During the review of the calculated hazard ranking at the September 2019 risk assessment meeting and at individual jurisdictional annex meetings, each municipality had the option to adjust the calculated rankings to incorporate perceived adaptive capacity of the community with respect to the relevant hazard; as well as change the overall hazard ranking to more accurately reflect risk in the community. Therefore, municipal hazard rankings presented in Section 9 (Jurisdictional Annexes) may not align with the calculate hazard ranking presented in Table 4.4-9.

SECTION 5. CAPABILITY ASSESSMENT

2020 HMP Changes

- The sections in the 2020 have been realigned to increase the readability of the plan. In the 2015 HMP, the capability assessment section was presented in Section 6 as part of the mitigation strategy. For the 2020 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 in 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, Essex 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 Essex 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 Essex County.

To complete the capability assessment, the contracted consultant met with Essex County and each municipality one-on-one to review the capability assessment from the 2015 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 Essex 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 Essex County.

5.2.1 Planning and Regulatory Capabilities – Federal and State

Table 5-1. Planning and Regulatory Capabilities – Federal and State

Capability		
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 4.3.6 (Flood) provides information on recent legislation related to reforms to the NFIP. All municipalities in Essex County actively participate in the NFIP. As of September 30, 2018, there were 4,221 NFIP policies in Essex County. There have been 4,752 claims made, totaling over $110.3 million for damages to

Capability		
		structures and contents. There are 450 NFIP Repetitive Loss properties and 62 Severe Repetitive Loss properties in the county.
	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. As of April 2019, the Township of Fairfield (Class 6is actively participating in the CRS program. The Townships of Belleville and Montclair are Class 10 however their status is rescinded. Other communities in Essex County noted they explored the possibility of participating.
	Responsible Agency:	FEMA
	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 Essex County to promote mitigation. The State of New Jersey HMP was used as a resource in developing Essex 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

Capability		
		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. The County of Essex established a County Recreation and Open Space Trust Fund (Ord No. O-2007-00032) pursuant to P.L. 1997, Chapter 24, which shall be funded through the collection of property tac at a rate not to exceed $0.015 per $100 of total County equalized real property valuation. (N.J.S.A. 40:12-15.1 et seq.
	Responsible Agency:	NJDEP, Essex County Open Space Trust Fund Advisory Board
	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 Essex County Open Space Trust Fund can be used to acquire land and to maintain the properties.
	Hazard:	Coastal Storm, 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

5.2.2 Planning and Regulatory Capabilities – County and Local

Table 5-2 summarizes the planning and regulatory capabilities of Essex County and its municipalities. Detailed information regarding these capabilities can be found in each jurisdictional annex found in Volume II, Section 9 (Jurisdictional Annexes).

Table 5-2. Planning and Regulatory Capabilities – County and Local

Municipality	Master Plan	Capital Improvement Plan	Disaster Debris Management Plan	Floodplain or Watershed Plan	Stormwater Management Plan	Stormwater Pollution Prevention Plan	Urban Water Management Plan	Habitat Conservation Plan	Economic Development Plan	Shoreline Management Plan	Community Wildfire Protection Plan	Community Forest Management Plan	Transportation Plan	Agriculture Plan	Climate Action Plan	Tourism Plan	Business Development Plan	Comprehensive Emergency Management Plan	Threat & Hazard Identification & Risk Assessment	Post-Disaster Recovery Plan	Continuity of Operations Plan	Public Health Plan	Other
Essex County	-	X	X	-	-	-	-	-	-	-	-	-	X	-	X	-	-	X	-	-	X	X	X
Belleville	X	X	X	-	X	X	-	-	X	-	-	-	-	-	-	-	-	X	-	X	X	X	-
Bloomfield	X	X	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	X	X	-	-
Caldwell	X	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	-
Cedar Grove	X	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-	X	-	-	-	-	-
East Orange	X	-	X	-	-	X	-	-	-	-	-	-	X	-	X	-	X	X	X	-	X	X	
Essex Fells	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	-	X
Fairfield	X	X	-	X	X	X	-	-	-	-	-	-	-	-	-	-	-	X	X	X	X	X	-
Glen Ridge	X	X	X	-	X	X	-	-	X	-	-	X	X	-	-	-	-	X	-	X	X	-	-
Irvington	X	X	-	X	X	X	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	-	-
Livingston	X	X	-	-	X	X	-	-	-	-	-	X	X	-	-	-	-	X	-	-	X	X	X
Maplewood	X	X	X	-	X	X	-	-	X	-	-	-	-	-	-	-	X	X	-	-	-	-	X
Millburn	X	X	-	-	X	X	-	-	-	-	X	X	X	-	-	-	-	X	-	X	-	-	X
Montclair	X	X	X	-	X	X	-	X	-	-	-	-	X	-	-	-	-	X	-	-	-	-	X
Newark	X	X	-	-	X	-	-	-	X	-	-	-	-	-	X	-	-	X	-	X	X	-	X
North Caldwell	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-	-	X	X	-	-	-	-	X
Nutley	X	X	X	-	X	X	-	X	X	-	-	X	X		X		X	X	-	X	X	X	X
Orange	X	X	-	-	X	-	-	-	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-
Roseland	X	X	X	-	X	X	-	-	X	-	-	-	-	-	-	-	-	X	-	-	-	X	-
South Orange	X	-	-	X	X	X	-	-	X	-	-	X	-	-	-	-	-	X	-	-	-	X	X
Verona	X	X	-	-	X	X	-	-	-	-	-	-	X	-	-	-	-	X	-	-	X	-	-
West Caldwell	X	X	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-	X	X
West Orange	X	X	-	-	X	X	-	-	-	-	-	X	X	-	-	-	-	X	-	-	-	-	X

Notes:

X Jurisdiction currently has this capability in place

- No capability in place

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 Essex County.

5.3.1 Administrative and Technical Capability – Federal and State

Table 5-3. 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 (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

Capability		
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, Coastal Storms
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
	Hazard:	Flood, Severe Weather, Coastal Storms
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

Capability		
		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 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:	Flood, Coastal Storm, Severe Weather

5.3.2 Administrative and Technical Capability – County and Local

Table 5-4 summarizes the administrative and technical capabilities in Essex 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 5-4. Administrative and Technical Capability – County and Local

Capability		
Office of Emergency Management	**Description:**	The Essex County Sheriff's Office – Office of Emergency Management (ECSO OEM) works closely with all Essex County municipalities, all public safety disciplines and critical private/public sector entities to engage in comprehensive disaster planning for Essex County. In addition to serving as a liaison to local, county, state and federal agencies, the ECSO OEM also serves as a liaison to utility companies and private sector companies within our region. These partners are key players who help support response and recovery efforts during emergencies. ESCO OEM is leading the 2020 Essex County HMP update and hosting information about the HMP on their website (https://www.essexsheriff.com/oem-category/2020-mid-plan-update/), including links to the citizen survey and informational brochure.
	Responsible Agency:	Essex County Sheriff's Office
	Provides Funding for Mitigation:	No
	Hazard:	All
Essex County Department of Public Works	**Description:**	The Essex County Department of Public Works (the Department) maintains public infrastructure, and ensures a healthy, safe and natural environment. They are committed to providing efficient and effective high-quality customer service to the citizens and visitors of Essex County. Public Works Crews are always at work building and maintaining County infrastructure, ensuring wastewater and stormwater systems are fully operational, and ensuring roads are safe. The Department consists of six divisions responsible for a variety of activities. These range from the construction and maintenance of roads and highways in the unincorporated areas of the county, to the management of the region's public facilities. • Division of Engineering • Division of Planning • Division of Buildings & Grounds • Division of Roads & Bridges • Division of Fleet Management • Division of Environmental Affairs The Department o supported the update of the 2020 Essex County HMP and sat on the Steering Committee for the planning process.
	Responsible Agency:	Essex County Department of Public Works
	Provides Funding for Mitigation:	The Capital Improvements Plan is updated each year by the Engineering Division and the Department. This includes mitigation-related projects such as county roadway improvements, drainage improvements on county roads, and various studies for county-owned structures and facilities. The County also includes projects that will assist with making the County more resilient to future storms.
	Hazard:	All
Division of Planning	**Description:**	The Division of Planning operates under the auspices of the Department. Functions include responsibility for long-range planning relating to development and conservation of land and resources in the County. This includes studies pertaining to the census, safety, land use, traffic, storm water, and transportation facilities. The Division of Planning includes the operations of the Essex County Planning Board, Essex County Construction Board of Appeals, and the Essex County Transportation Advisory Board.

Capability		
		The Division of Planning supported the update of the 2020 Essex County HMP and sat on the Steering Committee for the planning process.
	Responsible Agency:	Essex County Department of Public Works
	Provides Funding for Mitigation:	No
	Hazard:	All
Essex County Health Department	**Description:**	The Health Department services all of Essex County's 22 municipalities in the areas of solid waste enforcement. The Health Department is the County Environmental Health Act (CEHA) agency overseeing Essex Regional Health Commission for noise, air, pesticide, and odor. The Health Department strives to be an impactful, visible and valuable environmental health education resource for all of Essex County. The Health Department supported the updated of the 2020 Essex County HMP and provided information to incorporate into the various sections of the plan.
	Responsible Agency:	Health and Rehabilitation
	Provides Funding for Mitigation:	No
	Hazard:	All
Essex Regional Health Commission	**Description:**	The Essex Regional Health Commission (the Commission) was established in 1967 as the Suburban Municipal Air Pollution Commission for the sole purpose of air pollution control. The Commission was and still is a consortium of municipalities which together formed a regional health commission. Through a joint agreement with member municipalities, it is an exemplary model of shared services, offering cost efficient, regional programs working in close coordination with local health departments of Essex County. From each of the thirteen currently participating municipalities, an appointed Commissioner serves on the governing body. The Commission is also a subcontractor to the Essex County Health Department, established for the purposes of meeting the standards of the County Environmental Health Act. The Essex County Department of Health is the certified lead agency for the provision of environmental services within Essex County under the auspices of the County Environmental Health Act. The Commission currently provides the County programs for air, noise, water pollution, pesticides, and various pilot programs in all twenty two municipalities in Essex County. The Commission supported the update of the 2020 Essex County HMP and sat on the Steering Committee for the planning process.
	Responsible Agency:	Essex County Health Department
	Provides Funding for Mitigation:	No
	Hazard:	All
Essex County Transportation Advisory Board	**Description:**	The Essex County Transportation Advisory Board works with and advises the Division of Planning and serves as the principal non-staff advisor and commenter concerning the goals, policies, plans and direction of transportation planning in Essex County. The goal of the Board is to contribute to the improved effectiveness and efficiency of the Essex County transportation system through a participatory public forum which discuses and resolves transportation problems in Essex County.
	Responsible Agency:	Essex County Division of Planning
	Provides Funding for Mitigation:	No
	Hazard:	All
Essex County Environmental Commission	**Description:**	The Essex County Environmental Commission provides advice, outreach and education to the office of the Essex County Executive, Board of Chosen Freeholders and the municipal Environmental Commissions in order to protect, restore and renew Essex County's natural resources and to increase environmental awareness, ensuring that all Essex County citizens can enjoy a healthy environment and an enhanced quality of life within a sustainable regional community. The Essex County

Capability		
		Environmental Commission is supported through the Essex County Department of Parks, Recreation, and Cultural Affairs.
	Responsible Agency:	Essex County Department of Public Works
	Provides Funding for Mitigation:	No
	Hazard:	All
Hudson Essex Passaic Soil Conservation District	**Description:**	The Hudson Essex Passaic Soil Conservation District, serving three counties, is a special purpose subdivision of the State of New Jersey Dept of Ag: Division of Ag & Natural Resources. HEPSCD is one of 15 soil conservation districts in New Jersey empowered to conserve and manage soil and water resources in cooperation with the State Soil Conservation Committee. The District addresses stormwater, soil erosion and sedimentation issues that result from land disturbance activities (primarily construction). District certification of plans for qualifying projects is a prerequisite to local construction permits. The mission of the New Jersey Conservation Partnership is to provide leadership in the planning and implementation of natural resource management programs for the agricultural and development communities and the general public through a locally based delivery system in coordination with local, state and federal partners.
	Responsible Agency:	State of New Jersey Dept of Agriculture
	Provides Funding for Mitigation:	No
	Hazard:	All
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:	Essex County Environmental Commission
	Provides Funding for Mitigation:	No
	Hazard:	All
Sustainable Essex Alliance (SEA)	**Description:**	Regional hubs have formed across New Jersey and are comprised of municipal and schools green team and environmental commission members, municipal and county representatives, and business, community and nonprofit leaders. The hub in Essex County is called the Sustainable Essex Alliance (SEA) is a coalition of local municipal green teams and sustainability organizations working together to create solutions for local environments and economies. The Alliance is currently pursuing a renewable community energy aggregation program to provide residents of Essex County with the option of 100% green energy. The Alliance has also initiated the NJ Home Performance with ENERGYSTAR™ Program and Comfort Partners Program that offer rebates and financing for energy efficiency upgrades, insulation, and helpful assessments to reduce bills and environmental impact. Participating communities include: Belleville, Bloomfield, Caldwell, Cedar Grove, East Orange, Essex Fells, Fairfield, Glen Ridge, Irvington, Livingston, Maplewood, Millburn, Montclair, Newark, North Caldwell, Nutley, Orange, Roseland, South Orange, Verona, West Caldwell, and West Orange.
	Responsible Agency:	Sustainable Jersey
	Provides Funding for Mitigation:	No
	Hazard:	All

Capability		
County and Municipal Emergency Management Coordinators	**Description:**	According to NJSA Appendix A:9-33 et seq. (Chapter 251 P.L. 1942, as amended by Chapter 438, P.L. 1953) each municipality appoints a Municipal Emergency Management, serving a term of three years, and is responsible for planning, activating, coordinating and conducting emergency management operations within the municipality. The County holds regular meetings and Coordinators attend training/exercises. For example the UASCI region provided funding to Kean University Fire Safety to provide training on the utilization of tenders in community. Several Essex County municipalities attended including: Belleville, Cedar Grove, Montclair and North Caldwell https://www.keanfiresafety.com/uasi/
	Responsible Agency:	Municipalities
	Provides Funding for Mitigation:	No
	Hazard:	All

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 5-5. 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/hazard-mitigation-grant-program Essex 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

Capability		
		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/flood-mitigation-assistance-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather, Coastal Storms
Pre-Disaster Mitigation Program	**Description:**	The PDM program is an annually funded, nationwide, competitive grant program. No disaster declaration is required. Federal funds will cover 75 percent of a project's cost up to $3 million. As with the HMGP and FMA, a FEMA-approved local HMP is required to be approved for funding under the PDM program. The PDM program is detailed on the FEMA website: https://www.fema.gov/pre-disaster-mitigation-grant-program. Essex County used the PDM program to fund this 2020 HMP update.
	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 2019, the total amount of funds available under HSGP was $1.095 billion.

Capability		
		HSGP is comprised of three interconnected grant programs including the State Homeland Security Program, Urban Areas Security Initiative (UASI), and the Operation Stonegarden. Together, these grant programs fund a range of preparedness activities, including planning, organization, equipment purchase, training, exercises, and management and administration. Essex County is part of the Jersey City/Newark UASI region. The UASI program provides funding to address the unique multi-discipline planning, operations, equipment, and training and exercise needs of high-threat, high-density urban areas and to assist in building and sustaining capabilities related to terrorism prevention, protection, mitigation, response, and recovery. Additional information regarding HSGP is available on the website: https://www.fema.gov/homeland-security-grant-program.
	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/fire-management-assistance-grant-program.
	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/welcome-assistance-firefighters-grant-program.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	-
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.grants.gov/web/grants/view-opportunity.html?oppId=316238.
	Responsible Agency:	FEMA
	Provides Funding for Mitigation:	Yes
	Hazard:	Dam Failure
Small Business Administration Loan	**Description:**	The Small Business Administration (SBA) provides low-interest disaster loans to homeowners, renters, business of all sizes, and most private nonprofit organizations. 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.

Capability		
		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/.
	Responsible Agency:	HUD
	Provides Funding for Mitigation:	Yes
	Hazard:	All
Federal Highway Administration-Emergency Relief	**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://www.fhwa.dot.gov/programadmin/erelief.cfm.
	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. Currently, a total of $5.2 billion has been allocated to New Jersey-related entities. 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).

Capability		
		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/program_offices/comm_planning/affordablehousing/programs/home/.
	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	**Description:**	Investing in critical road, rail, transit and port projects across the nation.

Capability		
Generating Economic Recovery (TIGER)		Information on this program is available on the website: https://www.transportation.gov/tags/tiger-grants.
	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:	-
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/emergency-management-performance-grant-program
	Responsible Agency:	U.S. DHS
	Provides Funding for Mitigation:	Yes
	Hazard:	All

Capability		
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:	-
~~Land and Water Conservation Fund~~	~~**Description:**~~	~~Funding to states, local and conservation organizations for outdoor recreational development, renovation, land acquisition, and planning.~~ ~~Information on this program is available on the website:~~
	~~**Responsible Agency:**~~	~~U.S. Department of the Interior~~
	~~**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. 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

Capability		
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. Not only are state Green Acres funding available, but Essex County enacted its own county green acres tax to provide funding for the state program match, as well as for other recreation and open space programs (see below). Essex County has used the Green Acres Program to acquire open space, with a majority of land being municipal- or county-owned. Green Acres open space exists in: Belleville, Bloomfield, Caldwell, Cedar Grove, East Orange, Essex Fells, Fairfield, Glen Ridge, Irvington, Livingston, Maplewood, South Orange, Millburn, Montclair, Newark, North Caldwell, Nutley, Orange, Roseland, South Orange, Verona, West Caldwell, and West Orange.
	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, Passaic 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. The Blue Acres Program is active in 16 municipalities currently, including Newark in Essex County.
	Responsible Agency:	NJDEP
	Provides Funding for Mitigation:	Yes
	Hazard:	Flood, Severe Weather, Coastal Storm
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 Community Affairs	**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 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.

Capability		
	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 **p**rovide 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
	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

Capability		
	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:	-
Local		
Transportation Alternatives Set Aside Program	**Description:**	Funded through the FHWA's Federal Aid Program and administered by the New Jersey DOT, in partnership with the North Jersey Transportation Planning Authority, Transportation Alternatives Set Aside Program (TAP) provides federal funds for community based "non-traditional" projects designed to strengthen the cultural, aesthetic, and environmental aspects of the nation's intermodal system. TAP was established by Congress in 2012 under MAP-21 and is funded through a set-aside of the Federal-aid Highway Program.
	Responsible Agency:	Essex County Division of Planning
	Provides Funding for Mitigation:	No
	Hazard:	Flood
Essex County Recreation and Open Space Trust Fund	**Description:**	Recreation and Open Space Trust Fund shall be used for any or all of the following purposes or any combination thereof as determined by the governing body: A. Acquisition of lands for recreation and conservation purposes. B. Development of lands acquired for recreation and conservation purposes. C. Maintenance of lands acquired for recreation and conservation purposes. D. Acquisition of farmland for farmland preservation purposes. E. Historic preservation of historic properties, structures, facilities, sites, areas or objects, and the acquisition of such properties, structures, facilities, sites, areas or objects for historic preservation purposes. F. Payment of debt service on indebtedness issued or incurred by the County of Essex for any of the above purposes, except for Subsection C above.
	Responsible Agency:	Essex County Recreation and Open Space Trust Fund Advisory Board
	Provides Funding for Mitigation:	No
	Hazard:	All

5.5 PLAN INTEGRATION

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 Essex 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, 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.

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 Essex County will reduce or eliminate potential losses from the natural and non-natural hazards identified in Section 4.2 (Hazard Identification) of this HMP. The mitigation strategy focuses on existing and potential future mitigation actions to alleviate the effects of hazards on Essex County's population, economy, environment and general building stock.

The Steering Committee reviewed the results of the risk assessment and capability assessment to identify and develop mitigation actions, which are presented herein. This section includes:

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.

2020 HMP Changes

- The mission statement, goals and objectives were updated to align with County and municipal 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.
- Three stakeholder focus-group sessions were held to obtain a comprehensive understanding of capabilities and problem areas to inform the updated mitigation strategy.

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. Essex 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 actions and projects include the following:

- Essex County facilitated the development of the 2015 Essex County HMP. The current planning process represents the regulatory five-year plan update process, which includes participation of the count and 22 jurisdictions in the county, along with key county and regional stakeholders.
- All jurisdictions participating in the HMP update participate in the NFIP, which requires the adoption of FEMA floodplain mapping and certain minimum standards for building within the floodplain.
- Reports, plans, and studies relating to or including information on natural hazards or natural hazard policies affecting Essex County have been reviewed and incorporated into this plan update as appropriate, as discussed in Section 2 (Planning Process), Section 5 (Capability Assessment), Section 9 (Jurisdictional Annexes) and References.
- Essex County and its municipalities continue to apply for FEMA grant funding for mitigation projects in the County. This includes:
    - Purchase and install photovoltaic power generation system at the Department of Public Works (DPW) headquarters located at 900 Bloomfield Avenue in Verona

  - Purchasing generators for critical facilities – DPW building at 900 Bloomfield Avenue in Verona, Essex County Patrol Division Headquarters in Newark, DPW fleet headquarters in Cedar Grove, and Roads/Bridges Headquarters in Cedar Grove.
- Essex County DPW continues to rehabilitate bridges that require structural work. Center Street Bridge in Nutley and Lyons Ave. Bridge in Irvington have been completed. The County has funds to complete Hoover Ave. bridge in Bloomfield, Cherry Hill bridge in Millburn, and Dougall Street bridge in West Caldwell.
- The County is working on improving drainage systems and upgrading culverts of County-owned roadways throughout the County. This includes enlarging the drainage system on Bloomfield Ave. in Verona which is an evacuation route for the County and stream culvert work in residential areas in the Eagle Rock Reservation area (Afterglow Road, Ravine Road, and Cole Road).
- Essex County provides continued education, training and exercise opportunities to first responders and other local officials regarding floodplain management, natural and human-caused hazards and the Community Rating System.
- Essex County Strategic Recovery Planning Report (SRPR) (August 27, 2014): This plan was prepared as part of the New Jersey Department of Community Affairs' Post Sandy Planning Assistance Grant Program. The plan provided a recommendation of projects, categorized as hazard mitigation or preparedness. Since the plan was adopted, the County has worked on addressing the recommendations of the plan including the following. The County continues to work through the recommendations of the SRPR.
  - Preparing to update the current Essex County Master Plan (Essex County Transportation Plan)
  - Reviewing and updating zoning and land use regulations, as appropriate. While zoning is controlled by the local government, the County still provides input in what should be included.
- Passaic River Basin Climate Resilience Planning Study (June 27, 2019): The North Jersey Transportation Planning Authority (NJTPA) developed this study to evaluate the vulnerability of the Passaic River Basin transportation assets to climate change events and identify adaptation strategies for agencies and municipalities to integrate resiliency into their transportation networks. The study area included Essex County. Adaptation strategies were identified for highly vulnerable and critical transportation assets in the County. Many of the recommended strategies identified are already being done or in the progress of being implemented in Essex County. This includes: increasing capacity of stormwater infrastructure and drainage systems, installing energy system back-ups (e.g. generators and solar panels), incorporating redundant power and communication lines and systems, implementing green infrastructure (e.g. tree planting), conducting routine maintenance of culverts and storm sewers (county and municipal level), incorporate floodproofing were appropriate at critical facilities, and conducting maintenance on flood-impacted infrastructure.

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 Focus Group Sessions
- Section 6.5 – Review and update the mission statement, 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 and Planning Committees participated in a facilitated SWOO session to identify strengths, weakness or challenges, obstacles and opportunities in hazard mitigation for the County's high-ranked hazards. Each of these hazards was discussed during the September 2019 session and each jurisdiction was asked to complete a SWOO worksheet to document strengths, weaknesses, obstacles and opportunities relevant to their jurisdiction for their high-ranked hazards. SWOO results were recorded to assist with the update to the County's mitigation strategy. The discussion of each hazard began with identifying County, municipal 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 meeting attendees were asked to identify potential opportunities for enhanced mitigation. The following summarizes the five general categories of potential opportunities identified during the session. Refer to Appendix B (Participation Documentation) which provides the information captured for each hazard during the SWOO session.

- Address challenges with financial resources
- Address challenges with staffing resources (both employed or contracted, and volunteer)
- Increase public awareness
- Increase and enhance local capabilities
- Reduce vulnerability

6.4 STAKEHOLDER FOCUS GROUP SESSIONS

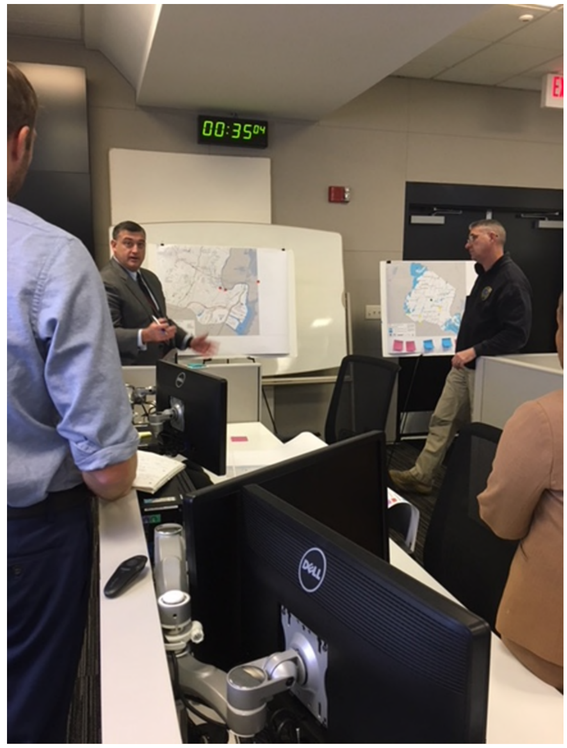


Exhibit 6-1. Map Exercise with Focus Group Session Participants

As discussed in Section 2 (Planning Process), the County hosted three stakeholder focus-group sessions to gather input from invited stakeholders, along with the Steering and Planning Committee members. These included 1) Utilities (water and wastewater); 2) Multi-modal Transportation; and 3) Green Infrastructure/Climate Change. The goal of each workshop was to identify the following for each sector:

- Capabilities Essex County has that contributes to the reduction of risk such as plans, ordinances, administrations, and projects;
- Problem areas that represent vulnerabilities/gaps/challenges within the County; and
- Potential actions or projects that could be undertaken to increase the County's resilience and decrease the County's risk to future hazard events.

In addition, sector-specific surveys were distributed to a larger audience to gather a comprehensive knowledge-base of capabilities, problems and potential mitigation actions. Information gathered during these sessions was shared with all plan participants and used to inform the updated mitigation strategy development. Refer to Appendix C (Meeting Documentation) for a complete listing of focus-group attendees and meeting notes.

6.5 REVIEW AND UPDATE OF MISSION STATEMENT, 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.

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.

6.5.1 Mission Statement

Per FEMA guidance (386-1), a mission statement or guiding principle describes the overall duty and purpose of the planning process, and serves to identify the principle message of the plan. It focuses or constrains the range of goals and objectives identified. This is not a goal because it does not describe outcomes. Essex County's mission statement is broad in scope, and provides a direction for the HMP.

The 2015 HMP mitigation strategy, inclusive of the 2015-identified mission statement was first examined at the July 2019 Steering Committee and Planning Committee kickoff meeting. During the 2020 HMP update planning process, the Steering and Planning Committees were provided the opportunity to comment on the mission statement as well as the goals, objectives and provide a status update on the mitigation actions. In October 2019, the Steering Committee reviewed the mission statement and enhanced it to include resilience. The revised mission statement was presented to and approved by the Planning Committee. The 2020 HMP mission statement is as follows:

Through strategic planning, partnerships and collaboration, identify and reduce the vulnerability and increase the resiliency to the current and future effects of natural and human caused hazards in order to protect the health, safety, quality of life, environment, and economy of all people and all communities within Essex County.

6.5.2 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.

As previously noted, the Steering and Planning Committees first examined the goals and objectives at the July 2019 kickoff meeting and were provided the opportunity to comment. In October 2019, the Steering Committee updated the 2015 goals and objectives based on the risk assessment results, discussions, research, and input from amongst the Steering Committee, goals and objectives in the State of New Jersey 2019 HMP, existing authorities, polices, programs, resources, stakeholders and the public. The updated goals and objectives were presented to the Planning Committee for review and were approved at the October 24, 2019 Mitigation Strategy Workshop. For the purposes of this plan, goals and objectives are defined as follows:

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 municipalities 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 2020 update were amended, as presented in Table 6-1. *Italicized* text indicates the updates made to the goals and objectives. Appendix F presents the 2015 mission statement, goals and objectives and the evaluation feedback from the Steering Committee.

Table 6-1. Essex County Hazard Mitigation Plan Goals and Objectives

Goals	Objectives
Goal 1: Protect Life	Objective 1.1: Improve warning and emergency communication systems
	Objective 1.2: Reduce the impacts of hazards on people, property, and vulnerable populations
	Objective 1.3: Integrate the hazard mitigation plan into existing county and local planning, building, codes, ordinances, and enforcement.
Goal 2: Protect Property	*Objective 2.1: Protect and increase resilience of critical facilities and lifelines to reduce disruption of essential activities during and after a hazard event.*
	Objective 2.2: Reduce repetitive and severe repetitive losses
	Objective 2.3: Protect environmental resources that serve a natural hazard mitigation function
	Objective 2.4: Encourage cost-effective and environmentally-sound development and land use by incorporating green infrastructure
Goal 3: Increase public preparedness and awareness	*Objective 3.1: Enhance and implement public education and outreach programs to increase awareness of hazard risks*
	Objective 3.2: Improve hazard information databases and maps and increase accessibility to those resources
	Objective 3.3: Provide stakeholder training on mitigation and resilience-related topics to support the identification and implementation of projects and access to funding
	NEW Objective 3.4: Improve education of public officials, stakeholders, and the general public regarding the impacts of future conditions, sea level rise, and climate change on people, property, transportation assets, and the economy.
Goal 4: Increase the understanding and awareness of risks from hazards	Objective 4.1: Review and incorporate updated hazard data into the County Hazard Mitigation Plan and other county and local planning mechanisms
	Objective 4.2: Increase support for the development of local mitigation planning and projects
	Objective 4.3: Incorporate new State and FEMA guidance, rules and regulations into the Plan
	NEW Objective 4.4: Strengthen understanding of, and adaptation to, a changing climate
Goal 5: Enhance County and local mitigation capabilities to reduce hazard vulnerabilities	*Objective 5.1: Implement and monitor the progress of on-going mitigation activities within the county*
	Objective 5.2: Encourage and support additional related training and education of public officials
	Objective 5.3: Encourage the formation of partnerships to leverage and share mitigation resources
	Objective 5.4: Integrate the County Hazard Mitigation Plan with other County, regional and local planning initiatives

Goals	Objectives
Goal 6: Support continuity of operations pre-, during and post- hazard events	*Objective 6.1: Ensure continuity of operations of essential county government services through training, planning and implementation of mitigation strategies*
	Objective 6.2: Increase resiliency by facilitating rapid disaster recovery ensuring that post-disaster efforts incorporate mitigation and adaptation strategies to minimize future losses.
	Objective 6.3: Support and encourage the implementation of alternative and sustainable energy sources

6.6 MITIGATION STRATEGY DEVELOPMENT AND UPDATE

6.6.1 Review of 2015 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 2015 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.

Beginning in June 2019, even prior to the official kickoff meeting due to the accelerated schedule, the planning consultant worked directly with each jurisdiction (phone, email, local support meetings) 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).

At the July 2019 kickoff meeting and during subsequent local-level planning meetings, all participating jurisdictions were further surveyed 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), communities were made aware of these either through direct communication (local meetings, email, phone), at Steering and Planning Committee meetings, or via their draft municipal annexes.

6.6.2 Identification and Analysis of Mitigation Techniques

Concerted efforts were made to assure that municipalities 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.

- Structure and Infrastructure Projects—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.

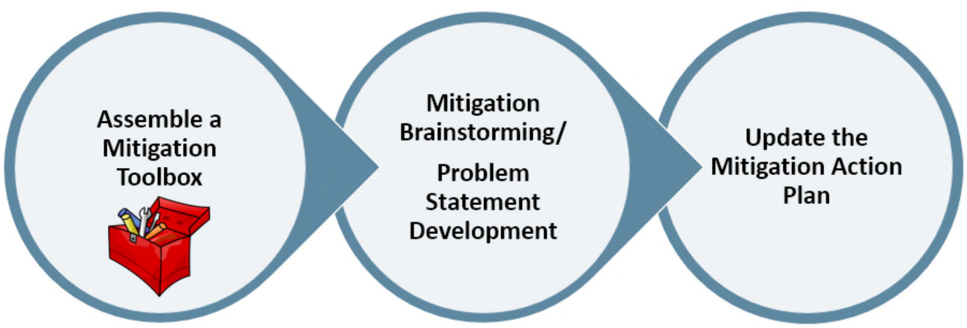
- Natural Systems Protection—These are actions that minimize damage and losses and preserve or restore the functions of natural systems.

- Education and Awareness Programs—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 2020 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 municipal 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 conducted by the contracted planning consultant on October 24, 2019, 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 2020 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 municipalities to develop the 2020 updated mitigation action plan.



The concept of a ‘mitigation toolbox’ was introduced to the Planning Partnership at the September 19, 2019 risk assessment meeting. A mitigation toolbox contains numerous resources available to the County and participating municipalities to assist with the development of an updated mitigation action plan. This toolbox was referred to throughout the 2020 HMP mitigation strategy update 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:

- 2020 HMP mission statement, goals and objectives
- 2015 HMP Mitigation Strategy
- Risk assessment results

- Capability assessment results
- Outcomes of the SWOO
- Outcomes of the Stakeholder Focus Group Sessions
- Mitigation Catalog
- Subject-matter expertise
- Stakeholder and public input (e.g., citizen survey results, survey results from Senior Wellness event)
- Existing plans/policies/programs
- FEMA resources (e.g., Mitigation Ideas).

As discussed in Section 2 (Planning Process) and earlier in this section, the September 19, 2019 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 October 2019 mitigation strategy workshop, the Planning Partnership focused problem statements based on the impacts of hazards in the County and their communities. 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. At the workshop, the Planning Partnership broke up into small groups and round-table discussions took place so municipalities could understand each other's problem statements and share either what others have done to address the problem or help brainstorm what the best mitigation action is to address. Information gathered from the stakeholder focus-group sessions in November was also shared with the Planning Partnership to further inform the updated mitigation strategy development.

As a result, problem statement worksheets were developed to detail the problems/challenges/gaps/identified vulnerabilities the jurisdiction faces, then mitigation alternatives 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.

Municipalities included mitigation actions to address vulnerable critical facilities located within the floodplain. For those facilities, each municipality was asked to identify the status of mitigation: already mitigated and how/to what flood level, reason for not mitigating (e.g. do not have the jurisdiction to mitigate), or the proposed mitigation number included in the proposed mitigation action table in each annex. It is recognized, however, that in the case of projects being funded through federal mitigation programs, the level of protection can be influenced by cost-effectiveness, as determined through a formal benefit-cost analysis. In the case of "self-funded" projects, municipal discretion must be recognized. Further, the County and municipalities have limited authority over privately-owned critical facility owners regarding mitigation at any level of protection. In the future, if critical facilities located in the floodplain are impacted, the County and local jurisdictions will consider 406 mitigation when examining the natural hazard impacts on that structure.

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, including:
    - Essex County Sheriff's Office
    - Essex County Office of Emergency Management
    - Essex County Department of Public Works
    - Essex County Division of Planning
- Input received through the public and stakeholder outreach process.

6.6.4 Mitigation Best Practices

Catalogs of hazard mitigation best practices were developed that present a broad range of alternatives to be considered for use in Essex 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.

6.6.5 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 and prioritization 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/prioritization criteria used in the 2020 update process is the same used in the 2015 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 municipality 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?

Participating jurisdictions were asked to use these criteria to assist them in evaluating and prioritizing mitigation actions identified in the 2020 update. 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 and then used by each jurisdiction to help prioritize the action or strategy as *Low*, *Medium*, or *High*. Actions that had a numerical value between 0 and 4 were categorized as *low*; actions with numerical values between 5 and 9 were categorized as *medium*; and actions with numerical values between 10 and 14 were categorized as *high*. While this provided a consistent, systematic methodology to support the evaluation and prioritization of mitigation actions, jurisdictions might have additional considerations that could influence their overall prioritization of mitigation actions.

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 municipality was asked to develop problem statements. With this process, participating jurisdictions were able to develop action-oriented and achievable mitigation strategies.

6.6.6 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 Essex 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

2020 HMP Changes

- In this update the maintenance process has been more clearly outlined to provide a roadmap for the annual monitoring of the plan. This includes a summary plan maintenance matrix that provides an overview of the planning partner responsibilities for monitoring, evaluation, and update of the plan.
- Specific discussion of ongoing or proposed integration actions including those to support incorporation of mitigation planning as an integral component of daily government operations is included in Section 5 (Capability Assessment) rather than summarized in this section of the plan,

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.	August 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 action to become an organic part of the ongoing county and municipal activities, the county will incorporate the distribution of the safe growth worksheet (see 7.1.2 below) for annual review and update by all participating jurisdictions.	August each year with interim email reminders to address integration in county and municipal activities.	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; compile and finalize the Annual Progress Report	Finalized progress report completed by October 14 of each year	Steering Committee; Plan Maintenance element	Jurisdictional points of contacts identified in Section 9 (Jurisdictional Annexes)

Task	Approach	Timeline	Lead Responsibility	Support Responsibility
Update	Reconvene the planning partners, at a minimum, every 5 years to guide a comprehensive update to review and revise the plan.	Every 5 years or upon major update to Comprehensive Plan or major disaster	Essex County HMP Coordinator	Jurisdictional points of contacts identified 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 Steering Committee and be the prime 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 Committee 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 Committee 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 Essex County HMP Coordinator is designated as:

Name: Captain Edward Esposito
Email Address: essexoem@essexsheriff.com

7.1.1 Monitoring

The Planning Committee 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, Essex 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 municipal and county representatives of directly access 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 annually, 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
- Hazard events and losses occurring in their jurisdiction,
- Additional mitigation actions believed to be appropriate and feasible,
- 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 Municipal Planning Mechanisms

As discussed in Section 5 (Capability Assessment), integrating hazard mitigation into a community's existing plans, policies, codes, and programs leads to development patterns designed to not increase risk from known hazards or to lead to redevelopment that reduces risk from known hazards. The Essex County Planning Partnership was tasked with identifying how hazard mitigation is integrated into existing planning mechanisms. Refer to Section 9 (Jurisdictional Annexes) for how this is done for each participating municipality. During this process, many municipalities recognized the importance and benefits of incorporating hazard mitigation into future municipal planning and regulatory processes.

During the HMP annual review process, each participating municipality will be asked to document how they are utilizing and incorporating the Essex County HMP into their day-to-day operations and planning and regulatory processes. Additionally, each municipality 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 community analyze how hazard mitigation is integrated into local plans, ordinances, regulations, ordinances, and policies. By completing the checklist, it will help municipalities 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 municipal activities will evolve into an ongoing culture within the county and its municipalities.

Table 7-2. Safe Growth Check List

Planning Mechanisms	Do you Do This?		Notes: How is it being done or how will this be utilized in the future?
	Yes	No	
Operating, Municipal 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, during adoption process, the municipality 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 municipality 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?			

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
• 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			
• 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?			
Master 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			

Planning Mechanisms	Do you Do This? Yes	No	Notes: How is it being done or how will this be utilized in the future?
• 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			
• Data and maps will be used as supporting documentation in grant applications.			
Municipal Ordinances			
• When updating municipal 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 municipality 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 Steering and Planning Committees (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 Essex County HMP Coordinator will advise the Planning Partnership of the meeting date, agenda and expectations of the members.

The Essex 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 municipal 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.

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 Essex 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 Planning Partnership, information presented at the annual 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 Essex County Sheriff's Office website to keep the public apprised of the plan's implementation (https://www.essexsheriff.com/oem-category/2020-mid-plan-update/). 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 May of each year.

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 of this plan has been collected to facilitate the risk assessment. This is an opportunity to increase the community's 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 the DMA 2000. It is the intent of Essex County to update this plan on a five-year cycle from the date of initial plan adoption.

To facilitate the update process, the Essex County HMP Coordinator, with support of the Planning Partnership, shall use the second annual meeting to develop and commence the implementation of a detailed plan update program. The Essex County HMP Coordinator shall invite representatives from NJOEM 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 Essex 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 Jersey State Hazard Mitigation Officer.

7.1.5 Grant Monitoring and Coordination

Essex 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 municipal partner as part of their annual progress reporting". The Essex County HMP Coordinator will keep the planning partners apprised of FEMA Hazard Mitigation Assistance grant openings and assist in developing letters of intent for grant opportunities when practicable.

Essex County intends to be a resource to the planning partnership 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, Essex 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.

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 (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”).

As discussed in Section 5 (Capability Assessment), it is the intention of Planning Partnership representatives to continue to incorporate mitigation planning as an integral component of daily government operations. The 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 Committee 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

Essex 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.essexsheriff.com/oem-category/2020-mid-plan-update/). In addition, public outreach and dissemination of the HMP will include:

- Links to the plan on municipal 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.

Planning Committee representatives and the Essex 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 public can also provide input at the annual review meeting for the HMP and during the next five-year plan update. The Essex 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 Committee 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 HMP.
- Appropriate links to the Essex County Hazard Mitigation Plan website are included on municipal websites.
- Public notices are made as appropriate to inform the public of the availability of the plan, particularly during HMP update cycles.

The Essex 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 Essex County HMP website is maintained and updated as appropriate.
- 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.