Warren County 2021 Hazard Mitigation Plan

Prepared for:

Warren County Planning and Zoning Department

&

Warren County Emergency Management Agency

204 4th Avenue
Warren, PA 16365

Prepared by:

MCM Consulting Group, Inc.

2595 Clyde Avenue, Suite # 1

State College, PA 16801

Certification of Annual Review Meetings

YEAR	DATE OF MEETING	PUBLIC OUTREACH ADDRESSED? *	SIGNATURE
2021			
2022			
2023			
2024			
2025			

**Confirm yes here annually and describe on record of change page.*

Record of Changes

DATE	DESCRIPTION OF CHANGE MADE, MITIGATION ACTION COMPLETED, OR PUBLIC OUTREACH PERFORMED	CHANGE MADE BY (PRINT NAME)	CHANGE MADE BY (SIGNATURE)

REMINDER: ***Please attach all associated meeting agendas, sign-in sheets, handouts and minutes.***

Table of Contents

Figures

Tables

Executive Summary

Mitigation is the effort to reduce loss of life and property by lessening the impact of disasters. Hazard mitigation focuses attention and resources on county and municipal policies and actions that will produce successive benefits over time. State and local governments engage in hazard mitigation planning to identify risks and vulnerabilities associated with natural as well as human-caused hazards and develop long-term strategies for protecting people and property from future hazard events. Mitigation plans are key to breaking the cycle of disaster damage, reconstruction, and repeated damage. This plan represents the work of citizens, elected and appointed government officials, business leaders, and volunteer and nonprofit groups to protect community assets, preserve the economic viability of the community, and save lives.

In 2020, Warren County Emergency Management Agency contracted the services of a consulting agency to revise and update the Warren County Hazard Mitigation Plan. The plan was successfully updated in accordance with the requirements set forth by PEMA and FEMA. The updated Warren County Hazard Mitigation Plan was adopted by the Warren County Commissioners in 2021.

The Warren County Commissioners secured a grant to complete the 2021 update to the Warren County Hazard Mitigation Plan. MCM Consulting Group, Inc. was hired to assist the county with the update of the plan. The planning kick-off meeting was conducted May 4, 2020.

The planning process for the 2021 Warren County Hazard Mitigation Plan Update consisted of the following:

- Identification and prioritization of the hazards that may affect the county and its municipalities.
- Assessment of the county's and municipalities' vulnerability to these hazards.
- Identification of the mitigation actions and projects that can reduce that vulnerability.
- Development of a strategy for implementing the actions and projects, including identifying the agency(ies) responsible for that implementation.

Throughout the planning process, the general public was given the opportunity to comment on the existing HMP and provide suggestions for the updated version. Due to COVID-19, public meetings were conducted via an online survey to provide residents an opportunity to provide input on the HMP. Several meetings were held virtually, and participants were invited to submit surveys and other documents via an online survey.

The following hazards were identified by the local planning team as presenting the highest risk to the county and its municipalities:

- Emergency Services
- Flash Flooding
- Invasive Species
- Winter Storms
- Windstorms
- Flooding
- Dam Failure
- Substance Abuse
- Pandemic and Infectious Disease
- Extreme Temperatures
- Environmental Hazards – Transportation and Fixed Facility
- Wildfire
- Drowning

- Utility Interruptions
- Disorientation

A total of twenty-two hazards are identified in the 2021 Warren County Hazard Mitigation Plan. A total of seventeen identified hazards were listed in the previous 2016 plan update. New hazards identified in this plan include emergency services, substance abuse, hailstorm, and invasive species.

To mitigate against the effects of these hazards, the local planning team identified the following goals for hazard mitigation over the next five years:

- Reduce potential injury/death and damage to existing community assets due to floods, flash floods, and ice jams.
- Reduce potential injury/death and damage to existing community assets due to all hazards.
- Promote disaster-resistant future development.
- Promote hazard mitigation as a public value in recognition of its importance to the health, safety, and welfare of the population.
- Improve response and recovery capabilities.
- Protect critical infrastructure.

Mitigation actions are specific projects and activities that help achieve goals. A total of thirty-seven actions were developed for this plan update as they pertain to hazards identified by the local planning team. The 2016 Warren County Hazard Mitigation Plan consisted of thirty actions. The individual objectives and actions that will be implemented are shown in section 6.4. Each municipality was provided the opportunity to submit new project opportunity forms for this update. A total of twenty-eight project opportunity forms were submitted during the 2016 HMP update. Municipalities were asked to indicate the current status of these projects submitted in 2016, of which six municipalities completed. A total of thirty-one project opportunities were submitted for this plan update.

The 2021 Warren County Hazard Mitigation Plan is the cornerstone to reducing Warren County's vulnerability to disasters. It is the commitment to reducing risks from hazards and serves as a guide for decision makers as they commit resources to reducing the effects of hazards. Hazard mitigation is the only phase of emergency management specifically dedicated to breaking the cycle of damage, reconstruction, and repeated damage.

The 2021 Warren County Hazard Mitigation Plan is a living document that reflects ongoing hazard mitigation activities and requires monitoring, evaluating, and updating to ensure the mitigation actions are implemented. To facilitate the hazard mitigation planning process and adhere to regulatory requirements, the plan will be reviewed annually, and any major revisions will be incorporated into the five-year update.

1. Introduction

1.1. Background

The Warren County Board of Commissioners, in response to the Disaster Mitigation Act of 2000 (DMA 2000), organized a countywide hazard mitigation planning effort to prepare, adopt and implement a multi-jurisdictional Hazard Mitigation Plan (HMP) for Warren County and all of its twenty-seven municipalities. The Warren County Emergency Management Agency and Planning Department was charged by the County Board of Commissioners to prepare the 2021 plan. The 2016 HMP has been utilized and maintained during the five-year life cycle.

The Warren County Commissioners were successful in securing hazard mitigation grant funding to update the county hazard mitigation plan. The pre-disaster mitigation grant funding was administered by the Pennsylvania Emergency Management Agency and provided to Warren County as a sub-grantee. The Warren County Commissioners assigned the Warren County Emergency Management Agency with the primary responsibility to update the hazard mitigation plan. MCM Consulting Group, Inc. was selected to complete the update of the HMP. A local hazard mitigation planning team was developed comprised of government leaders and citizens from Warren County. This updated HMP will provide another solid foundation for the Warren County Hazard Mitigation Program.

Hazard mitigation describes sustained actions taken to prevent or minimize long-term risks to life and property from hazards and to create successive benefits over time. Pre-disaster mitigation actions are taken in advance of a hazard event and are essential to breaking the disaster cycle of damage, reconstruction and repeated damage. With careful selection, successful mitigation actions are cost-effective means of reducing risk of loss over the long term.

Hazard mitigation planning has the potential to produce long-term and recurring benefits. A core assumption of mitigation is that current dollars invested in mitigation practices will significantly reduce the demand for future dollars by lessening the amount needed for recovery, repair and reconstruction. These mitigation practices will also enable local residents, businesses, and industries to reestablish themselves in the wake of a disaster, getting the economy back on track sooner and with less interruption.

1.2. Purpose

The purpose of this all-hazard mitigation plan (HMP) is:

- Protect life, safety, and property by reducing the potential for future damages and economic losses that result from hazards.
- Qualify for additional grant funding, in both the pre-disaster and the post-disaster environment.
- Speed recovery and redevelopment following future disaster events.
- Demonstrate a firm local commitment to hazard mitigation principles.
- Comply with both state and federal legislative requirements for local hazard mitigation plans.

1.3. Scope

This Warren County Multi-Jurisdictional Hazard Mitigation Plan serves as a framework for saving lives, protecting assets and preserving the economic viability of the twenty-seven municipalities in Warren County. The HMP outlines actions designed to address and reduce the impact of a full range of natural hazards facing Warren County, including drought, earthquakes, flooding, tornadoes, hurricanes/tropical storms, and severe winter weather. Human caused hazards such as transportation accidents, hazardous materials spills and fires are also addressed.

A multi-jurisdictional planning approach was utilized for the Warren County HMP update, thereby eliminating the need for each municipality to develop its own approach to hazard mitigation and its own planning document. Further, this type of planning effort results in a common understanding of the hazard vulnerabilities throughout the county, a comprehensive list of mitigation projects, common mitigation goals and objectives and an evaluation of a broad capabilities assessment examining policies and regulations throughout the county and its municipalities.

1.4. Authority and Reference

Authority for this plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, as amended
- Code of Federal Regulations (CFR), Title 44, Parts 201 and 206
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended
- National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq.
- Authority for this plan originates from the following Commonwealth of Pennsylvania sources:
- Pennsylvania Emergency Management Services Code. Title 35, Pa C.S. Section 101
- Pennsylvania Municipalities Planning Code of 1968, Act 247 as reenacted and amended by Act 170 of 1988
- Pennsylvania Storm Water Management Act of October 4, 1978. P.L. 864, No. 167

The following Federal Emergency Management Agency (FEMA) guides and reference documents were used to prepare this document:

- FEMA 386-1: Getting Started. September 2002
- FEMA 386-2: Understanding Your Risks: Identifying Hazards and Estimating Losses. August 2001
- FEMA 386-3: Developing the Mitigation Plan. April 2003
- FEMA 386-4: Bringing the Plan to Life. August 2003
- FEMA 386-5: Using Benefit-Cost Review in Mitigation Planning. May 2007
- FEMA 386-6: Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning. May 2005
- FEMA 386-7: Integrating Manmade Hazards into Mitigation Planning. September 2003
- FEMA 386-8: Multijurisdictional Mitigation Planning. August 2006
- FEMA 386-9: Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects. August 2008
- FEMA Local Multi-Hazard Mitigation Planning Guidance. July 1, 2008
- FEMA National Fire Incident Reporting System 5.0: Complete Reference Guide. January 2008
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards. January 2013

The following Pennsylvania Emergency Management Agency (PEMA) guides and reference documents were used to prepare this document:

- PEMA: Hazard Mitigation Planning Made Easy!
- PEMA Mitigation Ideas: Potential Mitigation Measures by Hazard Type: A Mitigation Planning Tool for Communities. March 6, 2009
- PEMA: Standard Operating Guide. October 18, 2013

The following document produced by the National Fire Protection Association (NFPA) provided additional guidance for updating this plan:

- NFPA 1600: Standard on Disaster/Emergency Management and Business Continuity Programs. 2011

2. Community Profile

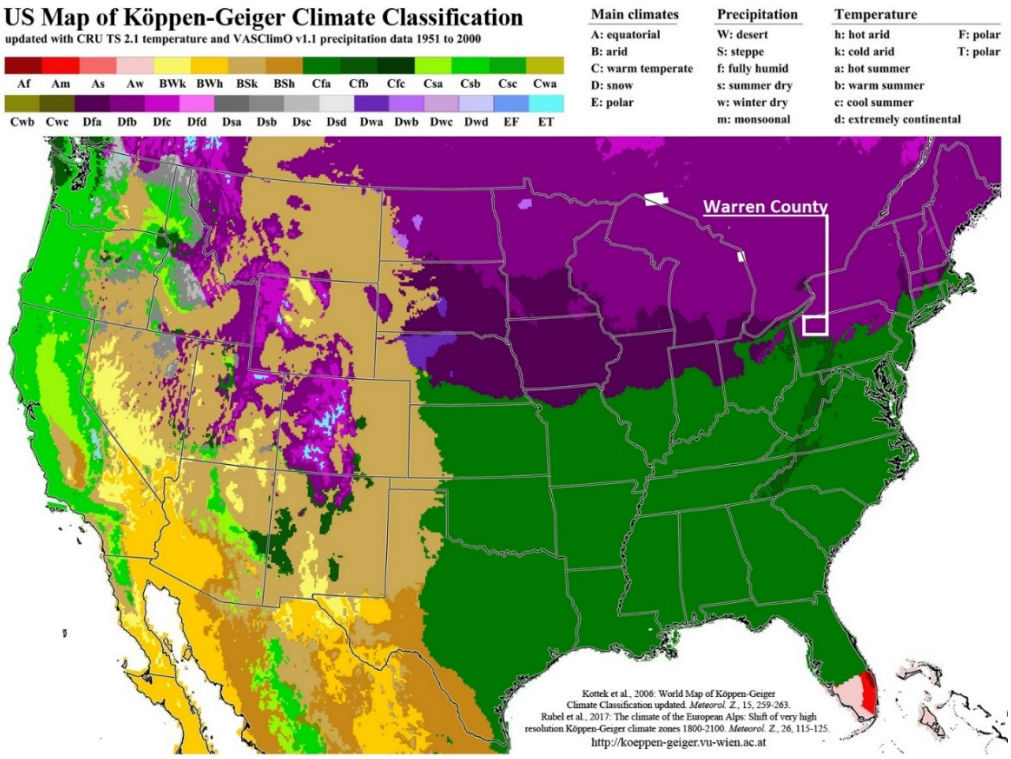
2.1. Geography and Environment

Warren County covers approximately 898 square miles and is situated in northwest Pennsylvania. Warren County is ranked as the 16th largest county in Pennsylvania by area. The county is bordered by Crawford and Erie counties on the west, by Chautauqua and Cattaraugus counties, New York State to the north, McKean County to the east, and Venango and Forest counties to the south. Warren County falls within the Appalachian Plateaus Physiographic Province, mostly in the High Plateau section, with a section of the north and northwestern part of the county in the Northwestern Glaciated Plateau Section, and a section of the north eastern in the Deep Valley Section. There is a total of 884 square miles of land and fourteen square miles of water.

Warren County presents a wide range of topographic features. Elevations in the county range from a high of 2,274 feet to a low of 1,135 feet, with an average elevation of 1,660 feet. Hardwood forests cover nearly 83% of the county. Approximately 150,000 acres of the county are part of the Allegheny National Forest (the only National Forest in Pennsylvania). Although Warren County has a large area of public land, most of the county's forests (approximately 70%) are owned by private individuals.

The climate in Warren County is characterized as a warm-summer humid continental climate, as depicted in *Figure 1 - Köppen-Geiger Climate Areas Map*. Average temperatures range from 24.5° F in January to 69.3° F in July. Warren County has an annual high temperature of 58°F and an annual low temperature of 38°F. There is an annual precipitation of 47.09 inches and an average annual snowfall of sixty-nine inches.

Figure 1 - Koppen-Geiger Climate Areas Map



River and stream valleys dominate the landscape of Warren County. The major water feature is the Allegheny River, which flows southerly through the county. Kinzua Dam controls the flow that eventually reaches Pittsburgh and joins the Ohio River. Three major tributaries feed the Allegheny River: the Conewango, Brokenstraw, and Kinzua creeks.

Warren County lies in the Ohio River Basin watershed and the Conewango Creek Watershed. The Ohio River Basis is in western Pennsylvania and is considered to be a national watershed because of its immense size, encompassing over 200,000 square miles and fourteen states. The Ohio River is the largest tributary to the Mississippi River. The Conewango Creek Watershed Association is a 900 square mile drainage basin in New York and Pennsylvania, that is comprised of many smaller watersheds. Likewise, the Conewango is a portion of the larger Allegheny and Ohio River watersheds. The Conewango watershed contains approximately 780 miles of streams, 423 square miles of forest, and 392 square miles of farmland.

Kinzua Dam is one of the largest dams in the United States east of the Mississippi River, and is located on the Allegheny River. Kinzua Lake extends twenty-five miles to the north. Construction began in 1960 and Kinzua Dam opened in 1965. The dam is 179 feet high, 1,897 feet long and at its base is 1,245 feet wide. The dam has a total capacity of 1,300,000-acre feet.

Because of its vast natural resources, Warren County has been, and continues to grow in popularity as a tourist destination. Ample recreation opportunities such as bicycling, camping, fishing, hiking, hunting, boating, swimming, cross-country skiing, and scenic drives are available throughout the county, making Warren County popular year-round.

2.2. Community Facts

At one time the land that encompasses Warren County was home to the Iroquois Seneca Nation. On March 12, 1800 Warren County was established from parts of Allegheny and Lycoming counties. Warren County was attached to Crawford County until 1805 and then to Venango County, until formally organized on March 16, 1819.

The following cities, boroughs and townships are in Warren County:

- Cities: Warren.
- Boroughs**:** Bear Lake, Clarendon, Sugar Grove, Tidioute, and Youngsville.
- Townships**:** Brokenstraw, Cherry Grove, Columbus, Conewango, Deerfield, Eldred, Elk, Farmington, Freehold, Glade, Limestone, Mead, Pine Grove, Pittsfield, Pleasant, Sheffield, Southwest, Spring Creek, Sugar Grove, Triumph, and Watson.

Warren County's leading industries are education, health, social services, manufacturing, and retail trade. The primary employment providers within Warren County are displayed below in *Table 1 – Warren County Top Employers.* This data reflects information from the Center for Workforce Information & Analysis' third quarter in 2015.

Table 1 – Warren County Top Employers

Warren County Top Employers	
Company	**Industry**
Blair Payroll LLC	Catalog and mail-order houses
Northwest Bancshares, Inc.	Financial
Warren County School District	Education
State Government	Government
United Refining Company	Manufacturing
Warren General Hospital	Healthcare
Whirley Industries, Inc.	Manufacturing
Rouse Estate	Long-term healthcare
Wal-Mart Associates, Inc.	Retail
Superior Tire & Rubber Corp.	Manufacturing
Source: Center for Workforce Information & Analysis	

The wealth of natural resources found in the county has been instrumental in shaping the diversity of communities within its borders. Agriculture, mining, and the network of rivers have played a large role in the economic development in Warren County.

2.3. Population and Demographics

The county is the 55th ranked county in terms of population within the Commonwealth of Pennsylvania. Warren County recorded a population of 41,815 during the 2010 U.S. Census. The population in this county is declining according to the U.S. Census Bureau who estimated the population to be 40,035 in 2018. The median income of households in Warren County is $48,409. This is approximately $11,036 less than the state median household income and $13,528 less than the national median household income (U.S. Census, 2018). The 2018 American Community Survey estimates 39,154 of the Warren County population to be in poverty status. With the majority of those being between the ages of 35 to 64.

The populations per municipality are identified in *Table 2 – Warren County Municipal Population* below.

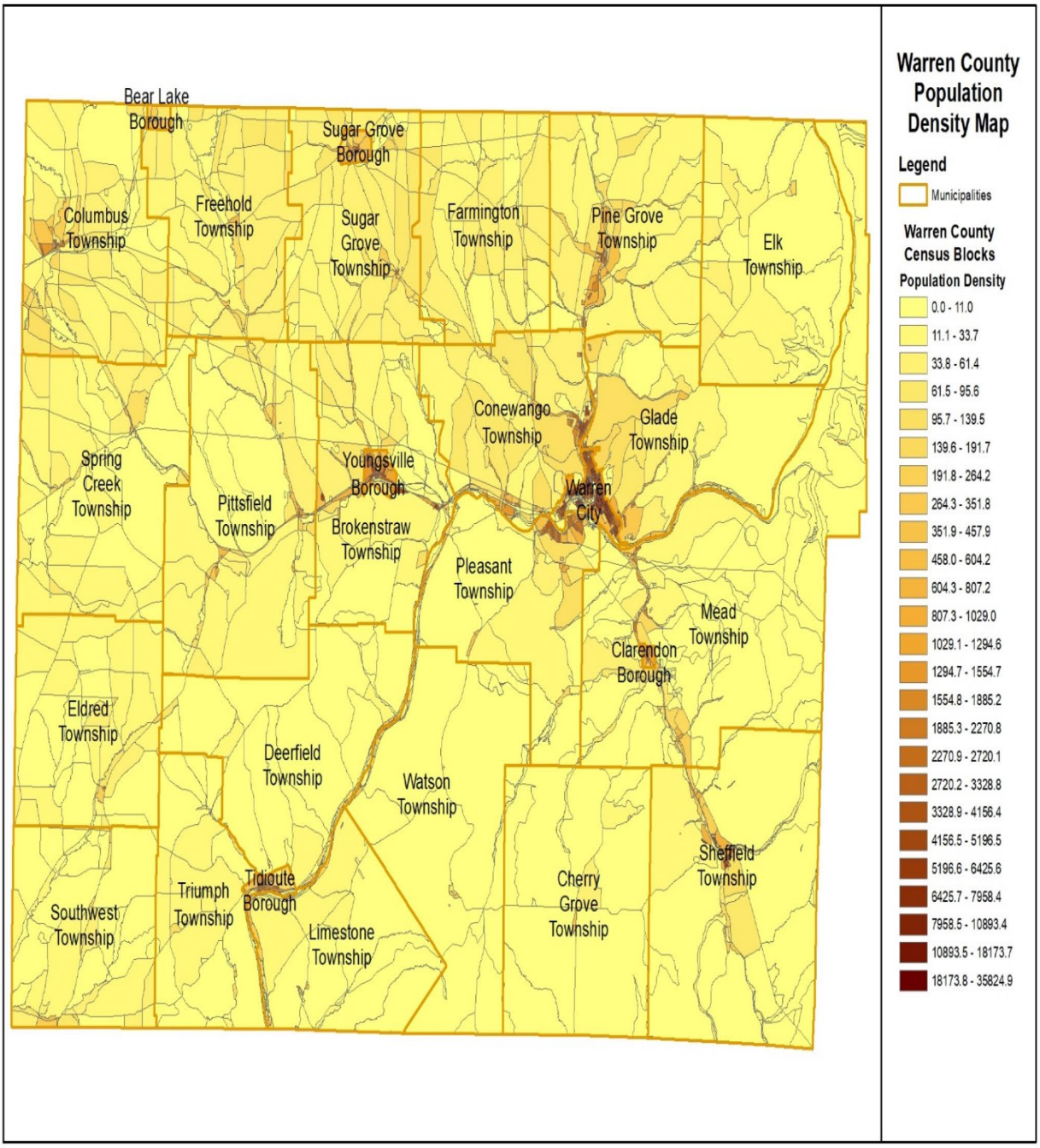
Table 2 - Warren County Municipal Population

Warren County Municipality Populations				
Municipality	**2000 Population**	**2010 Population**	**2018 ACS 5-Year Estimates**	**Median Age (2018 ACS 5-Year Estimates)**
Bear Lake Borough	193	164	192	46.0
Brokenstraw Township	2,068	1,884	1,817	49.3
Cherry Grove Township	228	216	134	52.2
Clarendon Borough	564	450	393	40.4
Columbus Township	1,741	2,034	1,869	48.2
Conewango Township	3,915	3,594	3,423	48.5
Deerfield Township	333	339	281	57.7
Eldred Township	709	650	699	41.3
Elk Township	551	520	467	54.7
Farmington Township	1,353	1,259	1,362	40.7
Freehold Township	1,402	1,510	1267	45.0

Warren County Municipality Populations				
Municipality	**2000 Population**	**2010 Population**	**2018 ACS 5-Year Estimates**	**Median Age (2018 ACS 5-Year Estimates)**
Glade Township	2,319	2,308	2,120	50.9
Limestone Township	418	403	284	58.8
Mead Township	1,555	1,386	1,474	47.4
Pine Grove Township	2,712	2,695	2,587	50.6
Pittsfield Township	1,519	1,405	1,339	47.4
Pleasant Township	2,528	2,444	2,310	55.4
Sheffield Township	2,346	2,121	2,284	43.8
Southwest Township	561	527	434	40.5
Spring Creek Township	872	852	838	42.7
Sugar Grove Borough	613	614	541	39.9
Sugar Grove Township	1,870	1,723	1,574	38.4
Tidioute Borough	792	688	747	55.0
Triumph Township	286	316	249	47.6
Warren City	10,259	9,710	9,250	43.8
Watson Township	322	274	202	55.6
Youngsville Borough	1,834	1,729	1,798	42.8
Total	43,863	41,815	40,035	47.0
Source: US Decennial Census, 2018 American Community Survey (ACS)				

The median age in Warren County is 47-years old (according to the 2018 American Community Survey). The 2018 Census Bureau's American Community Survey estimates the largest population in Warren County was 45-54 years old (14.2%) with ages 65-74 years old (12%) coming in at a relatively close second. A total of 23,603 housing units were identified during the 2018 ACS 5-year estimates.

Figure 2 – Warren County Population Density Map



2.4. Land Use and Development

Warren County is composed of twenty-seven municipalities, which include:

- Twenty-one townships
- Five boroughs
- One city

There are 884 square miles of land and fourteen square miles of water in Warren County. Nearly 9% of the total land area is classified as agricultural. There are 452 farms with a total of 68,153 acres, of this there are approximately 30,447 acres of cropland. The average size of the farms in the county are 151 acres. Forest is the primary land cover in the Commonwealth of Pennsylvania. The Allegheny National Forest covers more than 500,000 acres. Forests make up 83% of the county; 26% of the county is covered by the Allegheny National Forest.

2.5. Data Sources

- Warren County Comprehensive Plan
- Warren County Regional Planning Commission
- United States Census Bureau (2000, 2010, 2018)
- United States Department of Agriculture
- Natural Resources Conservation Service
- Pennsylvania State Data Center
- Warren County Conservation District
- Warren County Greenways Plan
- Pennsylvania Department of Environmental Protection
- Warren County Geographic Information Systems (GIS)
- Pennsylvania Spatial Data Access (PASDA)
- National Oceanic and Atmospheric Administration
- Pennsylvania Department of Conservation and Natural Resources
- Warren County Today - Summary of Indicators
- Pennsylvania Department of Labor and Industry
- Pennsylvania Emergency Management Agency
- U.S. Department of Agriculture Census of Agriculture (USDA)
- Conewango Creek Watershed Association

The countywide digital flood insurance rate maps (DFIRM) were used for all flood risk analysis and estimation of loss. The Warren DFIRMs were approved and effective on March 21, 2017. The DFIRM database provides flood frequency and elevation information used in the flood hazard risk assessment. Other Warren County GIS datasets including road centerlines, parcels and structures were utilized in conjunction with the DFIRM. In addition to the county's existing spatial datasets, the Warren County Planning and Zoning Department developed a database and maps of the county's critical facilities, special needs populations, transportation systems and hazardous materials facilities. Potential losses were then analyzed by using existing county tax assessment data and DFIRM data.

Geographic Information Systems (GIS) Data

GIS data was utilized in risk assessment, estimation of loss and the development of map products for the hazard mitigation plan update. A core foundation of data was available from the Warren County Emergency

Management Agency and Warren County Planning and Zoning Department. Some data was downloaded from the Pennsylvania Spatial Data Access (PASDA) and utilized. The following is a list of existing GIS data that was utilized in the plan update process and a list of new GIS data that was developed to complete the 2016 mitigation plan update.

Existing Warren County GIS Data Used:

- Structures
- Road Centerlines
- Driveways
- Elevations of the County
- Tax Parcels
- Municipality Boundaries
- Digital Flood Insurance Rate Maps
- Watershed and Sub-Sheds
- Lakes and Streams

New GIS Data Developed and Used:

- Critical Facilities
- Mobile Homes
- Mobile Home Parks
- Utility Locations
- Tornado Paths

The Warren County parcel dataset includes a value for the land in each parcel, as well as a combined value for all buildings on each parcel. Some parcels that contain multiple buildings with one or more buildings in the flood plain and one or more buildings out of the flood plain. The individual value by specific building within any given parcel was indeterminate from the data provided by Warren County. Therefore, the combined value of all buildings in that parcel has been used – not simply the value of only the structures in the floodplain.

Mobile home parks, depicted in the "Warren County Tornado Risk" map, were provided by Warren County as parcel polygons. The total building values in these parcels designated as mobile home parks were used to estimate the possible economic loss associated with a disaster.

HAZUS calculations and statistics were based on a total of 131 reaches. There were zero failed reaches.

The following maps provide a base map of Warren County and other specific features of the county.

Figure 3 - Warren County Base Map

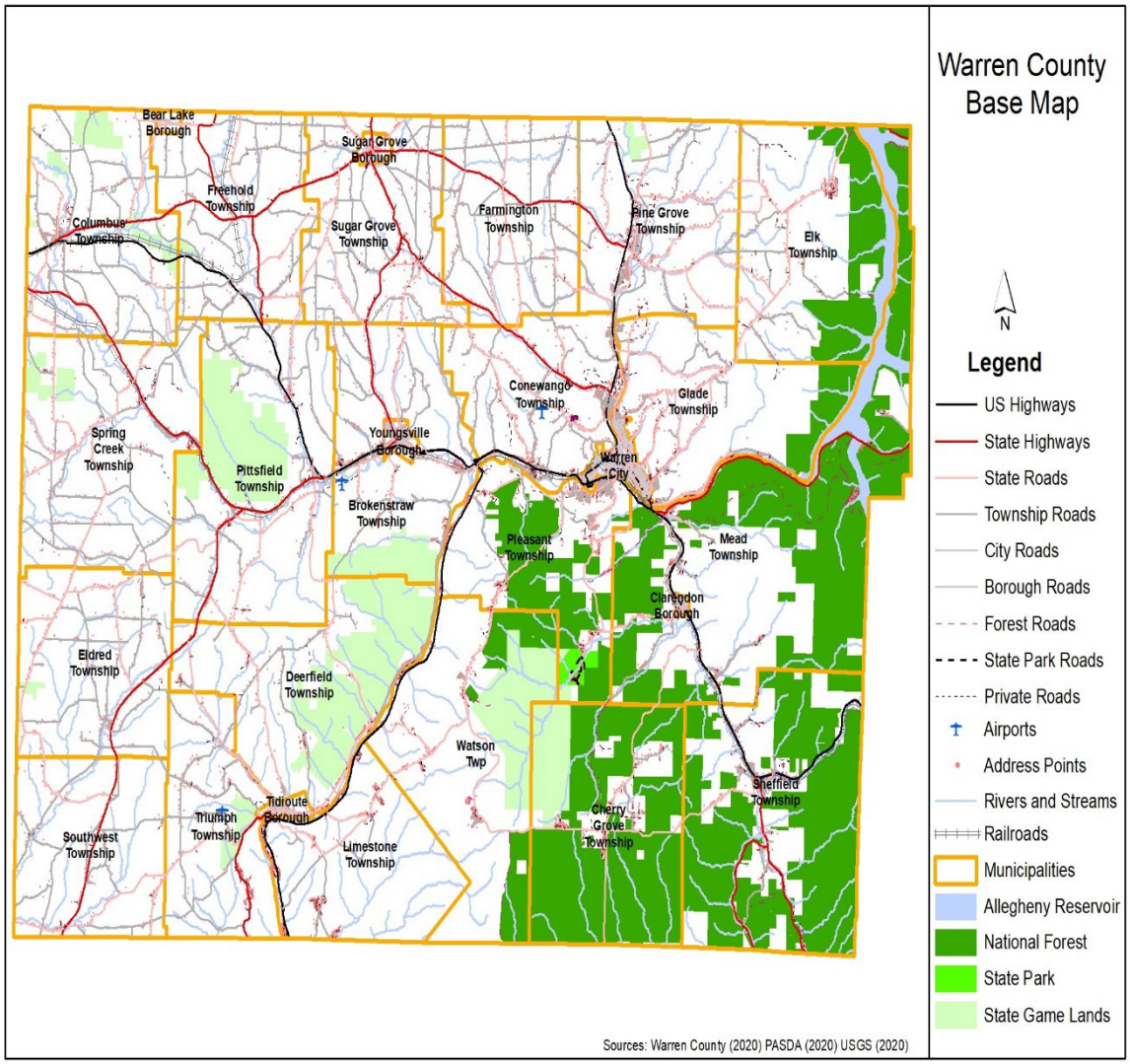


Figure 4 - Warren County Land Use Map

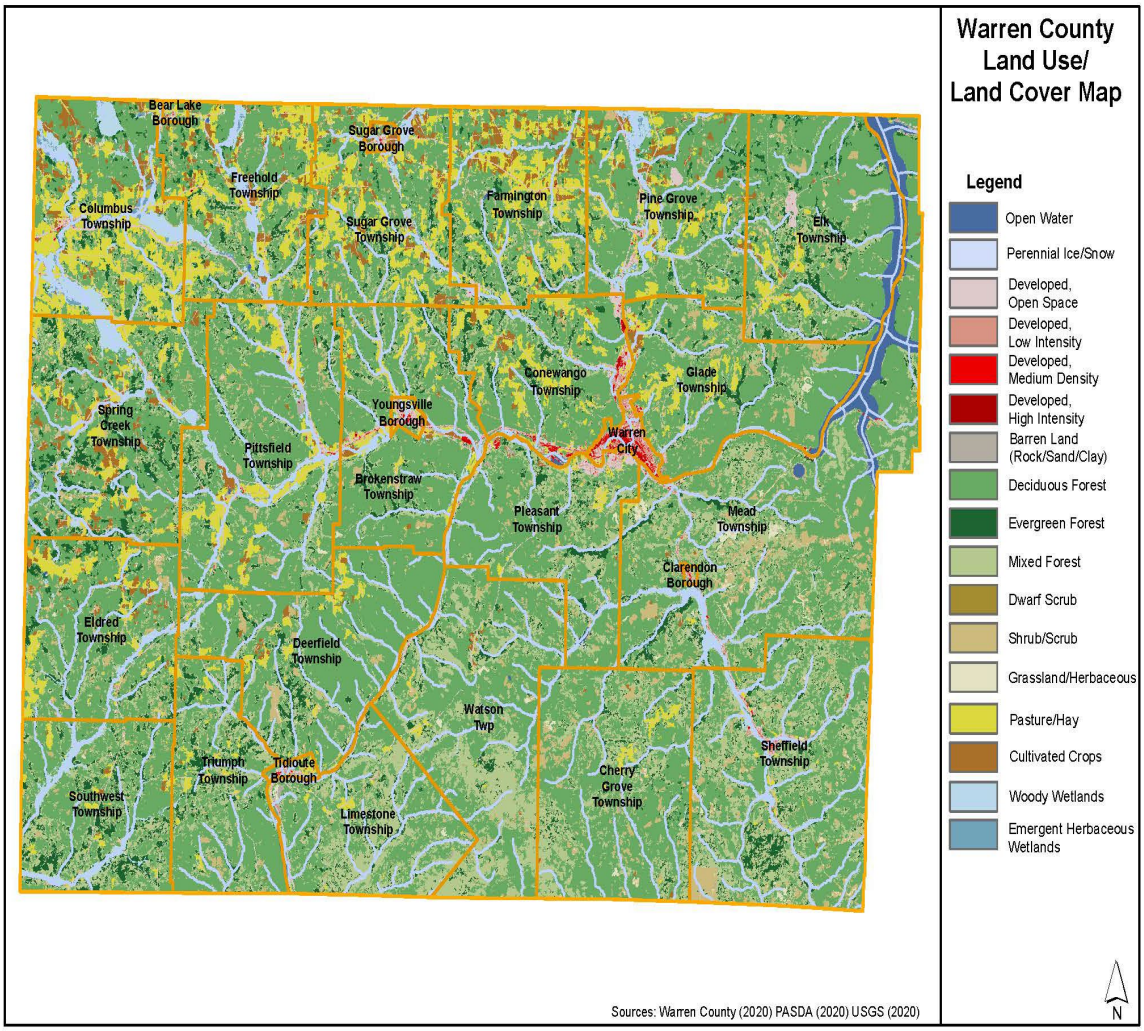


Figure 5 - Recreational Opportunities Map

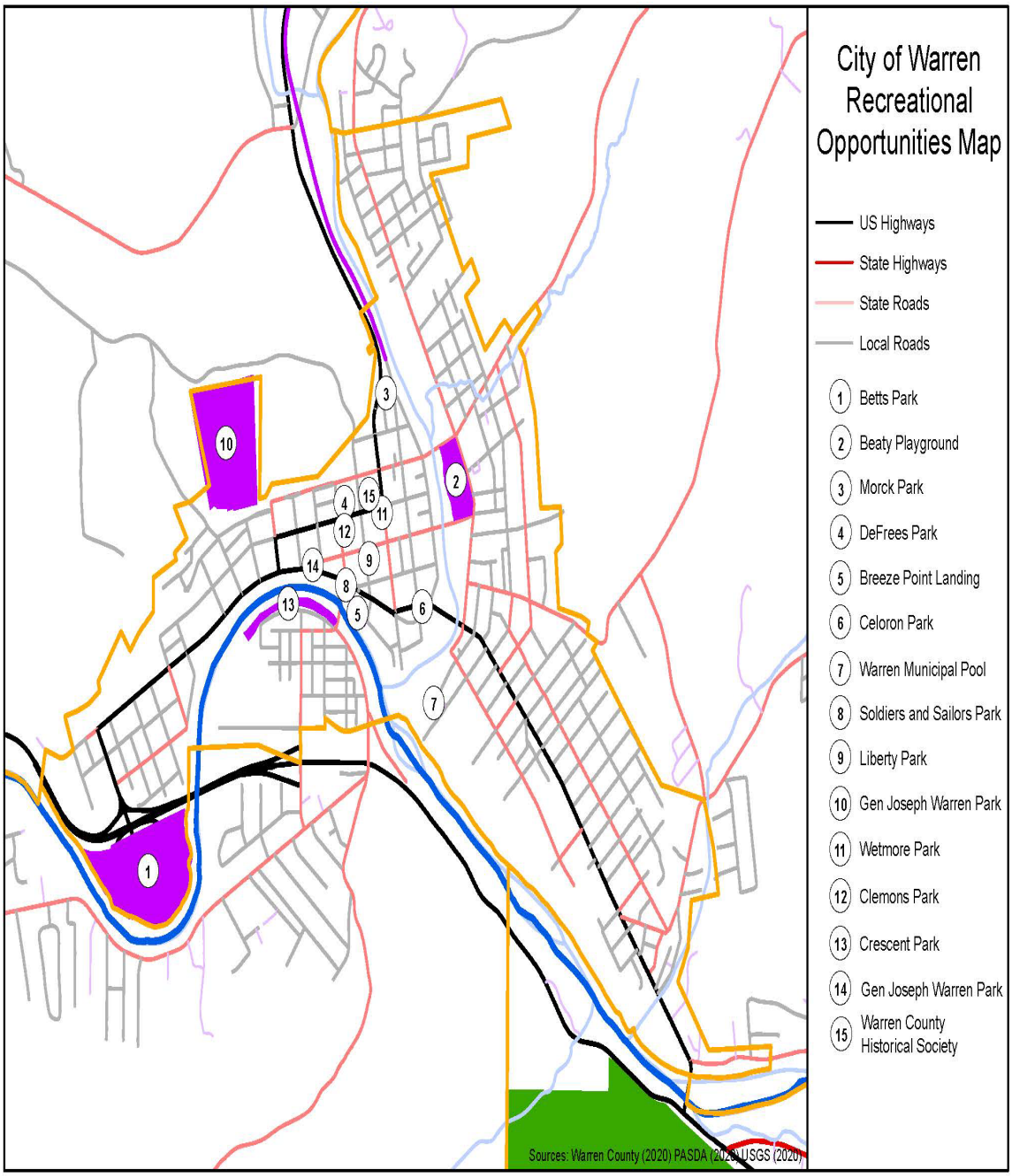
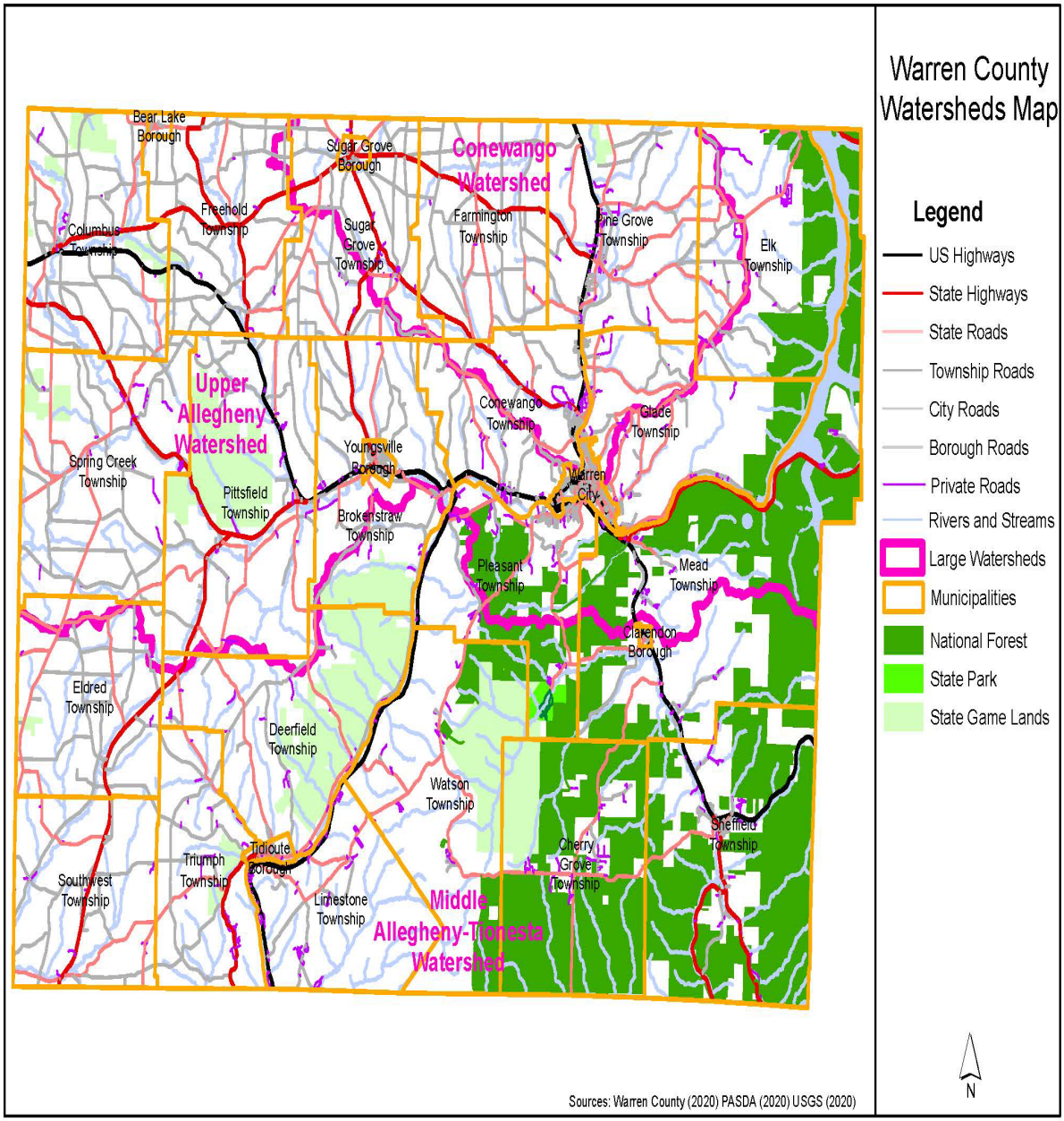


Figure 6 - Watershed Map



3. Planning Process

3.1. Update Process and Participation Summary

The Warren County Hazard Mitigation Plan update began May 4, 2020. The Warren County Commissioners were able to secure a hazard mitigation grant to start the process. The Warren County Emergency Management Agency was identified as the lead agency for the Warren County Hazard Mitigation Plan update. The planning process involved a variety of key decision makers and stakeholders within Warren County. Warren County immediately determined that the utilization of a contracted consulting agency would be necessary to assist with the plan update process. MCM Consulting Group, Inc. was selected as the contracted consulting agency to complete the update of the hazard mitigation plan. The core hazard mitigation team, which was referred to as the steering committee, included officials from the Warren County Emergency Management Agency, Warren County Planning and Zoning Department and MCM Consulting Group, Inc. (MCM).

The process was developed around the requirements laid out in the Federal Emergency Management Agency (FEMA) Local Hazard Mitigation Crosswalk, referenced throughout this plan, as well as numerous other guidance documents including, but not limited to, Pennsylvania's All-Hazard Mitigation Standard Operating Guide, FEMA's State and Local Mitigation Planning How-to Guide series of documents (FEMA 386-series) and the National Fire Protection Association (NFPA) 1600 Standard on Disaster/Emergency Management and Business Continuity Programs.

MCM Consulting Group, Inc. assisted Warren County Planning and Zoning Department as well as Warren County Emergency Management Agency in coordinating and leading public involvement meetings, local planning team meetings, analysis, and the writing of the updated HMP. The Warren County Local Planning Team (LPT) worked closely with MCM in the writing and review of the HMP. MCM conducted project meetings and local planning team meetings throughout the process. Due to COVID-19, most meetings were held virtually. Meeting agendas, meeting minutes and sign in sheets were developed and maintained for each meeting conducted by MCM. These documents are detailed in Appendix C of this plan.

Public meetings with local elected officials were held, as well as work sessions and in-progress review meetings with the Warren County Local Planning Team and staff. Due to COVID-19, a majority of meetings were held virtually. At each of the public meetings, respecting the importance of local knowledge, municipal officials were strongly encouraged to submit hazard mitigation project opportunity forms, complete their respective portions of the capabilities assessment and review and eventually adopt the county hazard mitigation plan. Warren County will continue to work with all local municipalities to collect local hazard mitigation project opportunities.

The HMP planning process consisted of:

- Applying for and receiving a hazard mitigation planning grant (HMPG) to fund the planning project.
- Announcing the initiative via press releases and postings on the county website.
- Involving elected and appointed county and municipal officials in a series of meetings, training sessions and workshops.
- Identifying capabilities and reviewed the information with the municipalities.
- Identifying hazards.
- Assessment of risk and analyzing vulnerabilities.
- Identifying mitigation strategies, goals, and objectives.
- Developing an implementation plan.

- Announcing completion via press releases and postings on the county website.
- Plan adoption at a public meeting of the Warren County Board of Commissioners.
- Plan submission to FEMA and PEMA.

The 2021 Warren County HMP was completed January 21, 2021. The 2021 plan follows an outline developed by PEMA which provides a standardized format for all local HMPs in the Commonwealth of Pennsylvania. The 2021 HMP format is consistent with the PEMA recommended format. The 2021 Warren County HMP has additional hazard profiles that were added to the HMP and these additional profiles increased the subsections in section 4.3 of the HMP.

3.2. The Planning Team

The 2021 Warren County Hazard Mitigation Plan update was led by the Warren County Steering Committee. The Warren County Steering Committee provided guidance and leadership for the overall project. The steering committee assisted MCM Consulting Group, Inc. with dissemination of information and administrative tasks. *Table 3 - Steering Committee* outlines the individuals that comprised this team.

Table 3 - Steering Committee

Warren County Hazard Mitigation Plan Update Steering Committee		
Name	**Organization**	**Position**
Dan Glotz	Warren County Planning and Zoning Department	Planning Director
Michael Lyon	Warren County Planning and Zoning Department	Zoning Officer/Floodplain Administrator
Scott Rose	Warren County Emergency Management Agency	Deputy Director
Michael T. Rearick	MCM Consulting Group, Inc.	Senior Consultant
Corbin Snyder	MCM Consulting Group, Inc.	Consultant

In order to represent the county, the Warren County Steering Committee developed a diversified list of potential local planning team (LPT) members. Members that participated in the 2016 hazard mitigation plan were highly encouraged to join the 2021 team. The steering committee then provided invitations to the prospective members and provided a description of duties to serve on the LPT. The following agencies, departments and organizations were invited to participate in the LPT: Warren County Commissioners, Warren County Conservation District, PennDOT, Penn State Extension, Warren County Assessment Office, DCNR Bureau of Forestry, USDA Forest Service, Forest County EMA, Crawford County EMA, McKean County EMA, Warren County Planning and Zoning Department, Warren County EMA and all twenty-seven municipalities. The invitations for membership of the LPT were disseminated by the Warren County Emergency Management Agency utilizing letters, email, and telephone calls. The LPT worked throughout the process to plan and hold meetings, collect information, and conduct public outreach.

The stakeholders listed in *Table 4 – Local Planning Team* served on the 2021 Warren County Hazard Mitigation Local Planning Team, actively participated in the planning process by attending meetings, completing assessments, surveys and worksheets and/or submitting comments.

Table 4 - Local Planning Team

Warren County Hazard Mitigation Plan Update Local Planning Team		
Name	**Organization**	**Position**
Dan Glotz	Warren County Planning and Zoning Department	Director
Scott Rose	Warren County Emergency Management Agency	Deputy Director
Jean Gomory	Warren Co. Conservation District	Watershed Specialist
Adam Elms	PennDot Warren County	Maintenance Manager
Lisa Hagberg	Youngsville Borough	Elected or Appointed Official
Randall Parrett	Forest County Emergency Management Agency	Director
Don Bovard	Crawford County Emergency Management Agency	Operations and Training Officer
Ben Kafferlin	Warren County Commissioner	County Commissioner
Cecile Stelter	DCNR Bureau of Forestry	District Forester
Rich Hatfield	ANF Bradford District Rangers Station	District Ranger
MaryLou Wagner	Cherry Grove Township	Elected or Appointed Official
Andy Brooks	Pleasant Township	Elected or Appointed Official
Michael Lyon	Warren County Planning and Zoning Department	Zoning Officer/Floodplain Administrator
Kale Asp	Warren County Emergency Management Agency	Director
Tracy Carl	McKean County Emergency Management Agency	Director
Harry Chrissy	Warren Co. Penn State Cooperative Extension	Educator
Brian Bull	Warren Co. Assessment Office	Chief Assessor
Diana Maille	Eldred Township	Elected or Appointed Official
Matt Maille	Eldred Township	Elected or Appointed Official
Fred Freeman	Glade Township	Elected or Appointed Official
James Stec	Deerfield Township	Elected or Appointed Official
Sarah Foster	Meade Township	Elected or Appointed Official
Kelly VanCise	Elk Township	Elected or Appointed Official
Arden Knapp	Pleasant Township	Elected or Appointed Official
Jennifer Fox	Conewango Township	Elected or Appointed Official

3.3. Meetings and Documentation

Meetings with local elected officials and the local planning team were held as needed. Meetings were mostly held via conference call and virtual meeting rooms due to COVID-19. At each of the meetings, municipal officials were strongly encouraged to submit hazard mitigation project opportunity forms, complete their respective portions of the capability assessment, review and eventually adopt the multi-jurisdictional HMP. *Table 5 - HMP Process Timeline* lists the meetings held during the HMP planning process, which organizations and municipalities attended and the topic that was discussed at each meeting. All meeting agendas, sign-in sheets, presentation slides, any other documentation is located in Appendix C. It should be noted that municipalities that were unable to attend regularly scheduled meetings were contacted individually.

The draft plan was made available for public review on January 21, 2021. The draft was advertised on Warren County's social media page and was made available digitally on the Warren County website at: https://warrencopa.com/planning-zoning/.

The public comment period remained open until February 22, 2021. All public comments were submitted via an online survey or in writing to Dan Glotz at the Warren County Planning and Zoning Department. All public comments have been included in this plan in Appendix C.

Table 5 - HMP Process Timeline

Warren County HMP Process - Timeline		
Date	**Meeting**	**Description**
05/04/2020	Warren County Hazard Mitigation Plan (HMP) Kick-Off Meeting	Identified challenges and opportunities as they relate to fulfilling the DMA 2000 requirements. Identified existing studies and information sources relevant to the hazard mitigation plan. Identified stakeholders, including the need to involve local officials.
06/30/2020	Local Planning Team Initial Meeting	Defined hazard mitigation planning and identified roles and responsibilities. Discussed the 2016 hazard mitigation plan and defined a timeline to complete the update.
06/30/2020	Municipal Kick-Off Meeting	Discussed the risk assessment and disseminated capability assessment surveys.
08/05/2020	Local Planning Team Meeting – Selection of Hazards	Warren County LPT met via WebEx to discuss hazards profiled in the previous plan and identify any *new* hazards to be included in the plan update.
09/16/2020	Local Planning Team Meeting – Risk Factor Assessment	Warren County LPT met via WebEx to determine a risk factor score for each of the selected hazards in the 2021 update. A municipal comparison document was then sent to all municipalities in Warren County for their input.
09/25/2020	Risk Factor Assessment Public Comment	Due to COVID-19, the risk factor assessment results of the Warren County Hazard Mitigation Plan were posted via social media and on the county website. Members of the public were encouraged to read and submit any comments on this via email or online survey.
10/07/2020	Local Planning Team Meeting – Mitigation Strategy	Warren County LPT met via WebEx to start mitigation strategy development by reviewing goals and objectives from the 2016 plan. Additionally, the LPT discussed *new* goals and objectives for the 2021 plan update.
11/04/2020	Local Planning Team Meeting – Mitigation Strategy	Warren County LPT met via WebEx to continue mitigation strategy development by finalizing the goals and objectives to be included in this plan update. The LPT also reviewed all mitigation actions from the 2016 plan and discussed new actions for the plan update.
11/04/2020	Meetings with Municipal Officials	Educated county and local elected officials on the hazard mitigation planning process. Presented the findings of the hazard vulnerability analysis and risk assessment. Sought input for mitigation projects throughout the county. Distributed hazard mitigation project opportunity forms. This meeting was held via conference calls due to COVID-19.
11/05/2020	Meetings with Municipal Officials	Educated county and local elected officials on the hazard mitigation planning process. Presented the findings of the hazard vulnerability analysis and risk assessment. Sought input for mitigation projects throughout the county. Distributed hazard mitigation project opportunity forms. This meeting was held via conference calls due to COVID-19.
01/14/2021	Local Planning Team Meeting – Draft Plan Review	The draft HMP was made available to all members of the LPT prior to the start of the public review period. All were invited to submit any changes to the document before it was released to the public.

Warren County HMP Process - Timeline		
Date	**Meeting**	**Description**
01/21/2021	Warren County Hazard Mitigation Plan – Draft Plan Public Review	The draft HMP was made available for all members of the public to review. All were invited to submit any comments to the Warren County Planning and Zoning Department.

3.4. Public and Stakeholder Participation

Warren County engaged numerous stakeholders and encouraged public participation during the HMP update process. Advertisements for public meetings were completed utilizing the local newspaper and the Warren County website. Copies of those advertisements are located in Appendix C. Municipalities and other county entities were invited to participate in various meetings and encouraged to review and update various worksheets and surveys. Copies of all meeting agendas, meeting minutes and sign-in sheets are located in Appendix C. Worksheets and surveys completed by the municipalities and other stakeholders are located in appendices of this plan update as well. Municipalities were also encouraged to review hazard mitigation related items with other constituents located in the municipality like businesses, academia, private and nonprofit interests.

The tools listed below were distributed with meeting invitations, provided directly to municipalities to complete and return to the Warren County Emergency Management Agency or at meetings to solicit information, data and comments from both local municipalities and other key stakeholders. Responses to these worksheets and surveys are available for review at the Department of Public Safety.

1. **Risk Assessment Hazard Identification and Risk Evaluation Worksheet:** Capitalizes on local knowledge to evaluate the change in the frequency of occurrence, magnitude of impact and/or geographic extent of existing hazards and allows communities to evaluate hazards not previously profiled using the Pennsylvania Standard List of Hazards.
2. **Capability Assessment Survey:** Collects information on local planning, regulatory, administrative, technical, fiscal, and political capabilities that can be included in the countywide mitigation strategy.
3. **Municipal Project Opportunity Forms and Mitigation Actions:** Copies of the 2016 mitigation opportunity forms that were included in the current HMP were provided to the municipalities for review and amendment. These opportunities are located in Appendix G. The previous mitigation actions were provided and reviewed at update meetings. New 2021 municipal project opportunity forms are included as well, located in Appendix G.

As a result of COVID-19, the normal approach to engaging public input could not be taken. In an effort to capture public input, in lieu of a traditional approach to hazard mitigation, the Warren County LPT decided to utilize a virtual survey platform where any member of the public can pose a question or comment regarding the entire HMP document. Members of the public were also encouraged to contact Warren County Planning and Zoning Department, Warren County Emergency Management Agency or MCM Consulting Group, Inc. with any comments or questions regarding this update. Any public comment that was received during public meetings or during the draft review of the plan were documented and included in the plan. Copies of newspaper public meeting notices, website posted public notices and other correspondence are included in Appendix C of this plan.

Warren County invited all contiguous counties to review the 2021 draft hazard mitigation plan. A letter was sent to the emergency management coordinator in McKean, Forest, Venango, Crawford, and Erie Counties in Pennsylvania, and Chautauqua County in New York on May 12, 2020. Copies of these letters are included in Appendix C.

3.5. Multi-Jurisdictional Planning

Warren County used an open, public process to prepare this HMP. Meetings and letters to municipal officials were conducted to inform and educate them about hazard mitigation planning and its local requirements. Municipal officials provided information related to existing codes and ordinances, the risks and impacts of known hazards on local infrastructure and critical facilities and recommendations for related mitigation opportunities. The pinnacle to the municipal involvement process was the adoption of the final plan. *Table 6 - Worksheets, Surveys and Forms Participation* reflects the municipality participation by completing worksheets, surveys, and forms.

Table 6 - Worksheets, Surveys and Forms Participation

Municipality Participation in Worksheets, Surveys and Forms			
Municipality	**Capability Assessment Survey**	**Risk Assessment Hazard Identification and Risk Evaluation Worksheet**	**Hazard Mitigation Opportunity Form Review and Updates**
Bear Lake Borough	X	X	
Brokenstraw Township	X	X	
Cherry Grove Township	X	X	
Clarendon Borough	X	X	
Columbus Township	X	X	
Conewango Township	X	X	
Deerfield Township	X	X	
Eldred Township	X	X	X
Elk Township	X	X	X
Farmington Township	X	X	
Freehold Township	X	X	
Glade Township	X	X	X
Limestone Township	X	X	
Mead Township	X	X	X
Pine Grove Township	X	X	X
Pittsfield Township	X	X	X
Pleasant Township	X	X	X
Sheffield Township	X	X	X
Southwest Township	X		
Spring Creek Township	X	X	X
Sugar Grove Borough	X	X	
Sugar Grove Township	X	X	
Tidioute Borough	X	X	
Triumph Township	X	X	X
Warren City	X	X	X
Watson Township	X	X	X
Youngsville Borough	X	X	

In March of 2020, Pennsylvania and the rest of the world experienced a pandemic event entitled COVID-19. Unfortunately, because of the pandemic, public meetings were unable to be held as normal during the hazard mitigation planning process. In lieu of a public meeting for the risk factor assessment results of the plan update were posted to Warren County's website as well as their social media platforms. Members of the public were encouraged to submit any comments via SurveyMonkey, an online survey platform, or to contact MCM Consulting Group, Inc. with any questions or comments.

All twenty-seven municipalities within Warren County adopted the 2016 Warren County Hazard Mitigation Plan as the municipal hazard mitigation plan. The goal of the Warren County Local Planning Team is to 100% participation by municipalities in adopting the 2021 Warren County Hazard Mitigation Plan.

4. Risk Assessment

4.1. Update Process Summary

A key component to reducing future losses is to first have a clear understanding of what the current risks are and what steps may be taken to lessen their threat. The development of the risk assessment is the critical first step in the entire mitigation process, as it is an organized and coordinated way of assessing potential hazards and risks. The risk assessment identifies the effects of both natural and manmade hazards and describes each hazard in terms of its frequency, severity, and county im-pact. Numerous hazards were identified as part of the process.

A risk assessment evaluates threats associated with a specific hazard and is defined by probability and frequency of occurrence, magnitude, severity, exposure, and consequences. The Warren County risk assessment provides in-depth knowledge of the hazards and vulnerabilities that affect Warren County and its municipalities. This document uses an all-hazards approach when evaluating the hazards that affect the county and the associated risks and impacts each hazard presents.

This risk assessment provides the basic information necessary to develop effective hazard mitigation/prevention strategies. Moreover, this document provides the foundation for the Warren County Emergency Operations Plan (EOP), local EOPs and other public and private emergency management plans.

The Warren County risk assessment is not a static document, but rather, is a biennial review requiring periodic updates. Potential future hazards include changing technology, new facilities and infrastructure, dynamic development patterns and demographic and socioeconomic changes into or out of hazard areas. By contrast, old hazards, such as brownfields and landfills, may pose new threats as county conditions evolve.

Using the best information available and Geographic Information Systems (GIS) technologies, the county can objectively analyze its hazards and vulnerabilities. Assessing past events is limited by the number of occurrences, scope and changing circumstances. For example, ever-changing development patterns in Pennsylvania have a dynamic impact on traffic patterns, population density and distribution, storm water runoff and other related factors. Therefore, limiting the risk assessment to past events is myopic and inadequate.

The Warren County Local Planning Team reviewed and assessed the change in risk for all natural and manmade hazards identified in the 2016 hazard mitigation plan. The mitigation planning team then identified hazards that were outlined within the Pennsylvania Hazard Mitigation Plan but not included in the 2016 Warren County Hazard Mitigation Plan that could impact Warren County. The team utilized the Hazard Identification and Risk Evaluation worksheet that was provided by the Pennsylvania Emergency Management Agency.

The Warren County Steering Committee met with municipalities and provided guidance on how to complete the municipal hazard identification and risk evaluation worksheet. Nineteen municipalities returned a completed worksheet. This information was combined with the county information to develop an overall list of hazards that would need to be profiled.

Once the natural and manmade hazards were identified and profiled, the local planning team then completed a vulnerability assessment for each hazard. An inventory of vulnerable assets was completed utilizing GIS data and local planning team knowledge. The team used the most recent Warren County assessment data to estimate loss to particular hazards. Risk factor was then assessed to each profiled hazard utilizing the hazard prioritization matrix. This assessment allows the county and its municipalities to focus on and prioritize

local mitigation efforts on areas that are most likely to be damaged or require early response to a hazard event.

4.2. Hazard Identification

4.2.1. Presidential and Gubernatorial Disaster Declarations

Table 7 - Presidential & Gubernatorial Disaster Declarations presents a list of all Presidential and Governor's Disaster Declarations that have affected Warren County from 1955 through 2020, according to the Pennsylvania Emergency Management Agency.

Table 7 - Presidential & Gubernatorial Disaster Declarations

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	**Hazard Event**	**Action**
September, 1955	Drought	Gubernatorial Declaration
January, 1966	Heavy snow	Gubernatorial Declaration
February, 1972	Heavy snow	Gubernatorial Declaration
June, 1972	Flood (Agnes)	Presidential Disaster Declaration
February, 1974	Truckers strike	Gubernatorial Declaration
January, 1978	Heavy snow	Gubernatorial Declaration
February, 1978	Blizzard	Gubernatorial Declaration
March, 1993	Blizzard	Presidential Emergency Declaration
January, 1994	Severe winter storms	Presidential Disaster Declaration
September, 1995	Drought	Gubernatorial Declaration
January, 1996	Severe winter storms	Presidential Disaster Declaration
January, 1996	Flooding	Presidential Disaster Declaration
July, 1999	Drought	Gubernatorial Declaration
September, 1999	Hurricane Floyd	Presidential Disaster Declaration
December, 1999	Drought	Gubernatorial Declaration
September, 2003	Hurricane Isabel/Henri	Presidential Disaster Declaration
September, 2004	Tropical Depression Ivan	Presidential Disaster Declaration
September, 2005	Hurricane Katrina – to render mutual aid and to receive and house evacuees	Presidential Emergency Declaration
September, 2005	Hurricane Katrina	Gubernatorial Proclamation of Emergency
September, 2006	Tropical depression Ernesto	Gubernatorial Proclamation of Emergency
February, 2007	severe winter storm	Gubernatorial Proclamation of Emergency
February, 2007	Waive the regulations regarding hours of service limitations for drivers of commercial vehicles	Gubernatorial Proclamation of Emergency
April, 2007	Severe storm	Gubernatorial Declaration
April, 2007	Severe winter storm	Gubernatorial Proclamation of Emergency
February, 2010	severe winter storm	Gubernatorial Proclamation of Emergency
October, 2010	Hurricane Sandy	Presidential Emergency Declaration
January, 2011	Severe winter storm	Gubernatorial Proclamation of Emergency
September, 2011	Severe storms and flooding (Lee/Irene)	Gubernatorial Proclamation of Emergency
April, 2012	Spring winter storms	Gubernatorial Proclamation of Emergency
October, 2012	Hurricane Sandy	Gubernatorial Proclamation of Emergency
June, 2013	High winds, thunderstorms, heavy rain, tornado, flooding	Gubernatorial Proclamation of Emergency

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	**Hazard Event**	**Action**
January, 2014	Extended prolonged cold	Gubernatorial Proclamation of Emergency
January, 2014	Driver hours waived due to prolonged and continued severe winter weather	Gubernatorial Proclamation of Emergency
February, 2014	Severe winter weather	Gubernatorial Proclamation of Emergency
February, 2014	Severe winter storm	Presidential Proclamation of Emergency
March, 2017	Severe winter storm	County and Municipal Declarations
July, 2017	Flash flooding	County and Municipal Declarations
January, 2018	Opioid crisis	Gubernatorial Proclamation of Emergency
March, 2020	COVID-19	Presidential Disaster Declaration

Source: Pennsylvania Emergency Management Agency and Federal Emergency Management Agency

4.2.2. Summary of Hazards

The Warren County Local Planning Team (LPT) was provided the Pennsylvania Standard List of Hazards to be considered for evaluation in the 2021 HMP Update. Following a review of the hazards considered in the 2016 HMP and the standard list of hazards, the local planning team decided that the 2021 plan should identify, profile and analyze twenty-five hazards. These twenty-two hazards include all of the hazards profiled in the 2016 plan. The list below contains the twenty-two hazards that have the potential to impact Warren County as identified through previous risk assessments, the Warren County Hazards Vulnerability Analysis and input from those that participated in the 2021 HMP update. Hazard profiles are included in Section 4.3 for each of these hazards.

Identified Natural Hazards

Drought

Drought is defined as a deficiency of precipitation experienced over an extended period of time, usually a season or more. Droughts increase the risk of other hazards, like wildfires, flash floods, and landslides or debris flows. This hazard is of particular concern in Pennsylvania due to the prevalence of farms and other water-dependent industries, water dependent recreation uses, and residents who depend on wells for drinking water.

Earthquake

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper ten to twenty miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons and disrupt the social and economic functioning of the affected area. Most property damage and earthquake-related deaths are caused by the failure and collapse of structures due to ground shaking which is dependent upon amplitude and duration of the earthquake. (FEMA, 1997).

Extreme Temperatures

Extreme cold temperatures drop well below what is considered normal for an area during the winter months and often accompany winter storm events. Combined with increases in wind speed, such temperatures in Pennsylvania can be life threatening to those exposed for extended periods of time. Extreme heat can be described as temperatures that hover 10°F or more above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined.

Flood, Flash Flood,

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding is typically experienced when precipitation occurs over a given river basin for an extended period of time. Flash flooding is usually a result of heavy localized precipitation falling in a short time period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. The severity of a flood event is dependent upon a combination of stream and river basin topography and physiography, hydrology, precipitation and weather patterns, present soil moisture conditions, the degree of vegetative clearing as well as the presence of impervious surfaces in and around flood-prone areas.

Hailstorm

In addition to flooding and severe winds, hail is another potential damaging product of severe thunderstorms. Hailstorms occur when ice crystals form within a low pressure front due to the rapid rise of warm air into the upper atmosphere and the subsequent cooling of the air mass. Frozen droplets gradually accumulate on the ice crystals until, having developed sufficient weight, they fall as precipitation in the form of balls or irregularly shaped masses of ice greater than 0.75 inches in diameter (FEMA, 1997). The size of hailstones is a direct function of the size and severity of the storm. High velocity updraft winds are required to keep hail in suspension in thunderclouds. The strength of the updraft is a function of the intensity of heating at the Earth's surface. Damage to crops and vehicles are typically the most significant impacts of hailstorms. Areas in eastern and central Pennsylvania typically experience less than two hailstorms per year while areas in western Pennsylvania experience 2-3 annually.

Hurricanes, Tropical Storms

Hurricanes, tropical storms, and nor'easters are classified as cyclones and are any closed circulation developing around a low-pressure center in which the winds rotate counterclockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. Potential threats from hurricanes include powerful winds, heavy rainfall, storm surges, coastal and inland flooding, rip currents, tornadoes, and landslides. The Atlantic hurricane season runs from June 1 to November 30.

Invasive Species

An invasive species is a species that is not indigenous to the ecosystem under consideration and whose introduction causes or is likely to cause economic, environmental, or human harm. These species can be any type of organism: plant, fish, invertebrate, mammal, bird, disease, or pathogen.

Landslide

In a landslide, masses of rock, earth or debris move down a slope. Landslides can be caused by a variety of factors, including earthquakes, storms, fire, and human modification of land. Areas that are prone to landslide hazards include previous landslide areas, areas on or at the base of slopes, areas in or at the base of drainage hollows, developed hillsides with leach field septic systems, and areas recently burned by forest or brush fires.

Lightning Strikes

Lightning is a discharge of electrical energy resulting from the build-up of positive and negative charges within a thunderstorm. The flash or "bolt" of light usually occurs within clouds or between clouds and the ground. A bolt of lightning can reach temperatures approaching 50,000°F. On average, eighty-nine people are killed each year by lightning strikes in the United States. Within Pennsylvania, the annual average number of thunder and lightning events in a given area can expect ranges between forty and seventy events per year (FEMA, 1997).

Pandemic and Infectious Diseases

A pandemic is a global outbreak of disease that occurs when a new virus emerges in the human population, spreading easily in a sustained manner, and causing serious illness. An epidemic describes a smaller scale infectious outbreak, within a region or population, that emerges at a disproportional rate. Infectious disease outbreaks may be widely dispersed geographically, impact large numbers of the population, and could arrive in waves lasting several months at a time.

Tornadoes, Windstorm

A tornado is a narrow, violently rotating column of air that extends from the base of a thunderstorm to the ground. About 1,250 tornadoes hit the U.S. each year, with about 16 hitting Pennsylvania. Damaging winds exceeding 50-60 miles per hour can occur during tornadoes, severe thunderstorms, winter storms, or coastal storms. These winds can have severe impacts on buildings, pulling off the roof covering, roof deck, or wall siding and pushing or pulling off the windows.

Wildfire

A wildfire is an unplanned fire that burnt in a natural area. Wildfires can cause injuries or death and can ruin homes in their path. Wildfires can be caused by humans or lightning, and can happen anytime, though the risk increases in period of little rain. In Pennsylvania, 98% of wildfires are caused by people.

Winter Storm

A winter storm is a storm in which the main types of precipitation are snow, sleet, or freezing rain. A winter storm can range from a moderate snowfall or ice event over a period of a few hours to blizzard conditions with wind-driven snow that lasts for several days. Most deaths from winter storms are not directly related to the storm itself, but result from traffic accidents on icy roads, medical emergencies while shoveling snow, or hypothermia from prolonged exposure to cold.

Identified Human Caused Hazards

Dam and Levee Failure

A dam is a barrier across flowing water that obstructs, directs, or slows down water flow. Dams provide benefits such as flood protection, power generation, drinking water, irrigation, and recreation. Failure of these structures results in an uncontrolled release of impounded water. Failures are relatively rare, but immense damage and loss of life is possible in downstream communities when such events occur. Aging infrastructure, hydrologic, hydraulic, and geologic characteristics, population growth and design and maintenance practices should be considered when assessing dam failure hazards. The failure of the South Fork Dam, located in Johnstown, Pennsylvania, was the deadliest dam failure ever experienced in the United States. It took place in 1889 and resulted in the Johnstown Flood which claimed 2,209 lives (FEMA, 1997). Today there are approximately 3,200 dams and reservoirs throughout Pennsylvania (Pennsylvania Department of Environmental Protection, 2009).

Disorientation

Large numbers of people are attracted to Pennsylvania's rural areas for recreational purposes such as hiking, camping, hunting, and fishing. As a result, people can be-come lost or trapped in remote and rugged wilderness areas. Search and rescue may be required for people who suffer from medical problems or injuries and those who become accidentally or intentionally disoriented. Search and rescue efforts are focused in and around state forest and state park lands (DCNR, 2009).

Drowning

Drowning is death from suffocation, typically associated with swimming, fishing, boating or bridge accidents, or suicide. It can be a significant hazard in communities with numerous residential pools or water bodies (e.g. ponds, lakes, rivers, etc.) and extensive outdoor recreational activity. Drowning rates are particularly high for children ages one to fourteen. The Centers for Disease Control and Prevention estimates that drowning is the second leading cause of injury death (after motor vehicle crashes) among children ages one to fourteen. (CDC, 2008).

Emergency Services

Emergency medical services (EMS) and fire department services play a crucial role in the emergency response system, and the functionality of these emergency services directly impacts many of the other hazards profiles in this report. Both EMS and fire services face challenges from lack of funding and lower rates of volunteerism.

Environmental Hazards

Environmental hazards are hazards that pose threats to the natural environment, the built environment and public safety through the diffusion of harmful substances, materials, or products. Environmental hazards include the following: Hazardous material releases: at fixed facilities or as such materials are in transit and including toxic chemicals, infectious substances, biohazardous waste and any materials that are explosive, corrosive, flammable, or radioactive (PL 1990-165, § 207(e)). Air or Water Pollution; the release of harmful chemical and waste materials into water bodies or the atmosphere Superfund Facilities: hazards originating from abandoned hazardous waste sites listed on the National Priorities List Manure Spills: involving the release of stored or transported agricultural waste.

Substance Abuse

Substance abuse is the rapid increase in the use of prescription and non-prescription opioid drugs in the United States beginning in the late 1990s and continuing throughout the first two decades of the 2000s. Opioids are a diverse class of moderately strong painkillers, including oxycodone, hydrocodone, and a very strong painkiller, fentanyl, which is synthesized to resemble other opiates such as opium-derived morphine and heroin. The potency and availability of these substances, de-spite their high risk of addiction and over-dose, have made them popular both as for-mal medical treatments and as recreation-al drugs. Due to their sedative effects on the part of the brain which regulates breathing, opioids in high doses present the potential for respiratory depression and may cause respiratory failure and death.

The Commonwealth of Pennsylvania, along with other states in the nation has enact-ed legislation to curb the prescription and distribution of these drugs to try to prevent addiction rising from abuse as a painkiller. This includes but is not limited to restrictions to prescribing to minors, quantity limits, a prescription data-base with entry requirements and other limits to its availability.

Terrorism

Terrorism is 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); and the use of chemical, biological, nuclear, and radiological weapons. Cyber-attacks have become an increasingly pressing concern. Cyber terrorism refers to acts of terrorism committed using computers, networks, and the Internet. The most widely cited definition comes from Denning's Testimony before the Special Oversight Panel on Terrorism: "Cyberterrorism…is gener-ally understood to mean unlawful attacks and threats of attack against computers, networks, and the infor-mation stored therein when done to intimidate or coerce a government or its people in furtherance of polit-ical or social objectives. Further, to qualify as cyberterrorism, an attack should result in violence against persons or property, or at least cause enough harm to generate fear".

Transportation Accidents

Transportation accidents are technological hazards involving the nation's system of land, sea, and air trans-portation infrastructure. A flaw or breakdown in any component of this system can and often does result in a major disaster involving loss of life, injuries, property and environmental damage, and economic conse-quences.

Utility Interruption

Utility interruption hazards are hazards that impair the functioning of important utilities in the energy, telecommunications and public works and information network sectors. Utility interruption hazards include the following:

- Geomagnetic Storms
- Fuel or Resource Shortage
- Electromagnetic Pulse
- Information Technology Failure
- Ancillary Support Equipment
- Public Works Failure
- Telecommunications System Failure
- Transmission Facility or Linear Utility Accident
- Major Energy, Power, Utility Failure

4.2.3. Climate Change

Impacts of Climate Change on Identified Hazards

Humans have become the dominant species on Earth and our society and influence is globalized. Human activity such as the large-scale consumption of fossil fuels and de-forestation has caused atmospheric carbon dioxide concentrations to significantly in-crease and a notable diversity of species to go extinct. The result is rapid climate change unparalleled in Earth's history and an extinction event approaching the level of a mass extinction (Barnosky et al., 2011; Wake & Vredenburg, 2008). The corresponding rise of average atmospheric temperatures is intensifying many natural hazards, and further threatening biodiversity. The effects of climate change on these hazards is expected to intensify over time as temperatures continue to rise, so it is prudent to be aware of how climate change is impacting natural hazards.

The most obvious change is in regard to extreme temperature (Section 4.3.3). As average atmospheric temperatures rise, extreme high temperatures become more threatening, with record high temperatures outnumbering record low temperatures 2:1 in recent years (Meehl et al., 2009). As climate change intensifies, it is expected that the risk of extreme heat will be amplified whereas the risk of extreme cold will be attenuated. Less immediately apparent, climate change could increase the prevalence of the West Nile Virus (Section 4.3.7). Some studies show increased insect activities during a similar rapid warming event in Earth's history (Curano et al., 2008). Other studies make projections that with the warming temperatures and lower annual precipitation that are expected with climate change, there will be an expansion of the suitable climate for mosquitos and West Nile Virus, potentially increasing the risk that the disease poses (Harrigan et al., 2014).

Climate change is likely to increase the risk of droughts (Section 4.3.1). Higher average temperatures mean that more precipitation will fall as rain rather than snow, snow will melt earlier in the spring, and evaporation and transpiration will increase. Along with the prospect of decreased annual precipitation, the risk of hydrological and agricultural drought is expected to increase (Sheffield & Wood, 2008). Correspondingly this will impact wildfires (Section 4.3.12). Drought is accompanied by drier soils and forests, resulting in an elongated wildfire season and more intense and long-burning wildfires (Pechony & Shindell, 2010). However, the Southwest United States is at a greater risk of this increased drought and wildfire activity than in the Eastern United States.

While it may seem counterintuitive considering the increased risk of drought, there is also an increased risk of flooding associated with climate change (Section 4.3.4). As previously mentioned, warmer temperatures mean more precipitation will fall as rain rather than snow. Combined with the fact that warmer air holds

more moisture, the result is heavier and more intense rainfalls, increasing the risk of flooding and dam and levee failures. Similarly, winter storms are expected to become more intense, if possibly less frequent (Section 4.3.13). Climate change is also expected to result in more intense hurricanes and tropical storms (Section 4.3.6). With the rise of atmospheric temperatures, ocean surface temperatures are rising, resulting in warmer and moister conditions where tropical storms develop (Stott et al., 2010). A warmer ocean stores more energy and is capable of fueling stronger storms. It is projected that the Atlantic hurricane season is elongating, and there will be more category 4 and 5 hurricanes than before (Trenberth, 2010).

Climate change is contributing to the introduction of new invasive species (Section 4.3.7). As maximum and minimum seasonal temperatures change, non-native species are able to establish themselves in previously inhospitable climates where they have a competitive advantage. This may shift the dominance of ecosystems in the favor of non-native species, contributing to species loss and the risk of extinction.

This type of sudden global change is novel to humanity. Despite the myriad of well thought out research, there is still much uncertainty surrounding the future of the Earth. All signs point to the intensification of the hazards mentioned above, especially if human society and individuals do not make swift and significant changes to reduce emissions and species losses.

4.3. Hazard Profiles

4.3.1. Drought

4.3.1.1 Location and Extent

While Pennsylvania is generally more water-rich than many U.S. states, the Commonwealth may be subject to drought conditions. A drought is broadly defined as a time period of prolonged dryness that contributes to the depletion of ground and surface water. Droughts are regional climatic events, so when such an event occurs in Warren County, impacts are not restricted to the county and are often more widespread. The spatial extent of the impacted area can range from localized areas in Pennsylvania to the entire Mid-Atlantic region.

There are three types of drought:

Meteorological Drought – A deficiency of moisture in the atmosphere compared to average conditions. Meteorological drought is defined by the duration of the deficit and degree of dryness and is often associated with below average rainfall. Depending on the severity of the drought, it may or may not have a significant impact on agriculture and the water supply.

Agricultural Drought – A drought inhibiting the growth of crops, due to a moisture deficiency in the soil. Agricultural drought is linked to meteorological and hydrologic drought.

Hydrologic Drought – A prolonged period without rainfall that has an adverse effect on streams, lakes, and groundwater levels, potentially impacting agriculture.

Leaving areas with little moisture, droughts are often one of the leading contributing factors to wildfires.

Droughts have several effects:

- Depletion of consumable water supply
- Depletion of agricultural water supply
- Depletion of forest water and water used to fight forest fires
- Depletion of water for navigational and recreational purposes
- Depletion of water for natural irrigation (besides crops and forests)

- Poor water quality

Droughts can have adverse effects on farms and other water-dependent industries. This can result in a local economic loss. According to the 2017 U.S. Census of Agriculture, there are 452 farms (a smaller number than recorded in the 2012 census) consisting of 68,153 acres that produce livestock and crops; the average size of a farm in Warren County is 151 acres, which is about ten acres greater than the average size of a farm recorded in the 2012 census.

Public safety is an issue in terms of consumable water not being available, as well as water for fire protection and emergency services.

4.3.1.2 Range of Magnitude

Warren County's Comprehensive Plan (October 2016) states that some of its objectives are these: protection of natural resources; providing for wetlands and a reliable supply of water that considers current and future availability; and, preservation and enhancement of prime agricultural land to encourage compatibility between regulations and operations. Drought can provide serious challenges to the plan's objectives because over 35% of the county's land use is in agriculture and the county is home to thousands of acres of forests, state and local parks and thirty-five areas of Natural Heritage significance.

Nearly 50% of the annual precipitation of 41.4 inches is during the spring/summer. Fall is usually the driest. Average snowfall for the county is 35.4 inches. Rural farming areas of Warren County are most at risk when a drought occurs. A drought can be a significant financial burden as approximately 54% of the county farmland use is devoted to crop cultivation and another 46% to livestock and poultry. (U.S. Census of Agriculture, 2017). Wildfires are often the most severe secondary effect associated with drought. Wildfires can devastate wooded and agriculture areas, threatening natural resources, structures near high wildfire loads, and farm production facilities. Prolonged drought conditions can have a lasting impact on the economy and can cause major ecological changes, such as increases in scrub growth, flash flooding and soil erosion.

Drought preparation includes three phases: drought watch, drought warning, and drought emergency, as shown in the table below.

Table 8 - Drought Preparation Phases

Drought Preparation Phases *(PA DEP, 2017)*				
Phase	**General Activity**	**Actions**	**Request**	**Goal**
Drought Watch	Early stages of planning and alert for drought possibility	Increased water monitoring, awareness and preparation for response among government agencies, public water suppliers, water users and the public	Voluntary water conservation	Reduce water use by 5%
Drought Warning	Coordinate a response to imminent drought conditions and potential water shortages	Reduce shortages - relieve stressed sources, develop new sources if needed	Continue voluntary water conservation, impose mandatory water use restrictions if needed	Reduce water use by 10-15%

Phase	General Activity	Actions	Request	Goal
Drought Emergency	Management of operations to regulate all available resources and respond to emergency	Support essential and high priority water uses and avoid unnecessary uses	Possible restrictions on all nonessential water uses	Reduce water use by 15%

Local Water Rationing: Although not a drought phase, local municipalities may, with the approval of the Pennsylvania Emergency Management Council, implement local water rationing to share a rapidly dwindling or severely depleted water supply in designated water supply service areas. These individual water rationing plans, authorized through provisions of 4 PA Code Chapter 120, will require specific limits on individual water consumption to achieve significant reductions in use. Under both mandatory restrictions imposed by the Commonwealth and local water rationing, procedures are provided for granting of variances to consider individual hardships and economic dislocations.

Long-term water shortages during severe drought conditions can have a significant impact on agribusiness, public utilities, and other industries reliant on water for production services. Warren County also has a growing agritourism business that would be threatened by long-term drought. *Table 8 - Drought Preparation Phases* shows the FEMA defined levels of drought severity along with suggested actions, requests and goals. Drought can cause municipalities to enforce water rationing and distribution.

The Commonwealth uses five parameters to assess drought conditions:

- Stream flows (compared to benchmark records);
- Precipitation (measured as the departure from normal, thirty-year average precipitation);
- Reservoir storage levels in a variety of locations such as three New York City reservoirs in the upper Delaware River Basin;
- Groundwater elevations in a number of counties (comparing to past month, past year and historic record); and
- Soil moisture via the Palmer Drought Index (See *Table 9 – Palmer Drought Severity Index*) - a soil moisture algorithm calibrated for relatively homogeneous regions which measures dryness based on recent precipitation and temperature.

Table 9 - Palmer Drought Severity Index

Palmer Drought Severity Index	
Severity Category	**PDSI**
Extremely wet	4.0 or more
Very wet	3.0 to 3.99
Moderately wet	2.0 to 2.99
Slightly wet	1.0 to 1.99
Incipient wet spell	0.5 to 0.99
Near normal	0.49 to -0.49
Incipient dry spell	-0.5 to -0.99
Mild drought	-1.0 to -1.99
Moderate drought	-2.0 to -2.99
Severe drought	-3.0 to -3.99
Extreme drought	-4.0 or less

4.3.1.3 Past Occurrence

Between 1930 and 1994, the Commonwealth of Pennsylvania experienced five significant droughts: 1930-1934, 1939-1942, 1953-1955, 1961-1967, and 1991-1992. The drought of 1991 had a significant impact on Warren County agricultural production. During the drought, Warren County farmers felt the negative impact. Specific data is limited, but the Governor's Proclamation of Disaster Emergency stated that the drought caused "millions of dollars" in damages to crops and agricultural businesses.

A significant drought occurred in 1963 when precipitation statewide averaged below normal for ten of twelve months. Drought emergency status led to widespread water use restrictions, and reservoirs dipped to record low levels. Corn, hay, and other agricultural products desiccated in parched fields, causing economic losses. Governor William Scranton sought drought aid for Pennsylvania in the face of mounting agricultural losses, and the event became a presidentially declared disaster in September 1963.

Warren County experienced a major drought in 1988. The Soil Conservation Service responded to inquiries by area farmers concerning deficient water supplies for livestock. Federal assistance for loss of crops in the county received in the form of drought disaster payments totaled $222,506.00. These payments were divided between losses for corn, hay and other vegetables. 1,901,247 pounds of emergency feed worth $69,093.00 was given to farmers who had losses of 40% or more of their normal crops. Farmers continued to suffer the effects of drought in 1989, where $75,851.00 was distributed for crop losses. Vegetables, oats, rye, soybeans and corn were lost due to drought. In 1990, only $502.00 were distributed for buckwheat and corn losses. In 1991, $64,598.00 was disbursed for crop losses. These conditions continued into 1992, where $53,389.00 was given to Warren County farmers due to crop losses. Drought conditions in 1993 brought $113,963.00 worth of federal aid to Warren County. In 2000, $23,182.00 in federal assistance was distributed to farmers in Warren County due to crop losses stemming from drought.

A Commonwealth-wide devastating drought began in December 1998 and continued into 1999, culminating with the governor of Pennsylvania declaring a drought emergency for most of the Commonwealth on July 21, 1999. Corn crop losses alone were estimated to be approximately $100 million with total crop losses estimated at over $500 million. Other than agricultural losses, the drought resulted in low stream

levels which caused some deaths of fish in abnormally dry streams. The drought emergency was lifted on September 30, 1999 with the arrival of Hurricane Floyd on September 16, 1999.

From 1999 through early 2003, the area experienced a severe drought (per PA DEP), as did most of the mid-Atlantic region.

Warren County most recently experienced drought emergencies and water supply deficiencies during the drought watches of 2016-2017. Drought conditions impact land covering Warren County and the potential for wildfire increases dramatically during extended drought conditions.

According to the Pennsylvania Department of Environmental Protection, the last time Warren County was in any declared drought status (watch) was in November 2016. The Commonwealth itself, however, endured an extended drought watch into May 2017 but dissolved the Commonwealth Drought Task Force on May 17, 2017 after a couple of rainy seasons.

According to the Palmer Drought Severity Index below, Warren County spent 5% - 9.9% of the time between 1895 and 1995 in a severe and extreme drought.

Figure 7 - Palmer Drought Severity Index

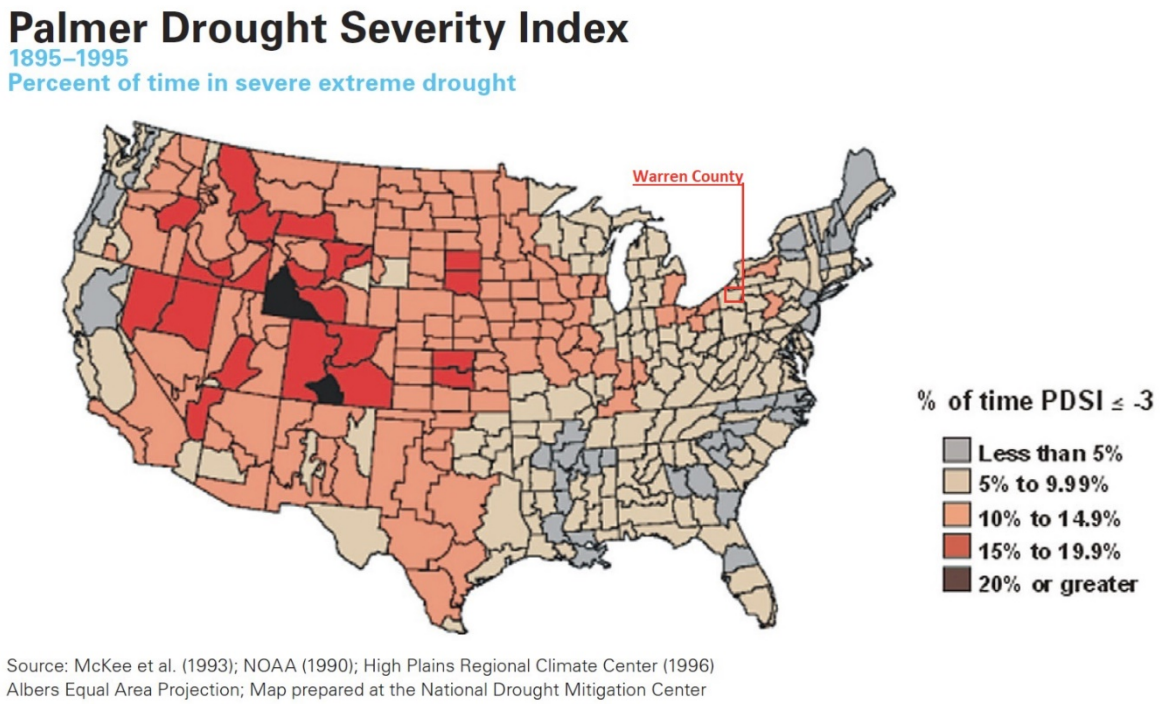


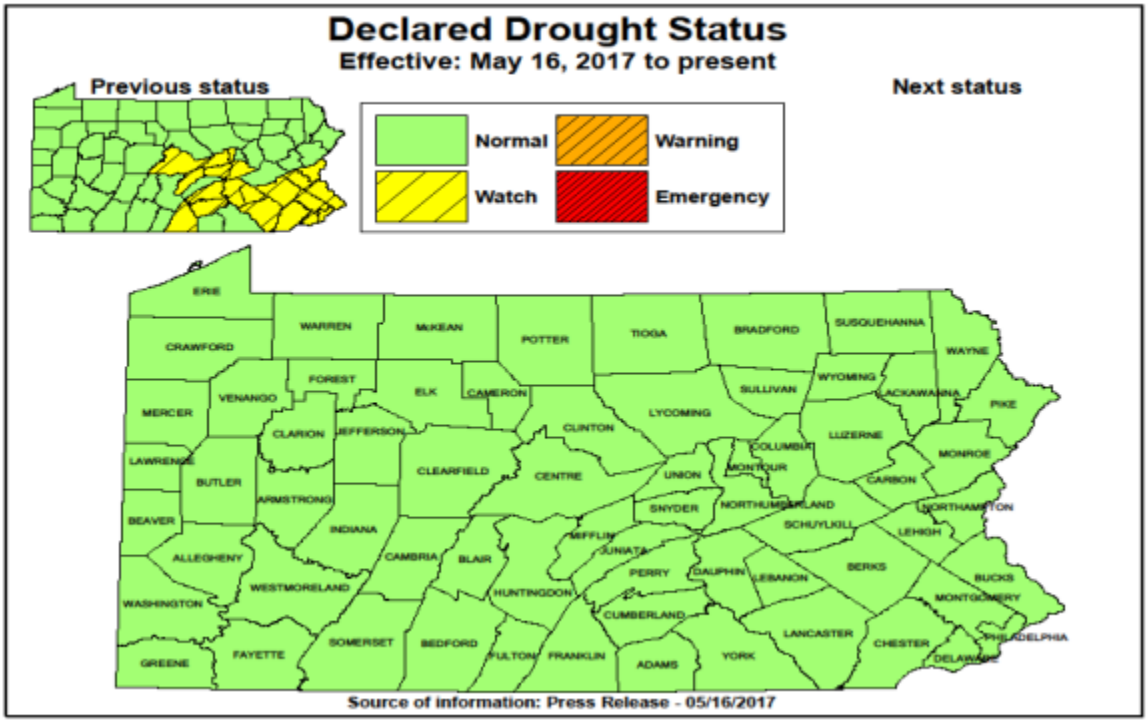
Table 10 – Drought Occurrence in Pennsylvania shows declared drought status for Pennsylvania from 1980 to January 2020 as reported by the Pennsylvania Department of Environmental Protection (PA DEP). The table also includes one disaster declaration that included Warren County due to drought events. In the summer of 1999, the entire mid-Atlantic region was in severe drought conditions.

Table 10 - Drought Occurrence in Pennsylvania

Drought Occurrence in Pennsylvania *(PA DEP, 2019)*			
Start	**End**	**Status**	**Duration**
11/18/1980	04/20/1982	Emergency	1 year, 5 months, 2 days
04/26/1985	12/19/1985	Watch	7 months, 23 days
07/07/1988	08/24/1988	Watch	10 months, 8 days
08/24/1988	12/12/1988	Warning	
12/12/1988	05/15/1989	Watch	
06/28/1991	07/24/1991	Warning	11 months, 26 days
07/24/1991	04/20/1998	Emergency	
04/20/1998	06/23/1992	Warning	
09/01/1995	09/20/1995	Warning	3 months, 17 days
09/20/1995	11/08/1995	Emergency	
11/08/1995	12/18/1995	Warning	
07/17/1997	01/16/1998	Watch	5 months, 30 days
12/03/1998	12/14/1998	Watch	1 year, 5 months, 2 days
12/14/1998	03/15/1999	Warning	
03/15/1999	06/10/1999	Watch	
06/10/1999	07/20/1999	Warning	
07/20/1999	09/30/1999	Emergency**	
09/30/1999	05/05/2000	Watch	
08/24/2001	06/14/2002	Watch	9 months, 21 days
09/05/2002	11/07/2002	Watch	2 months, 2 days
04/11/2006	06/30/2006	Watch	2 months, 19 days
08/06/2007	01/11/2008	Watch	5 months, 5 days
09/16/2010	11/10/2010	Watch	1 month, 25 days
08/05/2011	09/02/2011	Watch	28 days
03/24/2015	07/10/2015	Watch	3 months, 16 days
08/02/2016	05/16/2017	Watch	9 months, 14 days
**Gubernatorial Disaster Declaration			

Figure 8 – Declared Drought Status Spring 2020 shows the current drought status from May 16, 2017 to present throughout the Commonwealth.

Figure 8 - Declared Drought Status Spring 2020



4.3.1.4 Future Occurrence

It is difficult to forecast the exact severity and frequency of future drought events and the future of climate change will lead to increased uncertainty and extremity of climate events, suggesting that it is best to be prepared for potentially adverse conditions. As Warren County has experienced severe drought between five and ten percent of the time between 1895 and 1995 (*Figure 7 – Palmer Drought Severity Index* – a 100-year data collection*)*, the report can be used to make a rough estimate of the future probability of drought in Warren County, although it does not account for changes introduced by climate change. Drought conditions are expected to become more severe with climate change, as evaporation and transpiration will increase with higher temperatures (Sheffield & Wood, 2008; EPA, 2016).

The potential for a drought to occur in Warren County is, nevertheless, high. Given the frequency of drought watches issued for Warren County and its municipalities, the county can reasonably expect to be under a drought watch at least once per year. While some form of drought condition frequently exists in Warren County, the impact depends on the duration of the event, severity of conditions, and area affected.

Figure 9 – U.S. Drought Monitor

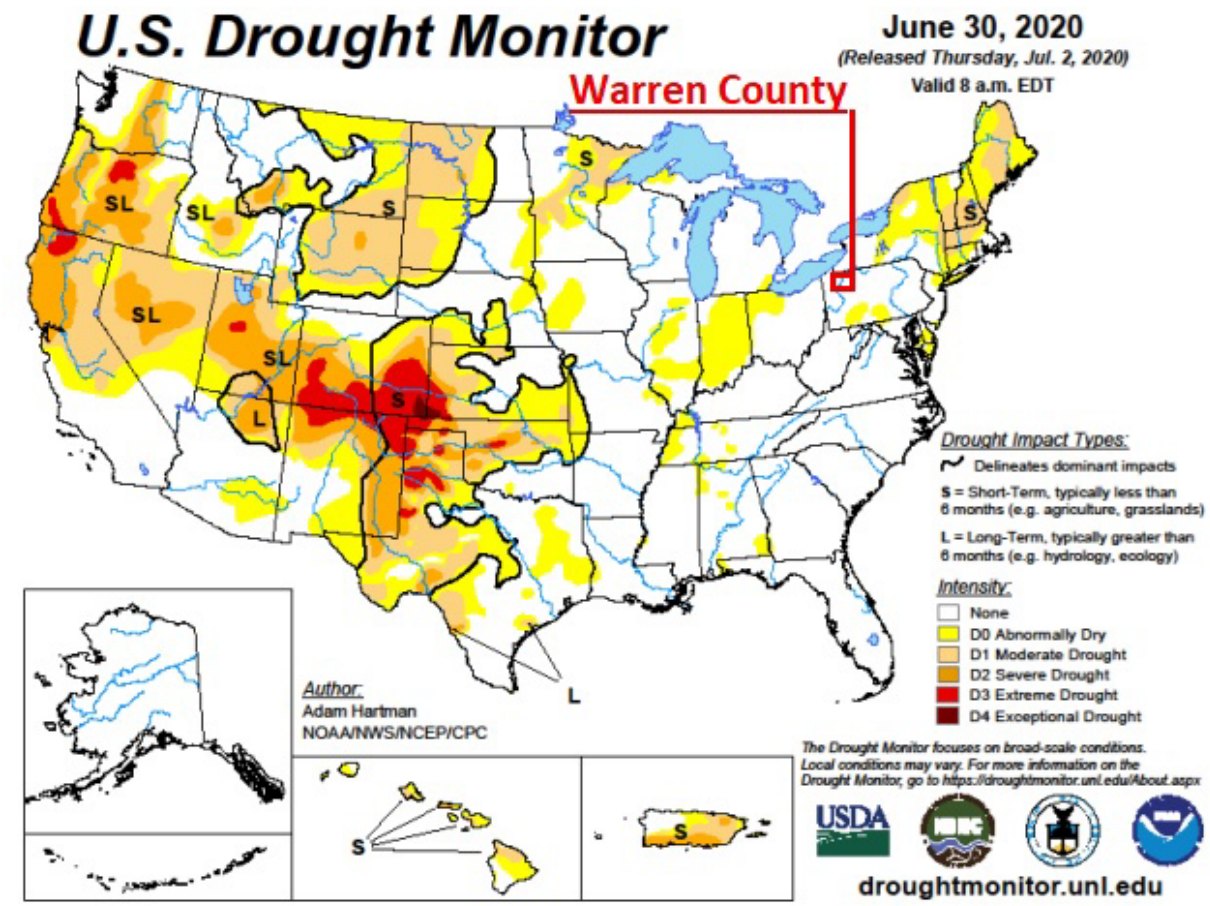


Figure 9 – U.S. Drought Monitor above shows that Warren County/all of Pennsylvania/the Mid-Atlantic region is currently in the percentile that is least vulnerable to drought events.

4.3.1.5 Vulnerability Assessment

Drought vulnerability depends on the duration and area of impact. However, other factors contribute to the severity of a drought. Unseasonably high temperatures, prolonged winds, and low humidity can heighten the impact of a drought.

Extended periods of drought can lead to lowered stream levels, altering the delicate balance of riverine ecosystems. Certain tree species are susceptible to fungal infections during prolonged periods of soil moisture deficit. Fall droughts pose a particular threat because groundwater levels are typically at their lowest following the height of the summer growing season.

Wildfire is the most severe secondary effect associated with drought. Wildfires can devastate wooded and agricultural areas, threatening natural resources and farm production facilities.

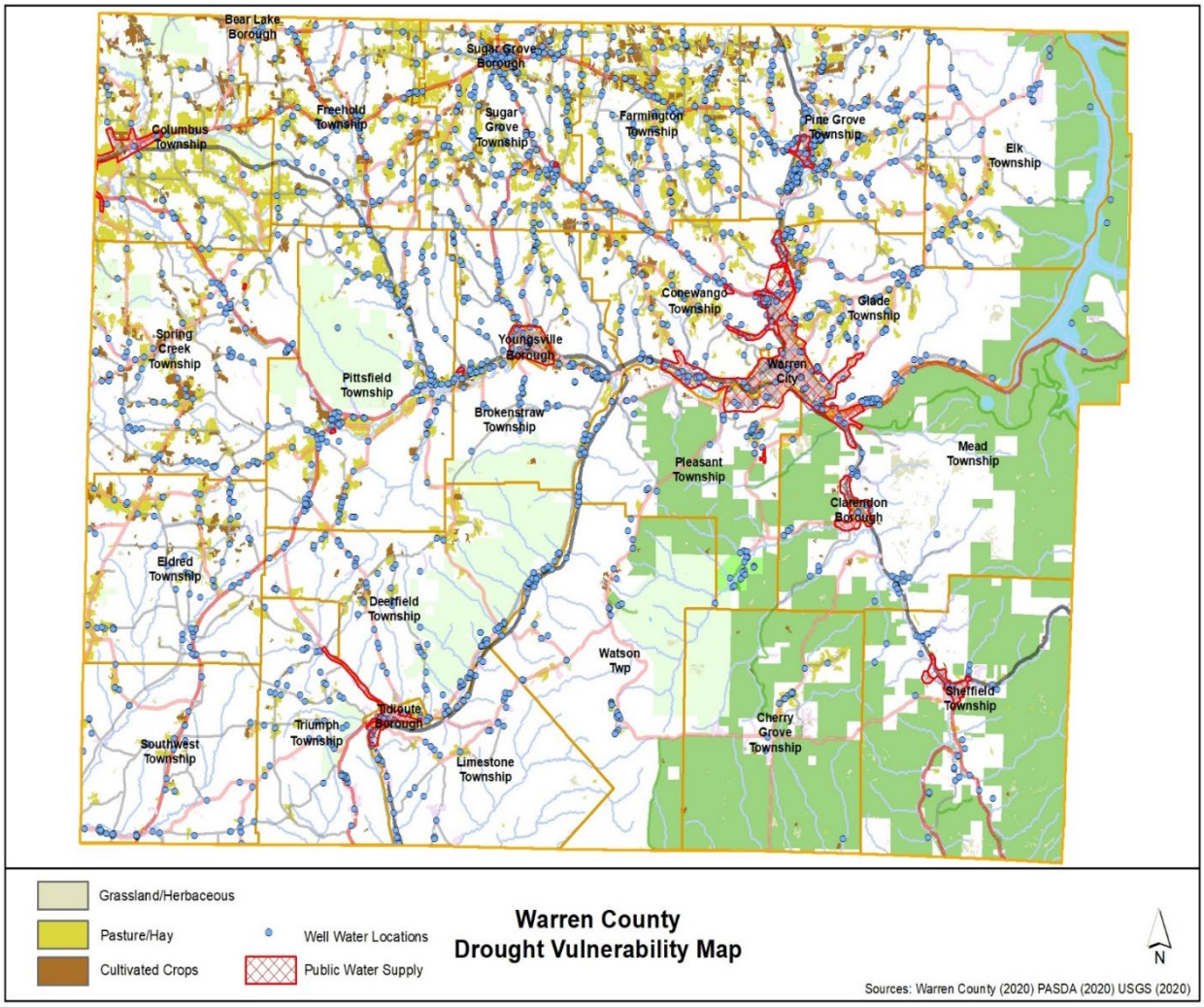
Prolonged drought conditions can cause major ecological changes, such as increases in scrub growth, flash flooding, and soil erosion.

Droughts can have adverse effects on farms and other water-dependent industries. This can result in a local economic loss. The 2017 U.S. Census of Agriculture lists over 68,000 acres of prime agricultural land in Warren County; nine local, county and state parks and six state Game Lands encompass over 32,000 acres and there are multiple recreational sites across the county dependent on consistent water sources and replenishment. From a societal perspective, public safety is an issue in terms of consumable water not being available, as well as water for fire protection and emergency services.

The most significant losses resulting from drought events are typically found in the agriculture sector. The 1999 Gubernatorial Proclamation was issued in large part due to significant crop damage. Preliminary estimates by the Pennsylvania Department of Agriculture indicated possible crop losses across the Commonwealth in excess of $500 million. This estimate did not include a 20% decrease in dairy milk production which also resulted in million-dollar losses (NCDC, 2009).

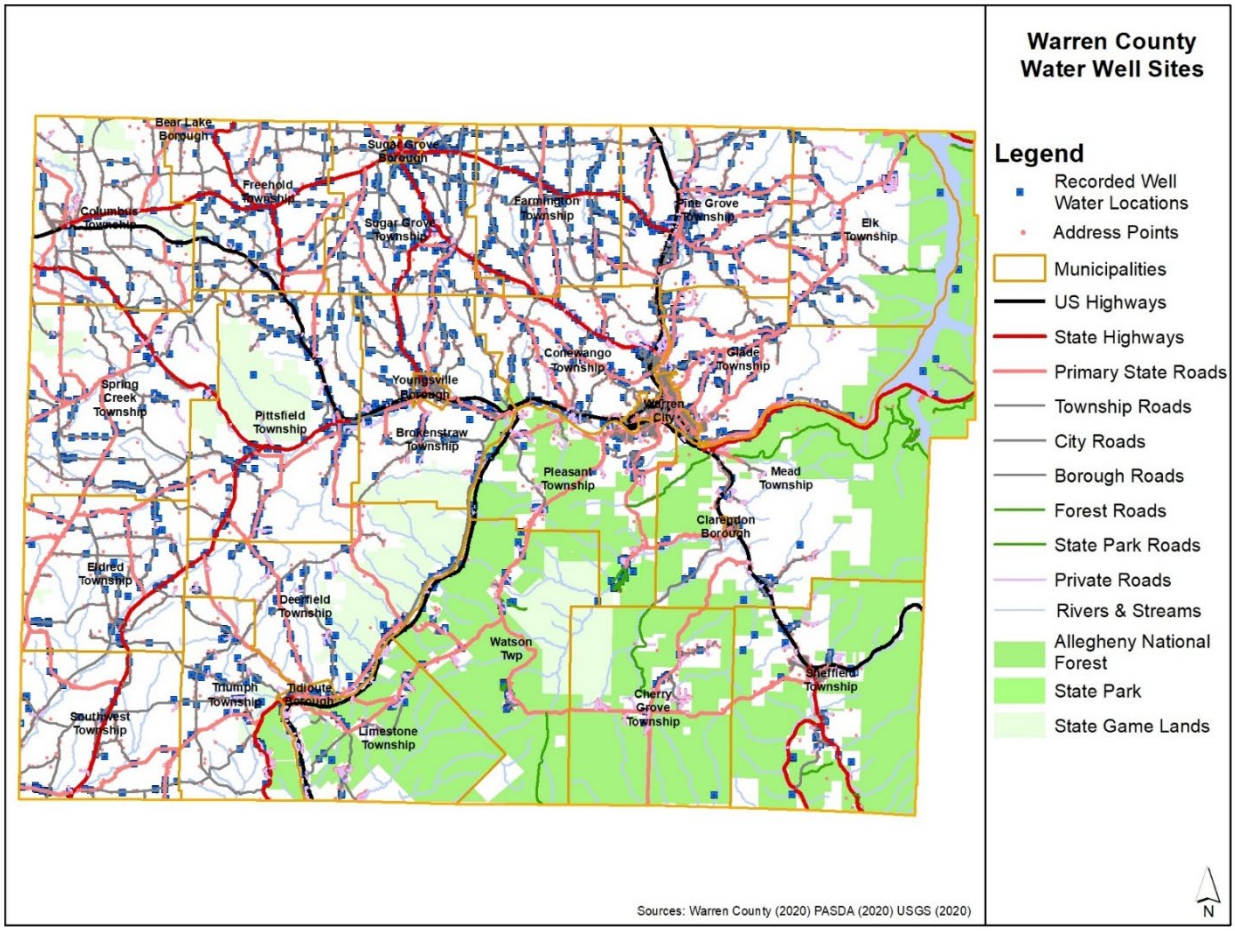
While these were statewide impacts, they illustrate the potential for droughts to severely impair the local economy in more agricultural communities. The 2017 Census of Agriculture reports there were 452 farms in Warren County, at an average size of 151 acres. Warren County ranks 52nd of sixty-seven counties in the Commonwealth for agricultural production, totaling just over $21,000.00 (USDA, 2017). Agricultural production from crops, including nursery and greenhouse crops, accounts for $6,000.00 in commerce annually. Production from livestock, poultry and their products accounts for $15,668.00 annually. A map of properties with tillable agricultural land use, forestry and other land in the county vulnerable to drought is shown in *Figure 10 – Land use and Cover Vulnerable to Drought*.

Figure 10 – Land Use and Cover Vulnerable to Drought



Public or municipal water supplies are also vulnerable to the effects of drought because supply sources include rivers, reservoirs, and groundwater. Public water service areas cover only some of the land area in the county, as depicted in *Figure 11 – Warren County Water Well Sites and Table 11 – Domestic Wells Per Municipality in Warren County.* The majority of the county relies on domestic wells for their fresh drinking water. Residents or water authorities that use private domestic wells are more vulnerable to droughts because their drinking water can literally dry up. Table 11 shows the number of domestic wells per municipality. There is a total of 3,394 domestic wells in the county. It is important to note that the well data was obtained from the Pennsylvania Groundwater Information System (PaGWIS). PaGWIS relies on *voluntary submissions* of well record data by well drillers; as a result, it is not a complete database of all domestic wells in the county. This is the most complete dataset of domestic wells available.

Figure 11 – Warren County Water Well Sites



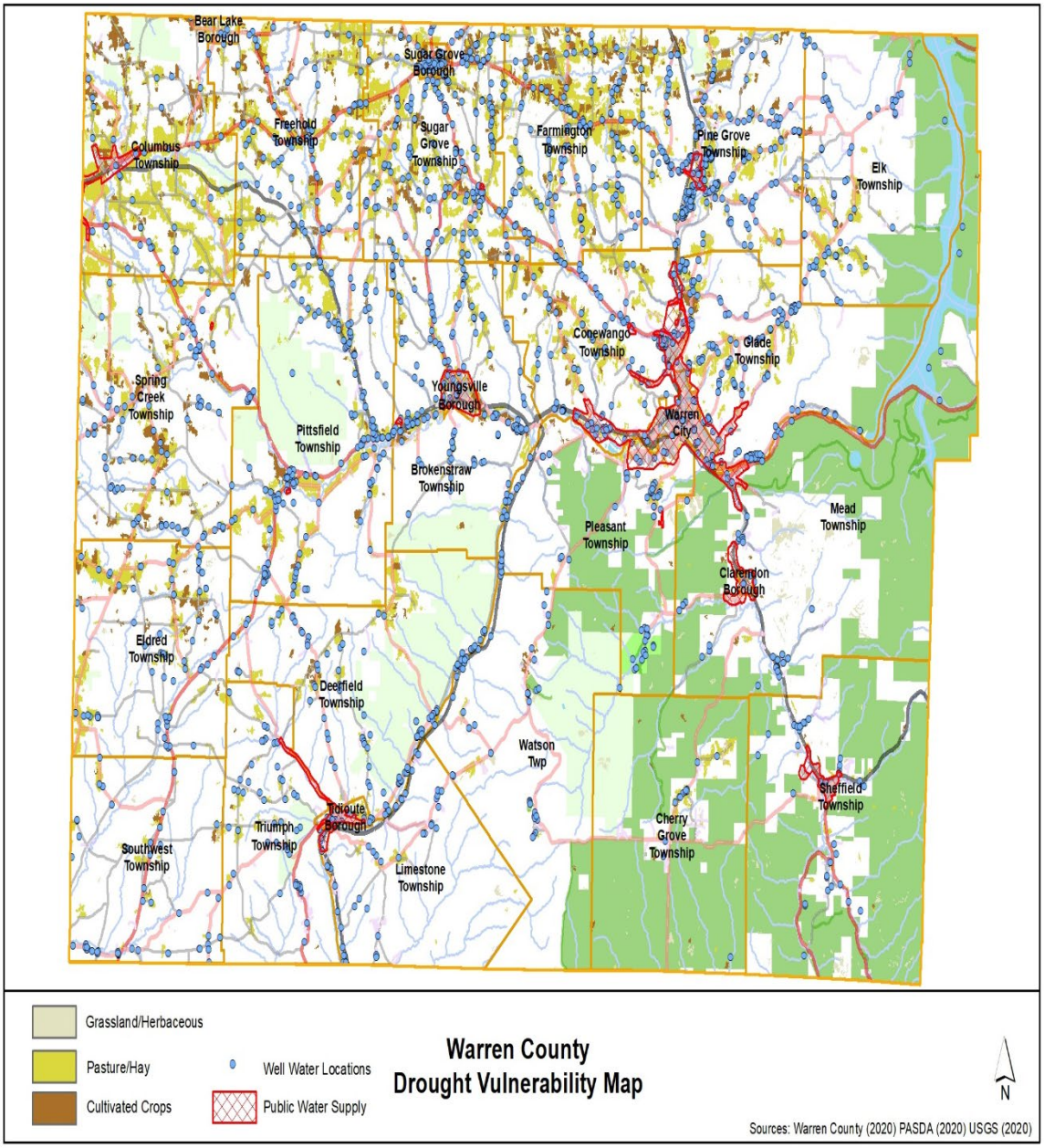
Through 2017, the USGS has conducted many Baseline Water Quality Studies throughout Pennsylvania, but one for Warren County is not yet completed. The studies comprise a useful reference to get a general sense of the water quality and challenges associated with domestic water wells in the Commonwealth.

The EPA provides a guide published in October 2017 for water utilities to aid in drought response and recovery. The guide outlines what goes into a good drought response plan, how to manage water supply and demand during a drought, best practices for communication and partnerships with other local utilities and provides case studies to discuss examples of drought management practices (EPA, 2017). The guide may be found here: https://www.epa.gov/sites/production/files/2017-10/documents/drought_guide_final_508compliant_october2017.pdf

Table 11 – Domestic Wells Per Municipality in Warren County

Domestic Wells Per Municipality in Warren County	
Municipality	**Domestic Wells**
Bear Lake Borough	1
Brokenstraw Township	180
Cherry Grove Township	71
Clarendon Borough	6
Columbus Township	43
Conewango Township	308
Deerfield Township	183
Eldred Township	74
Elk Township	107
Farmington Township	156
Freehold Township	96
Glade Township	192
Limestone Township	130
Mead Township	119
Pine Grove Township	390
Pittsfield Township	190
Pleasant Township	186
Sheffield Township	104
Southwest Township	81
Spring Creek Township	144
Sugar Grove Borough	70
Sugar Grove Township	210
Tidioute Borough	27
Triumph Township	79
Warren Borough	83
Watson Township	94
Youngsville Borough	22
Unknown	37
Not Listed	38
TOTAL	**3,394** (Not Listed in 2016 Plan – no comparison up or down)
Source: Pennsylvania Groundwater Information System	

Figure 12 - Warren County Drought Vulnerability Map



4.3.2. Earthquake

4.3.2.1 Location and Extent

An earthquake is sudden movement of the earth's surface caused by the release of stress accumulated within or along the edge off the earth's tectonic plates, a volcanic eruption, or by a human induced explosion (DCNR, 2007). Earthquake events in Pennsylvania, including Warren County, are usually mild events, impacting areas no greater than sixty-two miles in diameter from the epicenter. A majority of earthquakes occur along boundaries between tectonic plates, and some earthquakes occur at faults on the interior of

plates. Today, Eastern North America, including Warren County, Pennsylvania, is far from the nearest plate boundary. That plate boundary is the Mid-Atlantic Ridge and is approximately 2,000 miles to the east. The Ramapo Fault System runs through New York, New Jersey and eastern Pennsylvania (See *Figure 13 – Ramapo Fault System*). This fault system is associated with some small earthquakes, and it is thought unlikely to produce large earthquakes.

When the supercontinent of Pangaea broke apart about 200 million years ago, the Atlantic Ocean began to form. Since then, many faults have developed. Locating all of the faults would be an idealistic approach to identifying the region's earthquake hazard; however, many of the fault lines in this region have no seismicity associated with them. The best way to determine earthquake history for Warren County is to conduct a probabilistic earthquake-hazard analysis with the earthquakes that have already happened in and around the county (See *Figure 14 – Earthquake Hazard Zones).*

Natural gas extraction of the Marcellus/Utica Shale formation is possible in Warren County. Hydraulic fracturing or fracking is used to extract the gas, and the process is thought to lead to an increase seismic activity (Meyer, 2016). However, fracking does not appear to be linked to the increased rate of magnitude 3 and larger earthquakes (USGS 2014). Although over 100 permits for extraction have been issued by the Pennsylvania Department of Environmental Protection, no wells have been drilled as of January 2019 (See *Figure 15, Well Permits Issued*).

Figure 13 - Ramapo Fault System

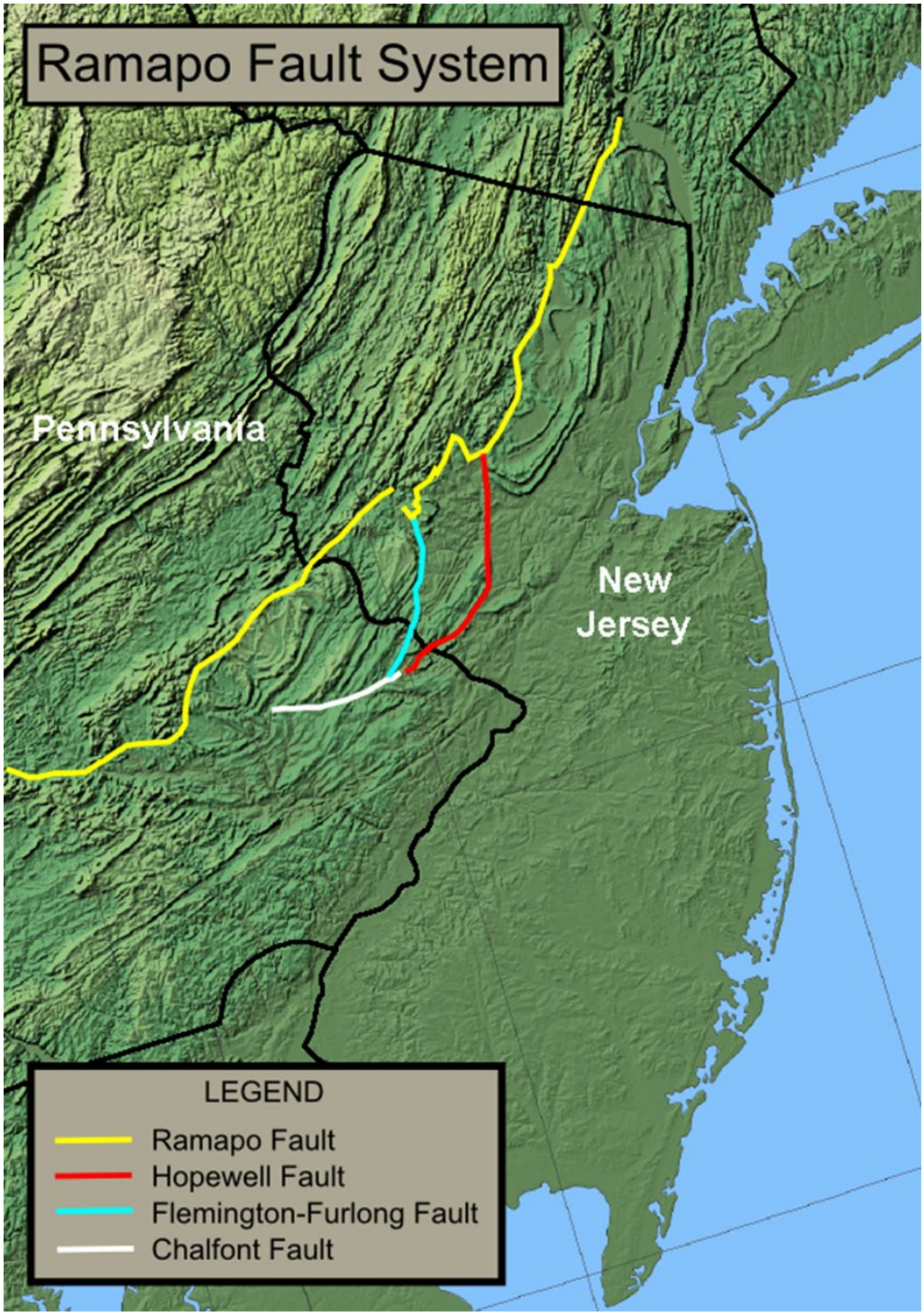


Figure 14 - Earthquake Hazard Zones

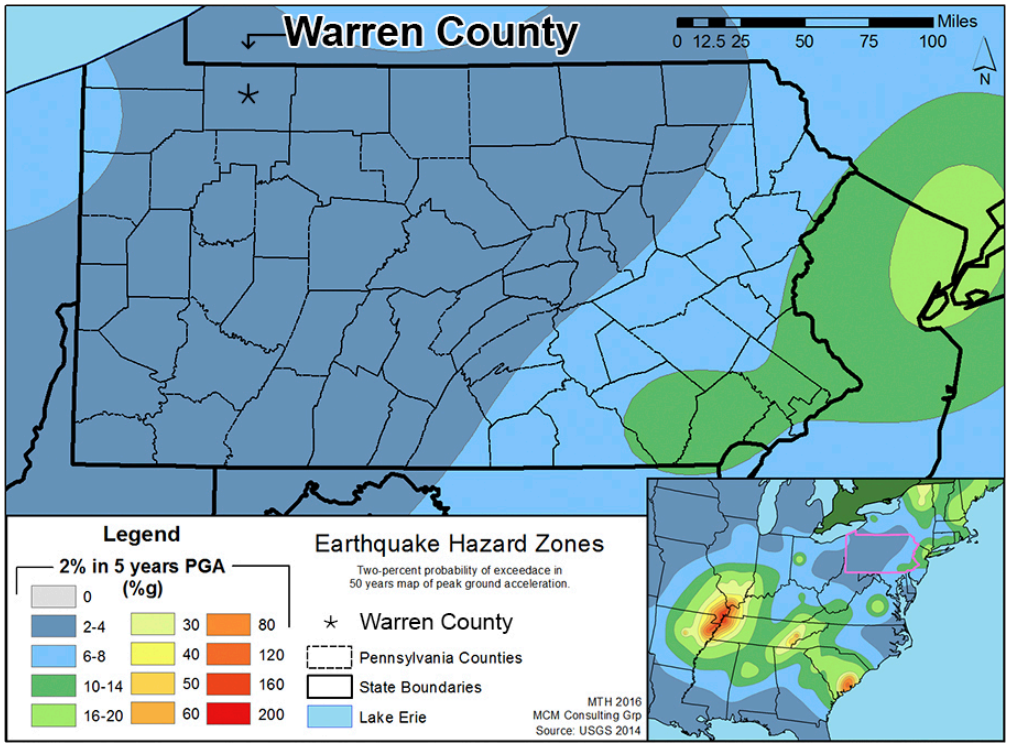
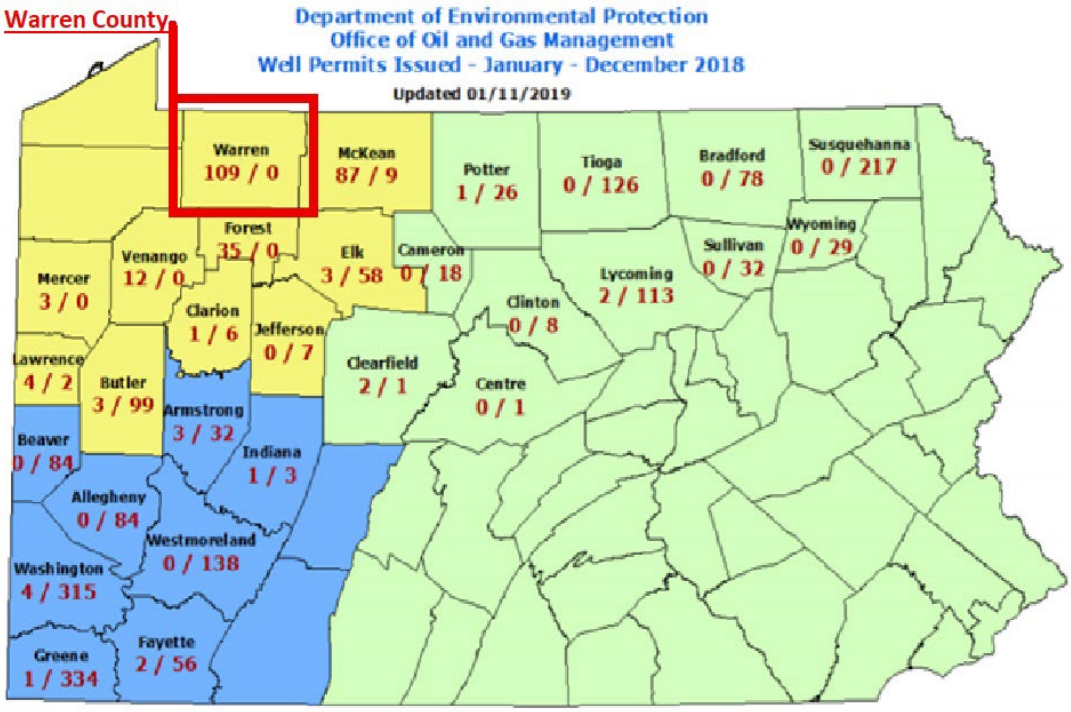


Figure 15 - Well Permits Issued



4.3.2.2 Range of Magnitude

Earthquakes result in the propagation of seismic waves, which are detected using seismographs. These seismograph results are measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake. *Table 12 – Richter Scale* summarizes Richter Scale magnitudes as they relate to the spatial extent of impacted areas. The Modified Mercalli Intensity Scale (*Table 13 – Modified Mercalli Intensity Scale*) is an alternative measure of earthquake intensity that is broken down by the impacts of the earthquake event. Earthquakes have many secondary impacts, including disrupting critical facilities, transportation routes, public water supplies and other utilities.

Table 12 - Richter Scale

Richter Magnitude	Earthquake Effects
Less than 3.5	Generally, not felt, but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings; can cause major damage to poorly constructed buildings over small regions.
6.1-6.9	Can be destructive in areas where people live up to about 100 kilometers across.
7.0-7.9	Major earthquake; can cause serious damage over large areas.
8.0 or greater	Great earthquake; can cause serious damage in areas several hundred kilometers across.

Table 13 - Modified Mercalli Intensity Scale

Scale	Intensity	Earthquake Effects	Richter Scale Magnitude
I	**Instrumental**	Detected only on seismographs	<4.2
II	**Feeble**	Some people feel it	
III	**Slight**	Felt by people resting; like a truck rumbling by	
IV	**Moderate**	Felt by people walking	
V	**Slightly Strong**	Sleepers awake; church bells ring	<4.8
VI	**Strong**	Trees sway; suspended objects swing; objects fall off shelves	<5.4
VII	**Very Strong**	Mild alarm, walls crack, plaster falls	<6.1
VIII	**Destructive**	Moving cars uncontrollable, masonry fractures, poorly constructed buildings damaged	<6.9
IX	**Ruinous**	Some houses collapse, ground cracks, pipes break open	
X	**Disastrous**	Ground cracks profusely, many buildings destroyed, liquefaction and landslides widespread	<7.3
XI	**Very Disastrous**	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed, general triggering of other hazards	<8.1
XII	**Catastrophic**	Total destruction, trees fall, ground rises and falls in waves	>8.1

The strongest recorded earthquake in Pennsylvania was a magnitude 5.1 on the Richter Scale, so it could be expected that effects of such an event could be felt in Warren County from earthquake events that happen around the Commonwealth.

4.3.2.3 Past Occurrence

According to the Pennsylvania Geological Survey *Earthquake Epicenters In and Near Pennsylvania* and Millersville University (2003), a 2.4 earthquake occurred on July 8, 1995 in the northeastern portion of the county. Additional detail about the event was not discovered during the writing of this plan update.

On December 31, 2011, a 4.0 earthquake occurred around Youngstown, Ohio; on August 23, 2011, a 5.9 earthquake occurred in Virginia and in January 2007, a 2.5 earthquake occurred just north of Meadville, Pennsylvania. Parts of the county experienced some of the shock waves from these minor earthquakes that have occurred around the region. Tremors were also felt from earthquakes in Ontario, Canada on June 23, 2011 and McDonald, Ohio on December 31, 2011. The strongest recorded earthquake in Pennsylvania history (5.2) occurred on September 25, 1998 in northwestern Pennsylvania and is known as the Pymatuning Earthquake for its epicenter near Pymatuning Lake. The effects of the earthquake were felt across Warren County and were blamed for many wells in the epicentral region drying up, while new springs and old wells began to flow. A three-month date range revealed 120 dry household-supply wells on the ridge of Jamestown and Greenville, Pennsylvania. Declines of up to 100 feet were observed on a ridge where at least eighty of the wells resided. The degree of the damage varied. Some of the wells lost all power or could barely hold their yields and some of the water in wells turned black or began to smell of sulfur.

The most likely cause of the wells drying was because of the increase in hydraulic conductivity or "fracking" of shale rock under this area caused by the earthquake. The quake affected the existing faults and created new faults in the shale. This created more permeability for the water to leak down from the hilltops on the ridge down to the valleys following the contours of the Meadville shale.

4.3.2.4 Future Occurrence

Earthquake activity and intensities are difficult to predict, but a probabilistic analysis of prior earthquakes can assist in gauging the likelihood of future occurrences. *Figure 14 – Earthquake Hazard Zones* shows that Warren County is in the lowest non-zero hazard zone for earthquake activity according to the USGS (2014), suggesting a low probability of earthquake occurrence. However, according to the USGS, there has been a recent trend increasing the frequency of magnitude 3 and larger earthquakes in the central and eastern US (*Table 14 – Recent Earthquake Trends in Central and Eastern United States*). This uptick in seismicity is considered to be due to hydraulic fracturing activities, and specifically occurs as a result of wastewater from the fracking process being injected into the earth (Meyer, 2016). Recent studies have moved towards being able to predict such induced seismicity by looking at uplift after injections, but more work needs to be done to confirm uplift as a reliable indicator of induced seismicity (Shirzei et al., 2016). As of August 2017, Warren County has fifty-two active wells. It is important to note that seismicity can occur even after wells become inactive and injection rates decline (Shirzaei et al., 2016).

Isostatic Rebound is a hypothesis for earthquake occurrence that has been kicked around for a lot of years, according to Charles Scharnberger, a retired professor of geology at Millersville University, who monitors the seismic station there. Scharnberger said Pennsylvania earthquakes are more of a mystery but could have something to do with the westward shift of the North American tectonic plate. Though the plates meet in California, where most of the seismic activity occurs, that movement still causes stress, squeezing and pressure along the entire length of the plate, reverberating as far back as the East Coast. A 3.4 earthquake like the one in Mifflintown, Juniata County in 2019 is in the medium range for Pennsylvania and may occur every couple of years. According to the USGS, this was the strongest earthquake felt or originating in Pennsylvania last year. It was followed by a 1.3 aftershock.

The chances of a devastating earthquake here are low, but Scharnberger said it's not impossible. His calculations on the probability of that happening based on the historic record indicate it's about a 1 in 200 chance in any given year.

Table 14 - Recent Earthquake Trends in Central and Eastern United States

Earthquake Trends in Central and Eastern U.S. *(USGS, 2016)*	
Year	**Number of M3+ Earthquakes (average per year)**
1973-2008	21
2009-2013	99
2014	659
2015	1000+

4.3.2.5 Vulnerability Assessment

According to the U.S. Geological Society Earthquake Hazards Program, an earthquake hazard is anything associated with an earthquake that may affect a resident's normal activities. For Warren County, this could include surface faulting, ground shaking, landslides, liquefaction, tectonic deformation, and seiches (sloshing of a closed body of water from earthquake shaking).

Earthquakes usually occur without warning and can impact areas a great distance from their point of origin (epicenter). Ground shaking is the greatest risk to building damage within Warren County. Risk to public safety and loss of life from an earthquake is dependent upon the severity of the event. Injury or death to those inside buildings, or people walking below building ornamentation and chimneys is a higher risk to Warren County's general public during an earthquake.

While historically the risk of earthquakes in southwestern Pennsylvania is low (See *Figure 14 - Earthquake Hazard* Zones), the uptick in seismicity due to hydraulic fracturing increases the likelihood of Warren County experiencing a damaging earthquake. Marcellus shale exploration for natural gas is widespread throughout Pennsylvania and is moderate in Warren County, meaning there has been moderate hydraulic fracturing. Considering the current knowledge of increased seismicity due to hydraulic fracturing, and the recent trends in Pennsylvania, Warren County could expect to experience more magnitude two and larger earthquakes. Increased seismic activity is expected to last even after hydraulic fracturing stops, so the increased seismic risk should be expected to last well into the future. This induced seismicity is dependent on local conditions, and the impacts of hydraulic fracturing on earthquakes is variable geographically (Van der Baan & Calixto, 2017). While seismicity is likely to increase, it is thought that regions that before were relatively inactive seismically will not experience uncharacteristically catastrophic earthquakes due to hydraulic fracturing (Zhao et al., 2018).

4.3.3. Extreme Temperatures

4.3.3.1 Location and Extent

Extreme temperatures can be devastating – extreme heat can cause sunburn, heat cramps, heat exhaustion, heat stroke, and dehydration, while extreme cold can cause hypothermia and frostbite. Both can potentially cause long-lasting disabilities. *Figure 16 – Average Maximum Temperature* and *Figure 17 – Average Minimum Temperature* show the historical annual mean maximum and minimum temperatures for Pennsylvania. The highest temperature of record in Pennsylvania, 111° F, was observed in Phoenixville on July 9 and 10, 1936, while the record low of -42° F occurred at Smethport on January 5, 1904. July has typically been the warmest month for Warren County, with an average high temperature of 79.9°F, making it one of the coolest places in Pennsylvania. January is typically the coldest month for Warren County, with normal

temperatures ranging from 12°F to lower 30s. Temperatures can vary across Warren County due to elevation changes in topography. *Figure 16 - Average Maximum Temperature Trends* and *Figure 17 – Average Minimum Temperature Trends* show how recent average temperatures are changing in the country at large. Figures 16 and 17 do not clearly identify temperature changes in western Pennsylvania, but data shows that Warren County is experiencing an increase in average temperatures of 2.1ºF since records began in 1900 (see *Figure 18 – Warren County Average Temperatures 1900-2020* (NOAA-NCEI, 2020).

Figure 16 - Average Maximum Temperature Trends

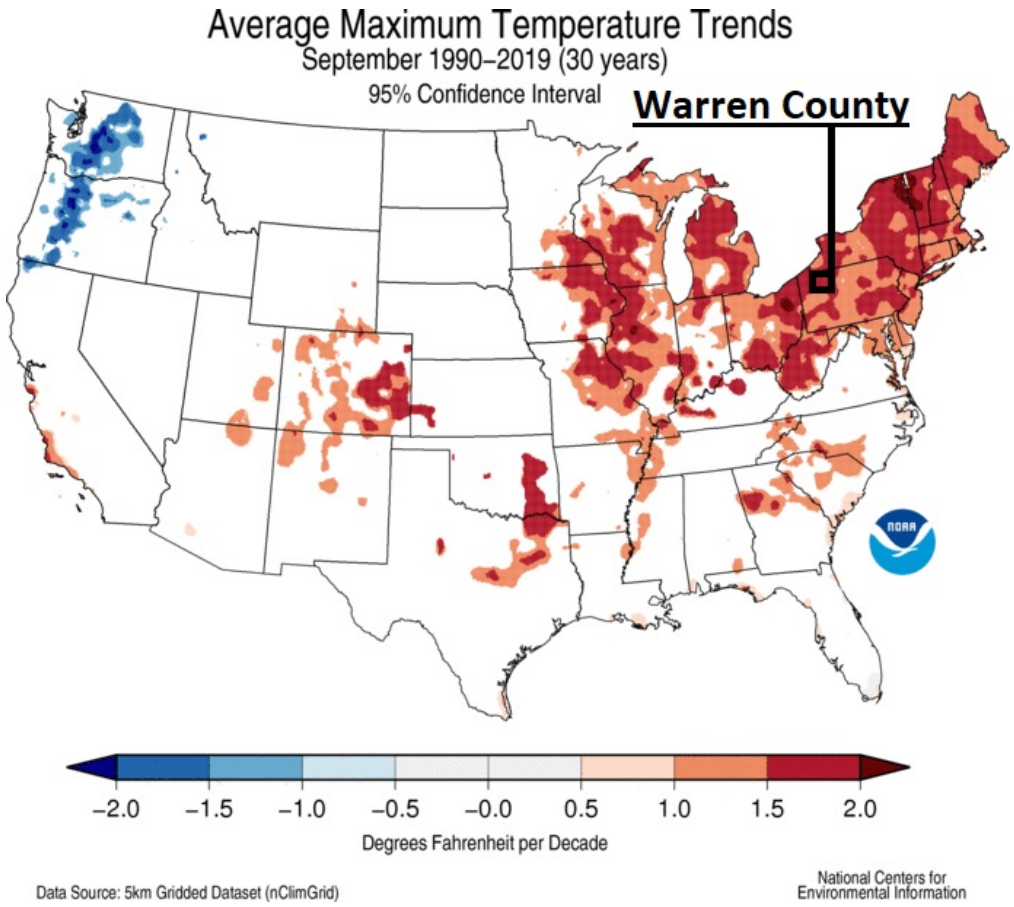


Figure 17 - Average Minimum Temperature Trends

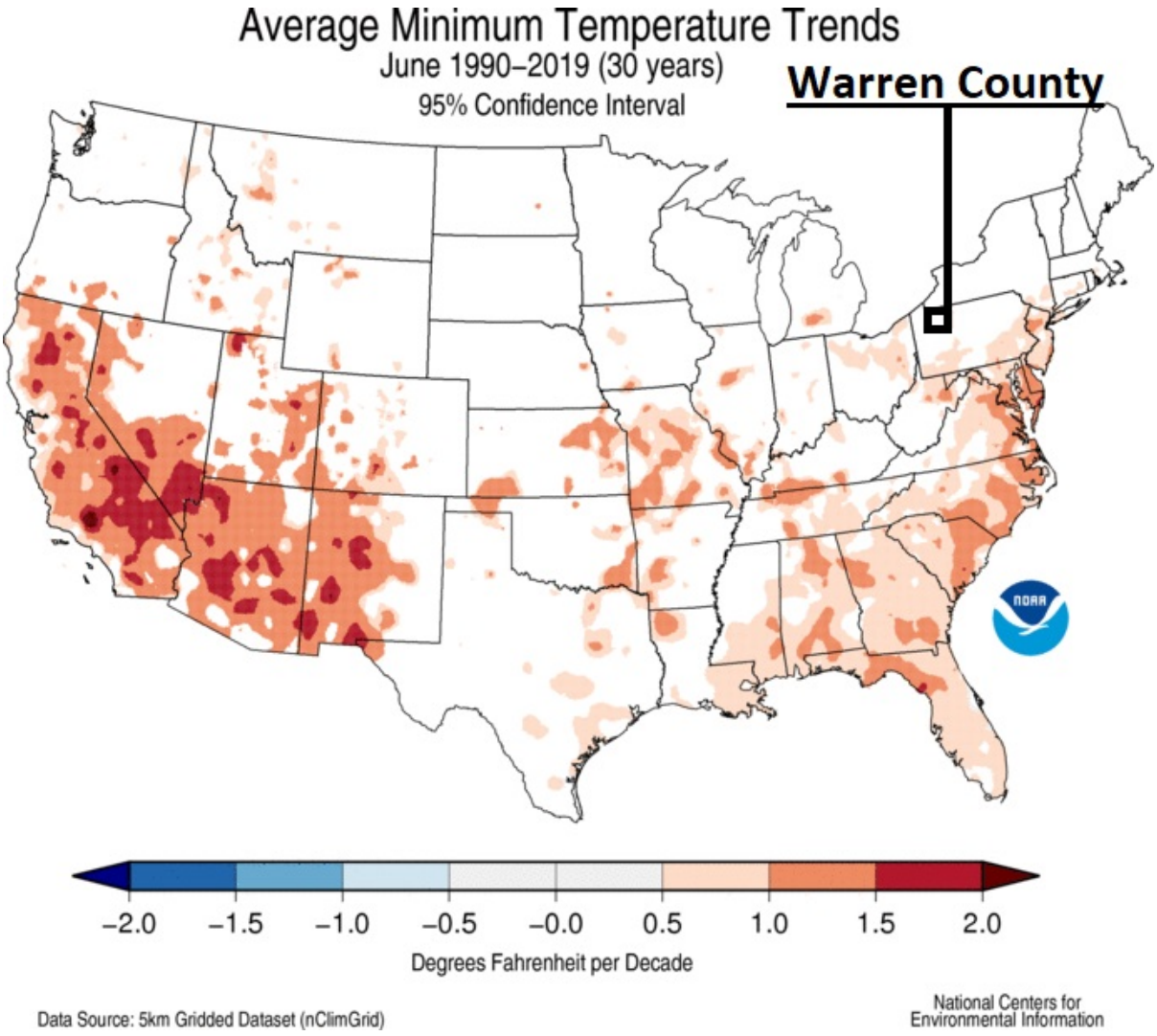
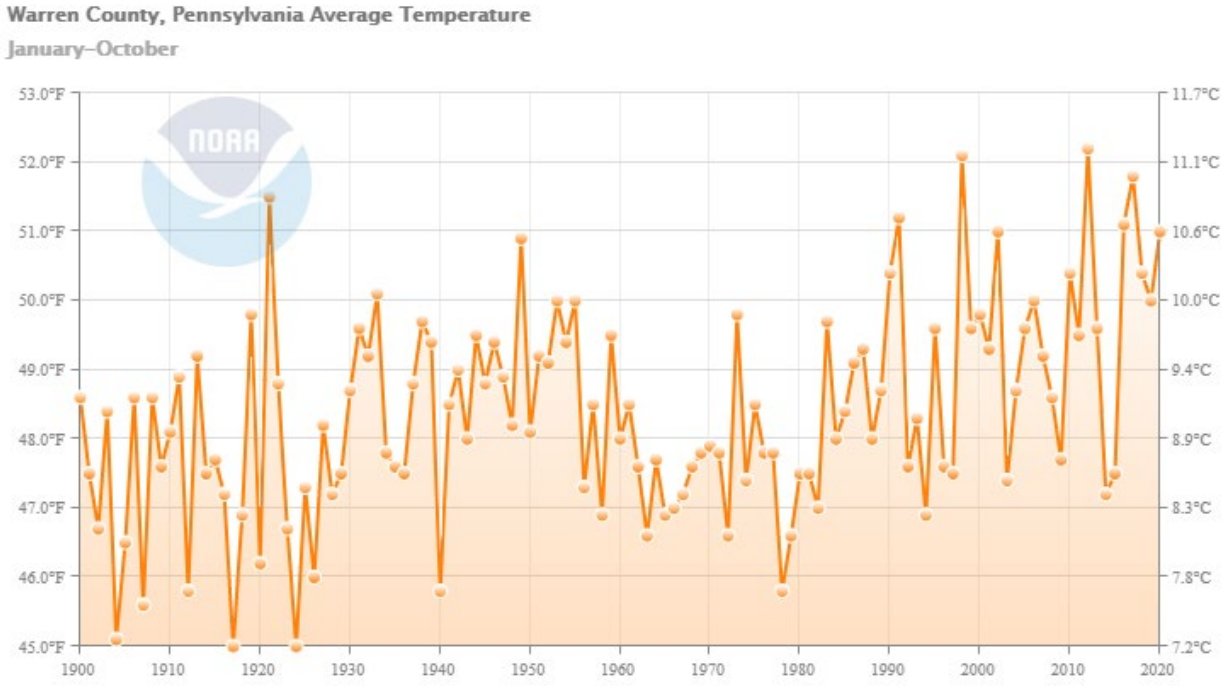


Figure 18 – Warren County Average Temperatures 1900-2020



4.3.3.2 Range of Magnitude

When extreme temperature events occur, they typically impact the entirety of Warren County, including the surrounding region. Extreme heat is described as temperatures that hover at least 10ºF above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined. The apparent temperature of the air increases as relative humidity increases, and the National Weather Service created a Heat Index chart (*Figure 19 – National Weather Service Heat Index*) which shows the likelihood of heat disorders relative to the temperature and relative humidity. Heat advisories are issued when the heat index temperature is expected to equal 100°F or higher for two consecutive days. Excessive heat watches are issued when there is a possibility that excessive heat warning criteria may be experienced within twenty-four to seventy-two hours, but their occurrence and timing are still uncertain. Excessive heat warnings are issued within twelve hours of the onset of extremely dangerous heat condition when the maximum heat index temperature is expected to be 105°F or higher for at least two days and night-time air temperatures will not drop below 75°F. (NOAA NWS, 2020). A potential worst-case extreme temperature scenario would be if widespread areas of the Commonwealth experienced 90°F or higher temperatures for an extended number of days. The heat could overwhelm the power grid and cause widespread blackouts, cutting off vital HVAC services for residents. It could create crisis management issues for senior citizens on fixed incomes and the homeless population.

Extreme cold temperatures drop well below typical temperatures and are often associated with winter storm events. Wind can make the apparent temperature drop further, and exposure to such extreme cold temperatures can cause hypothermia, frost bite and death. The National Weather Service created a wind chill chart (*Figure 20 – National Weather Service Wind Chill*) which shows the time frostbite takes to set in depending on temperature and wind speed. Wind chill warnings are issued when wind chills drop to -25°F or lower. *Wind Chill Advisories* are issued in the southeast and western sections of Pennsylvania when wind chill

values drop to -10°F to -24°F. Wind chill advisories are issued in the South Central to northern sections of the Commonwealth when wind chills drop to -15°F to -24°F (NOAA NWS, 2010).

Figure 19 - National Weather Service Heat Index

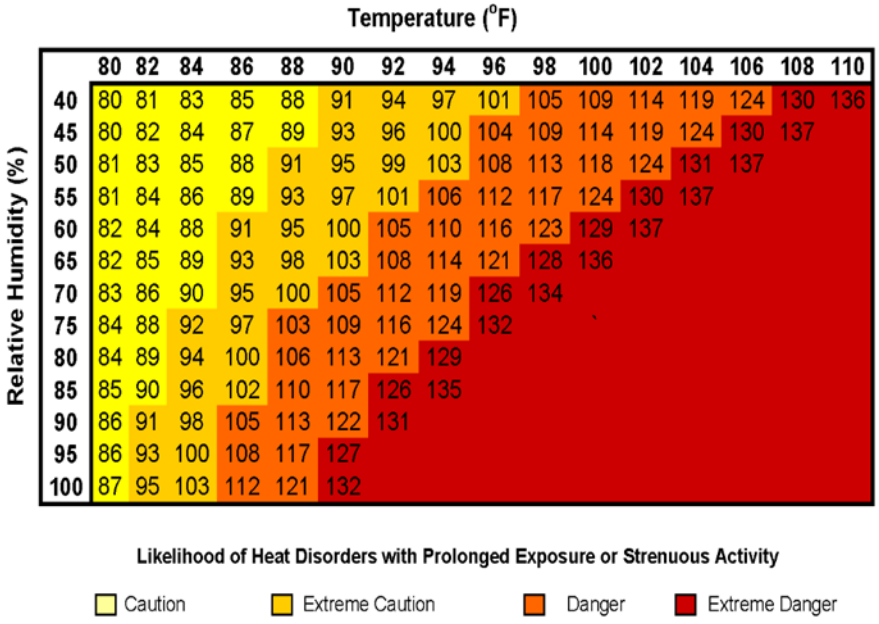
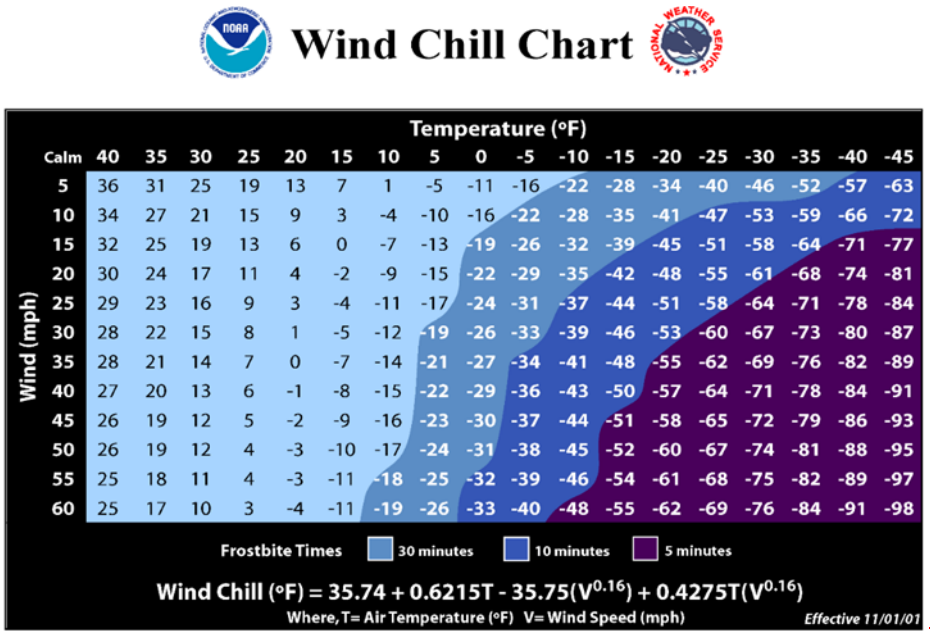


Figure 20 - National Weather Service Wind Chill



4.3.3.3 Past Occurrence

Warren County experiences extreme heat commonly during the summer months. Between 1960 and 2020, the highest recorded temperatures in the county were in 1988: 103ºF (July 7); 101ºF (July 16); and 100ºF (August 17). There was also recorded a 100ºF day in 1995 (July 15).

In January 1994, an arctic air mass caused temperatures to plunge 20°F below normal. The ambient air temperatures fell below 0°F for the overnight low. Hospitals area-wide reported numerous cases of frostbite, hypothermia, and heart attacks from the extreme cold. *Table 15 – Extreme Temperature Occurrences* summarizes the extreme temperature occurrences since 1988.

Table 15 - Extreme Temperature Occurrences

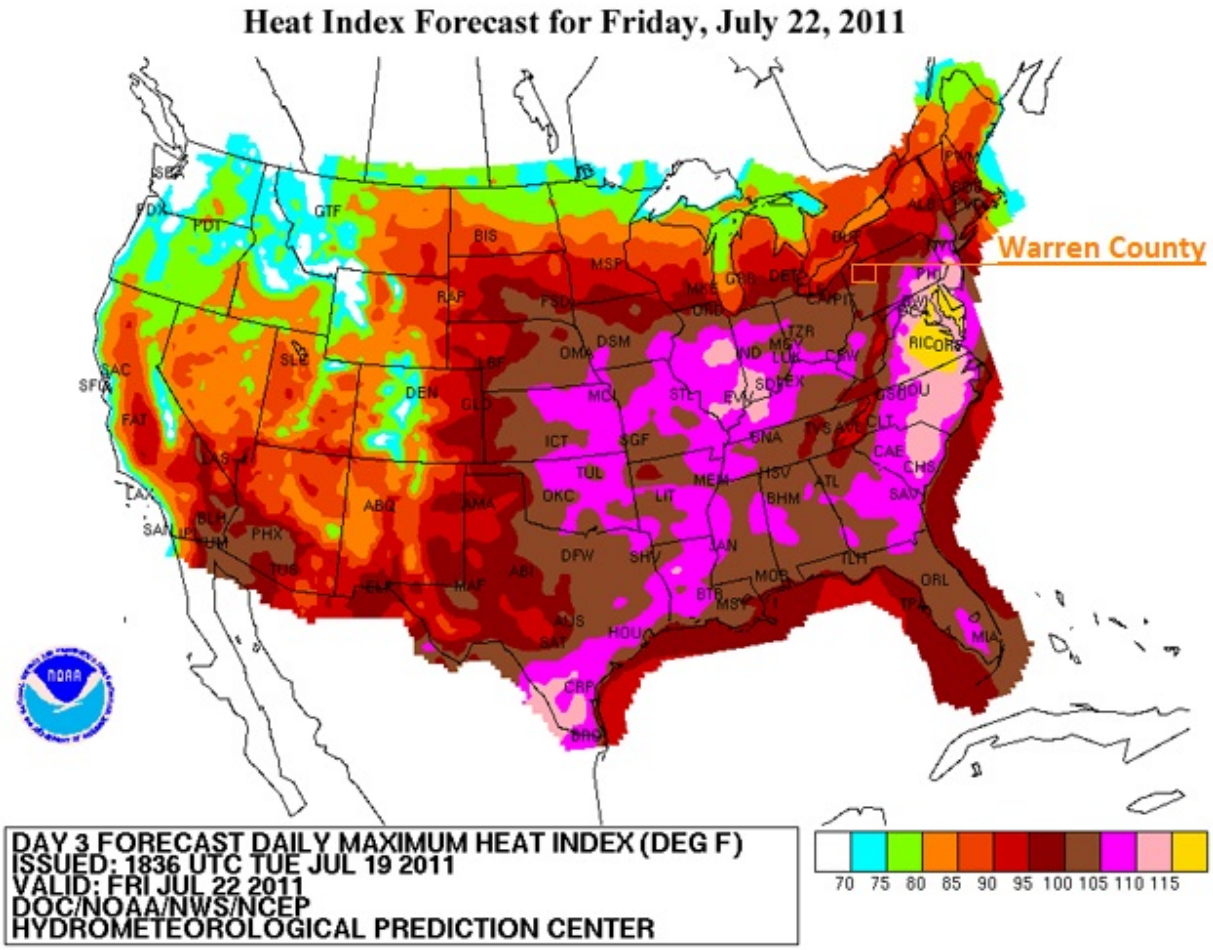
Why Identified	Past Occurrences (*NCEI, 2020*)
Extreme heat is responsible for more fatalities than all other hazards combined: about 50 fatalities a year in Pennsylvania. Extreme cold can cause serious human and pet health hazards in minutes; homeless populations are highly vulnerable.	**Extreme Heat** Highest temperatures on record (1960 - 2020): July 16, 1988 (103) July 7, 1988 (101) August 17, 1988 (100) July 15,1995 (100) **Extreme Cold** January 1994 -22°F at Pittsburgh International Airport January 1, 2014 Arctic Cold Front -13°F, -36°F wind chill western PA 2/15/15 – Arctic Cold Front -16°F, -25°F wind chill western PA 2/20/15 – Low temp -20°F western PA 2/24/15 – Low temp -24°F western PA 1/20/19 – Extreme Cold/Wind Chill – Warren County 1/30/19 – Extreme Cold/Wind Chill – Warren County

Extreme temperatures are expected during and around the summer and winter months. Extreme temperatures have occurred in Warren County in the past and will continue to occur in the future. Prediction of these events will continue to be enhanced with new technology and better recording of previous data and events.

In the state of Pennsylvania, there have been 315 extreme temperature events between 1950 and 2013, resulting in 587 deaths and 530 injuries (NCDC, 2013). Of those events, seventy-one were extreme cold (twenty-seven deaths, 129 injuries), and 205 were extreme heat (560 deaths, 401 injuries) (NCDC, 2013). From 1996 until December 2018, there were seven extreme cold events and one extreme heat event reported to the NOAA NCEI Storm Events database. While exact occurrence data for Warren County is somewhat limited below, it should be assumed that the county experienced the effects of extreme temperatures more than it has been documented – these instances serve as a sample of all events. The fact that the NOAA NCEI reports only one extreme heat event for Warren County does not mean it was the only extreme heat event to have impacted the county - it likely represents a reporting bias.

In 2011, Pennsylvania experienced record-breaking heat in nineteen counties and a total of forty-five broken heat records. *Figure 21 – Heat Index Forecast for Frida, July 22, 2011* shows the temperatures for July 22, 2011. Pennsylvania was again hit with record breaking temperatures on July 9, 2012 when daily record highs were broken in several cities in eastern Pennsylvania, including Harrisburg, Lancaster, and Chambersburg, which each reached 101 °F (38.3 °C).

Figure 21 - Heat Index Forecast for July 22, 2011

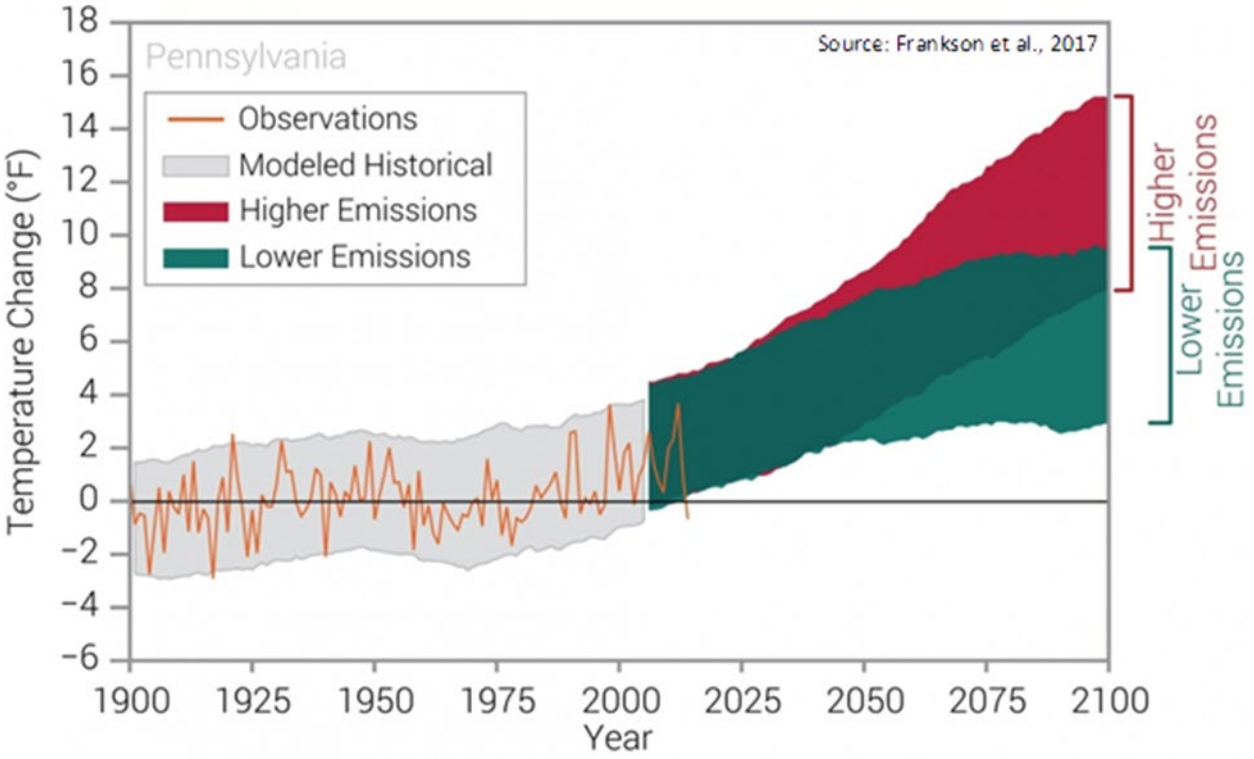


4.3.3.4 Future Occurrence

Extreme temperatures will continue to impact Warren County. Anthropogenic climate change is causing extreme climatic events to occur more frequently, suggesting that extreme temperatures are becoming a more threatening hazard as the impacts of climate change intensify. The annual average temperature has increased by 1.2˚F across the continental United States during the years 1986 to 2016 compared to the time period 1901 to 1960 and temperatures are expected to continue rising (Vose et al., 2017). *Figure 22 – Observed and Projected Temperature Change* shows these projected changes in temperature for Pennsylvania based on climate models considering the possibilities of increased and decreased levels of greenhouse gas emissions (Frankson et al., 2017). In recent years, record high temperatures have outnumbered record low temperatures 2:1 (Meehl et al., 2009; Vose et al., 2017) so it is expected that the risk of extreme heat will be amplified whereas the risk of extreme cold will be attenuated. The Northeastern United States is expected to experience twenty to thirty more days with temperatures above 90˚F, and twenty to thirty fewer days below freezing by approximately 2050 (Vose et al., 2017). While there may be fewer extreme cold events, those that do occur are expected to occur more often reach record-setting low temperatures (Vose et al., 2017). Historically, Warren County has had more extreme cold events than extreme heat due to the

geographic location of the county; however, this balance is expected to shift somewhat in the coming years to include a greater proportion of extreme heat events.

Figure 22 - Observed and Projected Temperature Change



4.3.3.5 Vulnerability Assessment

Extreme temperatures are usually a regional hazard when they occur. The very old and the very young are most vulnerable to extreme temperatures due to risk factors, mobility challenges and disabilities (United States Census Bureau, Quick Facts). *Table 16 – Warren County Municipal Vulnerability in* Age displays the total population of children under the age of five, adults between the age of 75-79, and adults over the age of eighty-five by municipality. As mentioned above, these age groups are most vulnerable to extreme temperatures, and other hazards, in Warren County. Extreme temperatures can increase the demand for utility services, often resulting in an increased cost to consumers. The increased expense can make it difficult for the consumer to afford the service. The increased demand for services may cause a decrease in availability of these services or failure of the system. A decrease or failure of the utility system during extreme temperature events puts a large population at great risk. Extreme temperature events can also drastically increase the volume of emergency calls, potentially overwhelming the public safety answering point. Extreme heat events can also contribute to drought conditions, which in turn increase the risk of wildfires.

Table 16 - Warren County Municipal Vulnerability in Age

Warren County Municipal Vulnerability in Age				
	Under 5 years	**Ages 75-79**	**Ages 85 and over**	**% of Municipal Population**
Bear Lake Borough	12	2	3	10.3%
Brokenstraw Township	82	92	165	18.1%

	Under 5 years	Ages 75-79	Ages 85 and over	% of Municipal Population
Cherry Grove Township	9	9	7	11.6%
Clarendon Borough	24	12	16	11.6%
Columbus Township	98	47	37	8.9%
Conewango Township	162	144	69	10.4%
Deerfield Township	13	15	2	8.8%
Eldred Township	42	21	7	10.8%
Elk Township	16	16	3	6.6%
Farmington Township	72	36	19	10.1%
Freehold Township	120	41	14	11.5%
Glade Township	101	83	76	11.3%
Limestone Township	5	21	5	7.6%
Mead Township	42	53	32	9.1%
Pine Grove Township	115	87	58	9.7%
Pittsfield Township	71	43	20	9.6%
Pleasant Township	83	123	134	13.9%
Sheffield Township	99	73	44	10.2%
Southwest Township	38	8	6	9.8%
Spring Creek Township	46	23	8	9.0%
Sugar Grove Borough	36	16	9	10.0%
Sugar Grove Township	111	42	16	9.7%
Tidioute Borough	35	32	17	12.3%
Triumph Township	19	14	6	12.3%
Warren City	533	307	273	11.5%
Watson Township	12	12	-	8.8%
Youngsville Borough	92	64	31	10.8%

4.3.4. Flood, Flash Flood, and Ice Jams

4.3.4.1 Location and Extent

Warren County is located in the Upper Allegheny River Basin. This area, like many others in Pennsylvania, is flood prone because most communities are located along streams and river valleys amidst the mountainous terrain. For inland areas such as Warren County, excess water from snowmelt or rainfall accumulates and overflows onto stream banks and adjacent floodplains. Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding is typically experienced when precipitation occurs over a given river basin for an extended period. Flash flooding is usually a result of heavy localized precipitation falling in a short time period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. Flash floods are the most common type of flooding in Warren County. The severity of a flood event is dependent upon a combination of creek, stream and river basin topography and physiography, hydrology, precipitation and weather patterns, present soil moisture conditions, the degree of vegetative clearing as well as the presence of impervious surfaces in and around flood-prone areas.

Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Snow melt combined with heavy rains can cause frozen rivers to swell, which breaks the ice layer on top of a river. The ice layer often then breaks into large chunks, which float downstream, piling up in narrow passages and near other obstructions such as bridges and dams. All forms of flooding can damage infrastructure.

Floodplains are lowlands adjacent to rivers, streams and creeks that are subject to recurring floods. The size of the floodplain is described by the recurrence interval of a given flood. Flood recurrence intervals are explained in more detail in Section 4.3.4.4. However, in assessing the potential spatial extent of flooding, it is important to know that a floodplain associated with a flood that has a 10% chance of occurring in a given year is smaller than the floodplain associated with a flood that has a 0.2% annual chance of occurring. The National Flood Insurance Program (NFIP) publishes digital flood insurance rate maps (DFIRMs). These maps identify the one percent annual chance of flood area. Special flood hazard area (SFHA) and base flood elevations (BFE) are developed from the one percent annual chance flood event, as seen in *Figure 23 – Flooding and Floodplain Diagram.* Structures located in the SFHA have a 26% chance of flooding in a thirty-year period. The SFHA serves as the primary regulatory boundary used by FEMA, the Commonwealth of Pennsylvania and Warren County local governments. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply to the following high risk special flood hazard areas in *Table 17 – Flood Hazard High Risk Zones.* Appendix D of this hazard mitigation plan includes a flooding vulnerability map for each municipality in Warren County with vulnerable structures and functional needs facilities identified using the most current DFIRM data for Warren County dated March 21, 2017.

Past flooding events have been primarily caused by heavy rains which cause small creeks and streams to overflow their banks, often leading to road closures. Flooding poses a threat to functional needs facilities, agricultural areas, and those who reside or conduct business in the floodplain. The most significant hazard exists for facilities in the floodplain that process, use and/or store hazardous materials. A flood could potentially release and transport hazardous materials out of these areas. As the water recedes it would spread the hazardous materials throughout the area. Most flood damage to property and structures located in the floodplain is caused by water exposure to the interior, high velocity water and debris flow.

Figure 23 - Flooding and Floodplain Diagram

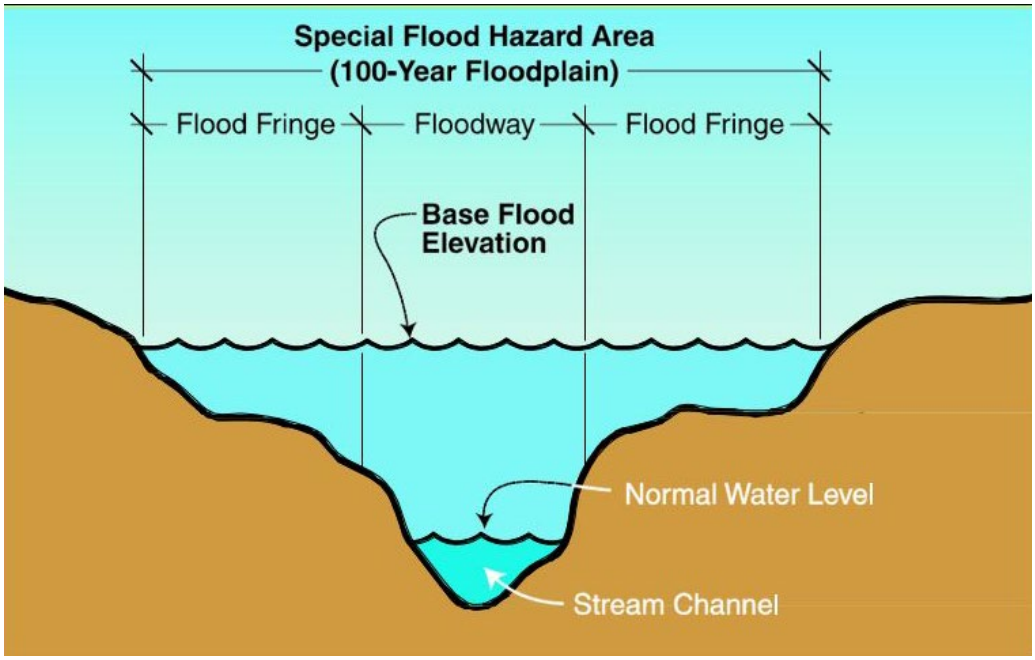


Table 17 - Flood Hazard High Risk Zones

Flood Hazard High Risk Zones *(FEMA, 2017)*	
Zone	**Description**
A	Areas subject to inundation by the 1% annual chance flood event. Because detailed hydraulic analysis has not been performed, no base flood elevations or flood depths are shown
AE	Areas subject to inundation by the 1% annual chance flood event determined by detailed methods. BFEs are shown within these zones.
AH	Areas subject to inundation by the 1% annual chance shallow flooding (usually areas of ponding) where average depths are 1-3 feet. BFEs derived from detailed hydraulic analysis are shown in this zone.
AO	Areas subject to inundation by the 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are 1-3 feet. Average flood depths derived from detailed hydraulic analysis are shown within this zone.
AR	Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection.

4.3.4.2 Range of Magnitude

A large amount of rainfall over a short time span can result in flash flood conditions. Small amounts of rain can result in floods in locations where the soil is frozen or saturated from a previous wet period or if the

rain is concentrated in an area of impermeable surfaces such as large parking lots, paved roadways, or other impervious developed areas.

Most injuries and deaths from flooding happen when people are swept away by flood currents and most property damage results from inundation by sediment-filled water. Several factors determine the severity of floods, including rainfall intensity and duration, topography, ground cover and rate of snowmelt. Water runoff is greater in areas with steep slopes and little or no vegetative ground cover. The county has mountainous terrain, especially in the Allegheny National Forest, which can contribute to more severe floods as runoff reaches receiving water bodies more rapidly over steep terrain. Also, urbanization typically results in the replacement of vegetative ground cover with asphalt and concrete, increasing the volume of surface runoff and stormwater, particularly in areas with poorly planned stormwater drainage systems.

In Warren County, there are seasonal differences in how floods are caused. In the winter and early spring (February to April), major flooding has occurred as a result of heavy rainfall on dense snowpack throughout contributing watersheds. One of the worst floods in the history of Warren County occurred in March 1956 after large amounts of snowmelt accompanied by heavy rains caused the Allegheny River to rise to its highest recorded level at 18.3 feet. Over 3,500 people evacuated from residences and critical facilities. In 2003, the City of Warren received 2.5 inches of rain in less than two hours; nearly four thousand residents were without power and related property damage was estimated at 4.5 million dollars.

Winter floods also have resulted from runoff of intense rainfall on frozen ground, and local flooding has been exacerbated by ice jams in rivers and streams. Ice-jam floods occur on rivers that are totally or partially frozen. A rise in stream stage will break up a totally frozen river and create ice flows that can pile up on channel obstructions such as shallow riffles, log jams, or bridge piers. The jammed ice creates a dam across the channel over which the water and ice mixture continues to flow, allowing for more jamming to occur. Four ice jam incidents are captured in *Table 18 – Warren County Flood Events (1865-2003)* and *Table 19 – Flood & Flash Flood Events (1993-2019)* and highlighted in gray below (dating as far back as 1936). Based on available data, a small percentage of flood events in Warren County can be attributed to ice jams. In addition to flooding, damage can occur to culverts and bridges from the ice itself. Records indicate that three bridges were completely lost in the City of Warren when an ice jam occurred in March of 1936.

Summer floods have occurred from intense rainfall on previously saturated soils. Summer thunderstorms deposit large quantities of rainfall over a short period of time that can result in flash flood events. In addition, the county occasionally experiences intense rainfall from tropical storms in late summer and early fall.

Severe flooding can cause injuries and deaths and can have long-term impacts on the health and safety of the citizens. Severe flooding can also result in significant property damage, potentially disrupting the regular function of critical facilities and have long-term negative impacts on local economies. Industrial, commercial and public infrastructure facilities can become inundated with flood waters, threatening the continuity of government and business. The special needs population must be identified and located in flooding situations, as they are often homebound and/or immobile. Mobile homes are especially vulnerable to high water levels. Flooding can have significant environmental impacts when flood waters release and/or transport hazardous materials and can also result in spreading diseases.

Flash floods can occur very quickly with little warning and can be deadly because of the rapid rises in water levels and devastating flow velocities. The more developed areas in the county can be especially susceptible to flash floods because of the significant presence of impervious surfaces, such as streets, sidewalks, parking lots, and driveways.

Severe flooding also comes with many secondary effects that could have long lasting impacts on the population, economy and infrastructure of Warren County. Power failures are the most common secondary effect associated with flooding. Coupled with a shortage of critical services and supplies, power failures *could* cause a public health emergency. Critical infrastructure, such as sewage and water treatment facilities, can be severely damaged, having a significant effect on public health. High flood waters can cause sewage systems to fail and overflow, contaminating groundwater and drinking water. Flooding also has the potential to trigger other hazards, such as landslides, hazardous material spills, floating unanchored fuel tanks and dam failures.

The maximum threat of flooding in Warren County is estimated by looking at potential loss data and repetitive loss data, both analyzed in the risk assessment portion of the hazard mitigation plan. In these cases, the severity and frequency of damage can result in permanent population displacement, and businesses may close if they are unable to recover from the disaster.

HAZUS software was used to estimate potential losses from a one hundred year flood event, and the full report can be found in Appendix F. Total building related loss from a one hundred year flood is expected to be approximately $130.73 million, with 122 million of that coming from residential homes. After adjusting for business interruption and extenuating circumstances after a flood event, total economic loss was estimated at $334.41 million. Residential occupancies account for nearly 29.58 million of all flooding related losses as estimated by HAZUS. In total, building and economic loss would 431.28 million.

Although floods can cause deaths, injuries and damage to property, they are naturally occurring events that benefit riparian systems which have not been disrupted by human actions. Such benefits include groundwater recharge and the introduction of nutrient rich sediment which improves soil fertility. However, human development often disrupts natural riparian buffers by changing land use and land cover, and the introduction of chemical or biological contaminants that often accompany human presence can contaminate habitats after flood events. Hazardous materials facilities are potential sources of contamination during flood events.

4.3.4.3 Past Occurrence

Warren County experiences flooding regularly, particularly between the months of December and April. Flash flooding is the most common type of flooding that occurs in the county with the Allegheny River, Brokenstraw Creek and Conewango Creek being the streams most prone to flooding. Nine of the fourteen Presidential Disaster and Emergency Declarations affecting Warren County have been in response to hazard events related to flooding (see *Table 7 – Presidential Disaster Declarations).*

Flooding events, including those associated with Disaster Declarations, are listed in *Table 18 – Warren County Flood Events (1865-2003)* and *Table 19 – Flood & Flash Flood Events (1993-2019).*

Table 18 – Warren County Flood Events (1865-2003) lists past occurrence information based on records from Warren County and has events, dates and descriptions dating back as far as records allow.

Table 19 – Flood & Flash Flood Events(1993-2019) lists information obtained from the National Climactic Data Center available from 1993 to 2019 and includes estimated property damage for select events. Note that property damage values are estimates based on best available information and “countywide” indicates that several locations in the county were affected.

Table 18 – Warren County Flood Events (1865-2003)

DATE	LOCATION AND/OR DESCRIPTION *(Events Highlighted Gray Represent Ice Jam Related Flooding)*
March 1865	High water marks indicate flooding crested at 18.26 feet
March 1873	High water marks indicate flooding crested at 16.76 feet
March 1913	High water marks indicate flooding crested at 16.57 feet
June 6, 1892	Stillwater Creek flood in Sugar Grove Borough. Entire town was a lake; bridge washed out. Flooding throughout the City of Warren.
July 6, 1917	Stillwater Creek flooded in Sugar Grove Borough; caused several thousand dollars in damages. Floodwaters damaged stores by depositing mud.
March 17, 1936	Flooding closed school for a day. Ice jam flooding took out three bridges that crossed the Conewango Creek; also took out some bridges in Warren City.
April 6, 1947	Flooding on Easter Sunday. Floodwaters crested at 17.4 feet. Over $500,000.00 in damages. Many bridges taken out by floodwaters.
March 8, 1956	One of the worst floods in the history of Warren County; caused by large amounts of snow melt accompanied by heavy rains; Allegheny crested at 18.3 feet (the highest it's ever been); Over 3,500 people evacuated from homes; Hospital was evacuated.
February 24, 1977	North Warren flooded by Conewango Creek. Comet Market hit hard; closed for ten days. Flooding caused by ice jam along Jackson Run.
July 21, 1992	Intense thunderstorms cause flooding throughout Warren County; Pine Grove Township got the worst of it (Pine Grove without power, access and exit routes); Route 62 north of Warren to the NY line was closed. 40 homes uninhabitable and 200 homes suffered various levels of damage. Some bridges washed away; $6,114,000.00 in damages.
January/February 1994	Extreme cold weather caused major ice jam flooding on Conewango Creek from the New York State border south through the townships of Pine Grove, Conewango, Glade, and into the City of Warren.
January 1996	Flooding resulted from massive snow accumulation and melting.
January 10, 1998	Flooding in Pine Grove and Glade Townships damaged seventeen homes. Some roads were closed.
July 23, 2003	Fierce storms brought torrential rain. Warren City received 2.5 inches of rain in an hour and a half. State of emergency declared. 3,500-4,000 residents without power. Storm widespread throughout county and damage encompasses 70% to 75% of county. $4,500,000.00 in damages.

Table 19 - Flood & Flash Flood Events (1993-2019)

DATE	LOCATION AND/OR DESCRIPTION *(Events Highlighted Gray Represent Ice Jam Related Flooding)*	ESTIMATED PROPERTY DAMAGE ($)
04/01/1993	Northern Warren County. Flooding due to a combination of snowmelt and heavy rainfall.	Not provided (NP)
06/13/1994	Countywide. Flash flood – Flooding of area streams caused several road closings	5,000
08/27/1994	Countywide. Flash flood – Over 3" of rain fell in 2 hrs.	NP
01/19/1996	Multiple Counties all over the Commonwealth. Flooding.	NP
05/11/1996	Sheffield. Flash flood.	NP
08/08/1996	Russell. Flash flood.	NP
08/15/1996	Grand Valley. Flash flood.	NP
09/17/1996	Western Warren County. Flash flood.	NP
09/28/1996	Columbus. Flash flood – Heavy rains flooded Route 426.	NP
01/26/1997	Tidioute. Flash flood – Ice jams formed after heavy rain and snowmelt caused streams to rise.	NP
06/25/1997	Garland. Flash Flood – heavy rains from thunderstorms. Route 3007 was closed.	NP
01/07/1998	Warren. Flash flood.	NP
06/21/2001	Warren. Flash flood.	NP
05/05/2002	Warren. Flash flood – Heavy rains caused flash flooding. A mudslide closed portions of Route 6 and Route 62 just south of the intersection of the two roads.	NP
07/23/2003	Countywide. Heavy rains. City of Warren received 2.5" in less than 2 hrs. Nearly four thousand residents without power.	4,500,000
07/23/2003	Tidioute. Flash flood – Heavy rains caused rapid flooding. Over 200 homes sustained water damage. Four personal bridges were destroyed. Twenty people were evacuated when Tidioute Creek and McGuire Run experienced rising water levels.	500,000
05/21/2004	Chandlers Valley and Sugar Grove. Flash flood – Heavy rains from thunderstorms. A total of 9 families were rescued by boat countywide. The Red Cross was activated and Route 957 was closed.	100,000
06/13/2004	Countywide. Flooding due to heavy rains during the night. In Sheffield Township, 5 feet of water was reported in 5 businesses.	NP
09/08/2004	Statewide. Flooding from Hurricane Frances. As much as 3" – 5" of rainfall fell over a 12 to 18 hr. period.	NP

DATE	LOCATION AND/OR DESCRIPTION *(Events Highlighted Gray Represent Ice Jam Related Flooding)*	ESTIMATED PROPERTY DAMAGE ($)
09/17/2004	Sheffield. Flash flood – Heavy rains caused Tionesta Creek to rise.	NP
09/17/2004	Statewide. Flooding from Hurricane Ivan.	50,000,000
06/12/2006	Tidioute. Flash flood – Several small creeks overtopped their banks after heavy rain. Several water rescues were performed. A mudslide occurred along Route 62.	NP
03/15/2007	Sheffield. Flooding due to heavy rain combined with snowmelt. A number of roads and bridges were closed including Route 666. Four homes sustained major damage.	NP
07/23/2008	Garland. Flash Flood – Heavy rains from thunderstorms. Portions of State Routes 6, 957, 426, 427 and 77 were closed. Several water rescues were performed.	NP
05/28/2009	Warren. Flash flood – Heavy rains from thunderstorms. A rockslide was reported along Route 59, one mile west of Kinzua Dam.	5,000
08/10-11/2009	Countywide. Flash flooding – Thunderstorms produced heavy rain and caused flash flooding in northern and eastern Warren County. Roads were closed in Chandlers Valley and Pine Grove Township. The City of Warren experienced flooding and manhole cover displacement from the heavy rains.	15,000
05/28/2013	Columbus. Flash flooding - Heavy thunderstorm rains caused flash flooding and closed portions of US Route 6 in Columbus Township, SR 69 (Jackson Run Road) and SR 59 (Kinzua Road) in the northern part of the county. Warren Fire units were called for a water rescue on Brown Run Road as Brown Run came out of its banks and over-flowed the bridge. The flood waters also impacted one home on the south-side of Kinzua Road.	2,500
05/21/2014	Bear Lake. Flash flooding - Heavy rain and flash flooding caused several road closures and flooded basements.	NP
06/12/2014	Columbus. Flash flooding - Heavy rain caused flash flooding during the late evening and into the overnight period on June 12-13, 2014. The flooding closed roads, including portions of SR 62, SR 6 and SR 59. Other secondary road closures included but were not limited to Dutchman Road in Mead Township and Chapman Dam Road near Clarendon.	NP
06/25/2014	Enterprise: Flooding - Two Mile Run caused approximately 30 residents of Sheffield Township to be evacuated and several roadways were closed due to the flooding	NP

DATE	LOCATION AND/OR DESCRIPTION *(Events Highlighted Gray Represent Ice Jam Related Flooding)*	ESTIMATED PROPERTY DAMAGE ($)
1/11/2018	Ice Jam Flooding – Sugar Grove, Freehold, Columbus.	NP
06/19/2019	Flash flooding - Heavy rains passed through multiple municipalities in Warren County causing water rescue calls, road closures, mud slides and other impacts. A Command Post was set up at the Youngsville Fire Department.	NP
7/4/2019	A large upper level system moving through the Mid Atlantic resulted in a three-day rain event that caused multiple flash floods through Central PA. State Route 62 Flooded North of Tidioute was closed.	1,000

The National Flood Insurance Program identifies *repetitive loss* properties as structures insured under the NFIP which have had at least two paid flood losses of more than $1,000.00 over any ten year period since 1978. A property is considered a *severe repetitive loss* property either when there are at least four losses each exceeding $5,000.00 or when there are two or more losses where the building payments exceed the property value. According to the *October 2019 Update of the Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan* (State HMP), there are ten single-family repetitive loss properties in Warren County; there were eleven, but one is reported as mitigated.

The following *Table 20 – NFIP Summary* lists the Warren County municipalities participating in the NFIP. All municipalities in Warren County participate in the NFIP. *Table 21 – Summary of Number and Type of Repetitive Loss Properties by Municipality* summarizes the number and type of repetitive loss properties located in Warren County according to FEMA.

Table 20 – NFIP Summary – FEMA

NFIP Summary					
Municipality	**CID**	**Losses**	**Building Payments**	**Content Payments**	**NFIP Policies** As of August 13, 2020
Bear Lake Borough	422544	0	0	0	0
Brokenstraw Township	422115	2	$7,428	$0	30
Cherry Grove Township	422545	0	0	0	0
Clarendon Borough	421221	2	$108	$11,509	0
Columbus Township	422116	0	0	0	2
Conewango Township	422117	0	0	0	24
Deerfield Township	422118	0	0	0	3

NFIP Summary					
Municipality	**CID**	**Losses**	**Building Payments**	**Content Payments**	**NFIP Policies** As of August 13, 2020
Eldred Township	422546	0	0	0	0
Elk Township	422119	0	0	0	1
Farmington Township	422120	2	$19,519	$0	1
Freehold Township	422121	0	0	0	3
Glade Township	422122	0	0	0	11
Limestone Township	422547	0	0	0	3
Mead Township	422123	2	$8,736	$3,396	17
Pine Grove Township	422124	14	$131,693	$16,319	31
Pittsfield Township	422125	0	0	0	19
Pleasant Township	422548	0	0	0	9
Sheffield Township	422126	0	0	0	20
Southwest Township	422127	0	0	0	3
Spring Creek Township	422128	0	0	0	2
Sugar Grove Borough	420842	0	0	0	4
Sugar Grove Township	422549	0	0	0	2
Tidioute Borough	422114	0	0	0	6
Triumph Township	422550	0	0	0	3
Warren City	420843	0	0	0	12
Watson Township	422551	0	0	0	7
Youngsville Borough	420844	4	$17,737	$15,633	38
Total		**26**	**$185,167**	**$46,858**	**251** ***(vs. 278 reported in 2016)***

Table 21 - Summary of Number and Type of Repetitive Loss Properties by Municipality

Summary of Number and Type of Repetitive Loss Properties by Municipality								
Municipality	**Type**					**Total Structures in the SFHA**	**Sum of Repetitive Loss Properties**	**Sum of Losses**
	Non-Residential	**2-4 Family**	**Single Family**	**Condo**	**Other Residential**			
Bear Lake Borough	0	0	0	0	0	0	0	0
Brokenstraw Township	0	0	2	0	0	157	1	2
Cherry Grove Township	0	0	0	0	2	0	0	2

Municipality	Type					Total Structures in the SFHA	Sum of Repetitive Loss Properties	Sum of Losses
	Non-Residential	2-4 Family	Single Family	Condo	Other Residential			
Clarendon Borough	0	0	0	0	2	0	1	2
Columbus Township	0	0	0	0	0	25	0	0
Conewango Township	0	0	0	0	0	102	0	0
Deerfield Township	0	0	0	0	0	98	0	0
Eldred Township	0	0	0	0	0	2	0	0
Elk Township	0	0	0	0	0	3	0	0
Farmington Township	0	0	2	0	0	5	1	2
Freehold Township	0	0	0	0	0	11	0	0
Glade Township	0	0	0	0	0	32	0	0
Limestone Township	0	0	0	0	0	354	0	0
Mead Township	0	0	2	0	0	74	1	2
Pine Grove Township	0	0	6	0	0	128	6	14
Pittsfield Township	0	0	0	0	0	148	0	0
Pleasant Township	0	0	0	0	0	74	0	0
Sheffield Township	0	0	0	0	0	233	0	0
Southwest Township	0	0	0	0	0	12	0	0
Spring Creek Township	0	0	0	0	0	5	0	0
Sugar Grove Borough	0	0	0	0	0	5	0	0
Sugar Grove Township	0	0	0	0	0	11	0	0
Tidioute Borough	0	0	0	0	0	59	0	0
Triumph Township	0	0	0	0	0	12	0	0
Warren City	0	0	0	0	0	121	0	0
Watson Township	0	0	0	0	0	84	0	0
Youngsville Borough	0	0	2	0	0	161	0	4
Total Repetitive Loss Properties:	**0**	**0**	**8**	**0**	**0**	**1916** ***(vs. 2009 reported in 2016)***	**10**	**26**

Source: FEMA, 2020

4.3.4.4 Future Occurrence

In Pennsylvania, flooding occurs commonly and can occur during any season of the year. Every two to three years, serious flooding occurs along one or more of Pennsylvania's major rivers or streams, and it is not unusual for this to occur several years in succession. Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and the related probability of

occurrence. The NFIP uses historical records to determine the probability of occurrence for different extents of flooding. The probability of occurrence is expressed in percentages as the chance of a flood of a specific extent occurring in any given year.

The NFIP recognizes the one percent annual chance flood, also known as the *base flood*, as the standard for identifying properties subject to federal flood insurance purchase requirements. A 1% annual chance flood is a flood which has a one percent chance of occurring over a given year. The existing FIRMs published between 1976 and 1991 can be used to identify areas subject to the one percent and 0.2% annual chance flooding. Areas subject to 2% percent and 10% annual chance events are not shown on maps; however, water surface elevations associated with these events are included in the flood source profiles contained in the Flood Insurance Study. FIRMs, Flood Insurance Studies (FIS), and other flood hazard information for counties throughout Pennsylvania can be obtained from the FEMA Map Service Center (http://www.msc.fema.gov).

Table 22 – Recurrence Intervals and Properties shows a range of flood recurrence intervals and associated probabilities of occurrence.

Table 22 - Recurrence Intervals and Properties

RECURRENCE INTERVAL	CHANCE OF OCCURRENCE IN ANY GIVEN YEAR (%)
10 year	10
50 year	2
100 year	1
500 year	0.2

4.3.4.5 Vulnerability Assessment

Warren County is highly vulnerable to flooding that causes loss of lives, property damage, and road closures. For purposes of assessing vulnerability, the county focused on community assets that are located in the special flood hazard area. While greater and smaller floods are possible, information about the extent and depths for this floodplain is available for all municipalities countywide, thus providing a consistent basis for analysis. Flood vulnerability maps for each applicable local municipality, showing the special flood hazard area and addressable structures, critical facilities and transportation routes within it, are included in Appendix D. These maps were created using the FEMA preliminary digital flood insurance rate maps. Warren County received new Digital Flood Insurance Rate Maps (DFIRM) for all the municipalities in the county in 2016 and the DFIRM data were adopted in 2017. This data was used for all flood related mapping, risk assessment and mitigation strategy development in the 2016 and 2021 hazard mitigation plans.

Table 23 – Critical Facilities within Special Flood Hazard Area identifies the critical facilities within Warren County that are located within the special flood hazard area. These facilities were identified using county GIS data. Critical facilities are facilities that if damaged would present an immediate threat to life, public health and safety.

Table 23 - Critical Facilities within Special Flood Hazard Area

Name	Facility Type	Location
Volunteer Fire Department	Emergency Services	Pittsfield Township
Tidioute Borough	Wastewater Facility	Tidioute Borough

Name	Facility Type	Location
Tidioute Borough	Municipal Government	Tidioute Borough
Tidioute Police Department	Emergency Services	Tidioute Borough
Volunteer Fire Department	Emergency Services	Sugar Grove Township
Emergency Medical Services	Emergency Services	Sugar Grove Township
Sheffield Township	Wastewater Facility	Sheffield Township

Flash Flooding:

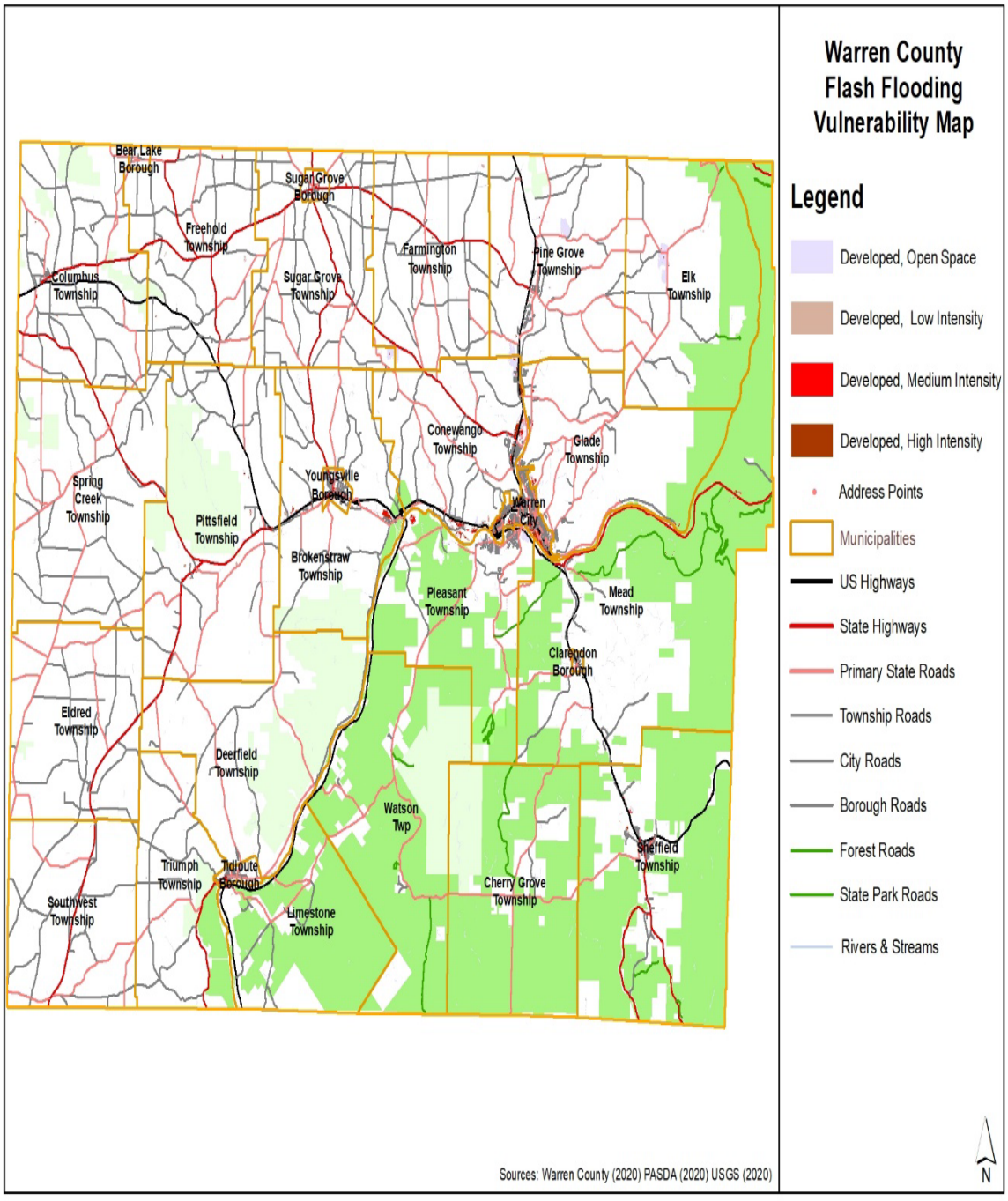
Flash flooding can occur anywhere within Warren County when the conditions are right. Locations that are more populated and have more impervious ground have a higher vulnerability to flash flooding. During the risk assessment process, numerous resources were utilized to determine flash flooding locations. Municipalities were asked to identify locations within the municipality that are prone to frequent flash flooding. The National Climatic Data Center was also queried to determine flash flood vulnerable areas.

Locations that are identified as vulnerable to flash flooding in Warren County are as follows:

- Bear Creek
- Chandlers Valley
- Columbus
- Garland
- Grand Valley
- Russel
- Sheffield
- Sugar Grove Borough
- Tidioute Borough
- Warren City

The Warren County Hazard Mitigation Team will continue to work with municipalities to identify vulnerable flash flooding locations and identify vulnerable special needs population and critical facilities. This will be a continuous process during the 2021-2026 mitigation plan period. As new data is developed, new special needs facilities appear, and new critical facilities are identified, the interface between flash flooding locations and the new data will be analyzed to identify new vulnerability.

Figure 24 –Flash Flooding Vulnerability



4.3.5. Hailstorms

4.3.5.1 Location and Extent

Hail is possible within most thunderstorms. It is produced by cumulonimbus (storm clouds) and within two nautical miles of the parent storm. In the form of solid precipitation, hail is produced when an ice crystal collects additional water in the lower part of the storm but is pushed upward by the storm's updraft. The liquid water freezes in the upper regions of the storm, making the ice crystal larger, this is also known as a hailstone. The hail will continue to grow in this manner until its weight exceeds the force of the updraft. Hailstones can take the shape of balls or irregular lumps of ice.

Hailstorms are not limited to any particular geographic area of the county. Neither prediction of the duration of the storm nor the extent of area affected by such an occurrence can be predicted.

4.3.5.2 Range of Magnitude

Hailstones can measure between 0.2 inches to six inches in diameter. The METAR (a format for reporting weather information, predominately used by pilots) reporting code for hail 0.20 inches or greater is GR, while smaller hailstones are coded GS. Hail that is larger than 0.80 inches are usually considered large enough to cause damage. The US National Weather Service will issue severe thunderstorm warnings when hail that is one inch or greater in diameter is expected.

National Oceanic and Atmospheric Administration Skywarn program requests trained Skywarn Spotters measure hail with a ruler, but if one is not available, related terms can be used. See *Table 24 – Hailstorm Size and Updraft Speed in Related Terms.* Hail should only be measured when it is safe to do so.

Table 24 – Hailstorm Size and Updraft Speed in Related Terms

Size of Hail in Related Terms		
Related Item	**Size of Hail (Inches)**	**Updraft Speed (MPH)**
BB	Less than 1/4”	Less than 24
Pea	1/4”	24
Marble	1/2”	35
Dime	7/10”	38
Penny	3/4"	40
Nickel	7/8”	46
Quarter	1”	49
Half Dollar	1 1/4"	54
Walnut	1 1/2"	60
Golf ball	1 3/4"	64
Hen Egg	2”	69
Tennis ball	2 1/2"	77
Baseball	2 3/4"	81
Teacup	3”	84
Grapefruit	4”	98
Softball	4 1/2"	103

4.3.5.2 Past Occurrence

In the 1960's the National Weather Service (NWS) developed the Skywarn® program. Skywarn® has trained weather spotters who provide reports of severe weather to NWS. These reports assist meteorologists to make life-saving warning decisions. Concerned citizens, amateur radio operators, truck drivers,

emergency management personnel and others volunteer their time and energy to report hazardous weather impacting their communities.

Even with data from Doppler radar, satellite, and surface weather stations, NWS technology cannot detect every instance of weather such as hail. So, reports from Skywarn® volunteers are a vital service for making warnings to those in the storm's path.

According to the National Center for Environmental Information (NOAA), Warren County experienced a total of thirty-nine hailstorm events between 1950 and 2020. Approximately ninety-six percent of hailstorm events occur during the months of April, May, June, July, August, and September. Additionally, approximately eighty-seven percent of historic hailstorm events have occurred during evening or afternoon. NOAA's National Weather Service storm prediction center reports on hail events for Warren County are detailed in *Table 25 – National Weather Service Hail Reports for Warren County*.

No significant property or crop damage was recorded during the hailstorm events between 1950 and 2020.

Table 25 – National Weather Service Hail Reports for Warren County

National Weather Service Hail Reports for Warren County			
Date	**Time**	**Location**	**Size (inches)**
04/14/1955	16:29	Warren Co.	0.75
05/31/1985	18:30	Warren Co.	1.75
05/31/1985	20:00	Warren Co.	2.75
05/31/1985	20:15	Warren Co.	2.75
04/06/1986	15:55	Warren Co.	0.75
07/20/1986	11:22	Warren Co.	0.75
08/28/1990	19:15	Warren Co.	0.75
05/25/1991	16:00	Warren Co.	1.75
08/30/1992	12:05	Warren Co.	0.75
08/31/1993	13:45	Pittsfield	1.00
05/10/1995	15:30	Sheffield	1.75
08/15/1996	17:02	Warren	0.75
07/15/1997	14:00	Youngsville	1.00
05/31/1998	12:10	Lottsville	0.88
06/02/1998	16:15	Scandia	1.75
06/30/1998	13:00	Sheffield	0.75
06/02/2000	11:15	Warren	0.75
04/28/2002	13:29	Clarendon	0.75

National Weather Service Hail Reports for Warren County			
Date	**Time**	**Location**	**Size (inches)**
05/25/2002	21:30	Sugar Grove	0.75
06/04/2002	15:15	Sheffield	1.00
05/18/2004	13:30	Russell	1.00
04/03/2006	13:42	Warren	0.88
06/13/2007	13:30	Sugar Grove	0.75
07/27/2007	19:52	Stoneham	0.75
08/25/2007	15:55	Youngsville	1.00
09/26/2007	16:50	Tidioute	1.75
09/26/2007	17:10	Clarendon	0.75
06/29/2008	17:00	Russell	0.88
07/23/2008	1:45	Wrightsville	0.88
07/26/2008	16:35	Grand Vly	1.75
12/09/2009	12:58	Grand Vly	1.00
08/19/2011	16:06	Irvine	1.00
05/29/2012	11:00	Columbus	1.00
05/10/2013	15:32	Garland	1.00
05/10/2013	15:35	Pittsfield Arpt	1.00
06/28/2013	11:30	Scandia	1.00
06/28/2013	12:00	Sheffield	0.75
07/01/2014	14:58	Tidioute	1.00
06/18/2017	14:55	Sugar Grove	1.00

Source: National Oceanic and Atmospheric Administration for National Center of Environmental Information

4.3.5.4 Future Occurrence

Hailstorm events are expected to continue annually, primarily between April and August, throughout Pennsylvania. The southeast and west sections of the Commonwealth can expect to experience a higher number of hailstorm events compared to other areas of Pennsylvania. The local planning team determined an overall risk factor score of 1.9 for this hazard making it a low hazard. Hailstorms are also associated with other hazards, such as thunderstorms, making it likely to occur.

4.3.6.5 Vulnerability Assessment

Automobiles, aircraft, skylights, livestock, and farmers' crops can all be seriously damaged by hail. Damage to crops and vehicles often represent the most significant impacts of hailstorms. While all jurisdictions

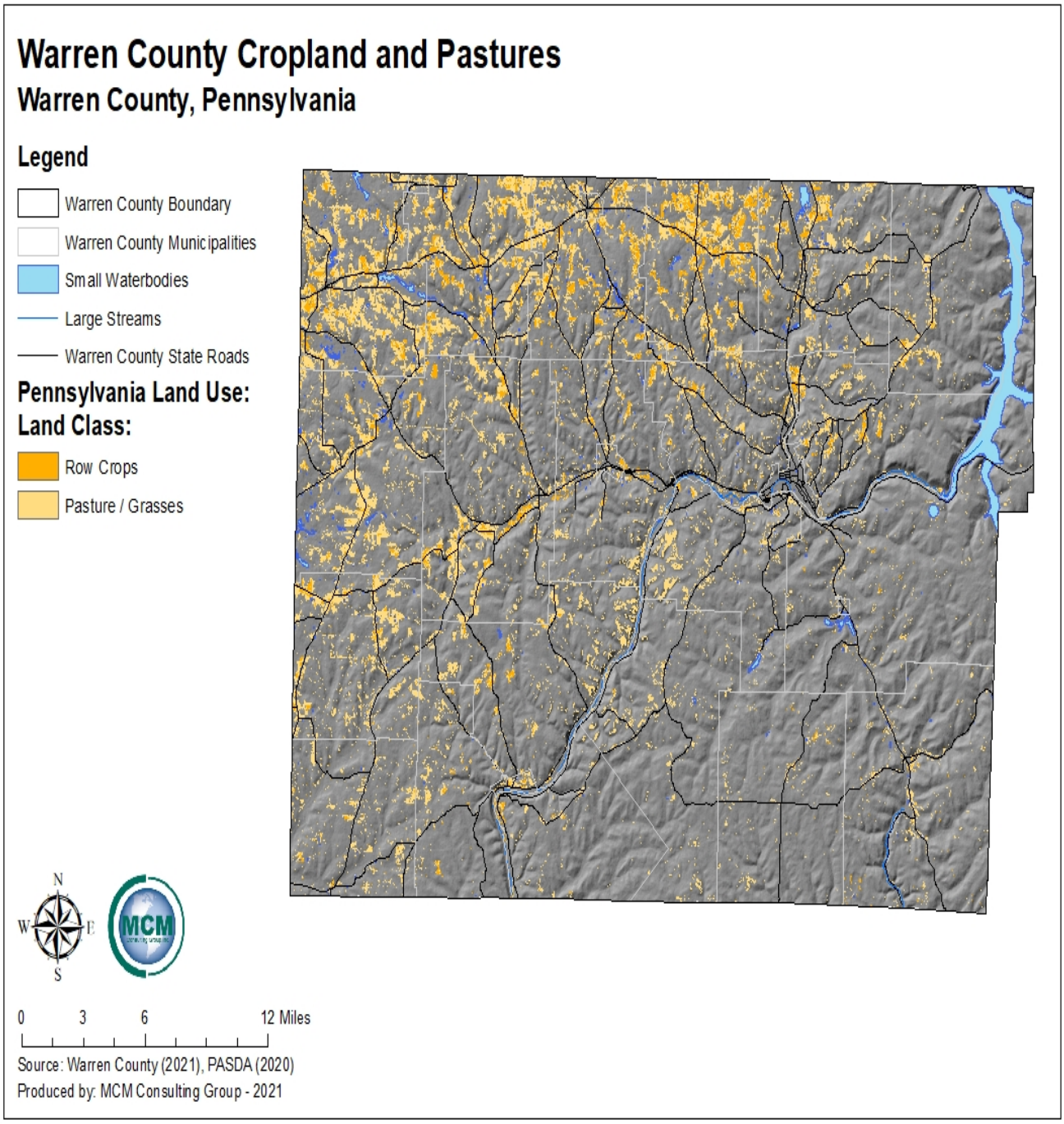
are vulnerable to the effects of hailstorms, jurisdictions with a high percentage of farmland and high agricultural yields are particularly vulnerable. *Figure 25 – Warren County Cropland and* Pastures displays cropland and pastures located in Warren County. From the perspective of potential agricultural losses, relative jurisdictional vulnerability can be determined by comparing each jurisdiction's farmland acreage and agricultural production. Across all communities in Pennsylvania, hailstorm events between 1950 and 2018 have caused $5,919,600 in reported property damage and $3,487,000 in reported crop damage (NCEI, 2018). Roofs can also be damaged by hail, although it most likely will go undetected until structural damage is seen, such as leaks and cracks. Although it is rare, hail has been known to cause concussions or fatal head traumas to humans. To alleviate damages from hail: automobiles could be placed in garages, grounded aircraft could be placed in a hanger, livestock and people moved inside structures during the storm. Unfortunately crops, skylights, roofs, and flying aircraft are unable to be protected from hail.

Environmental and other impacts from hailstorms range from:

- Crop production damage
- Flooding caused by accumulation of hail that blocks drains
- Trees brought down
- Flash flooding
- Mudslides
- Property damage
- Vehicle damage
- Cattle/livestock damage
- Dangerous driving
- Dangerous aircraft control

Even for communities that are prepared for a response to hailstorms, severe events of livestock damage, property damage, drop production damage, and flooding is still an occurrence. Vulnerability to the effects of hailstorms on crop and property damage is dependent on the acreage of land and location area.

Figure 25 - Warren County Cropland and Pastures



4.3.6. Hurricane, Tropical Storms

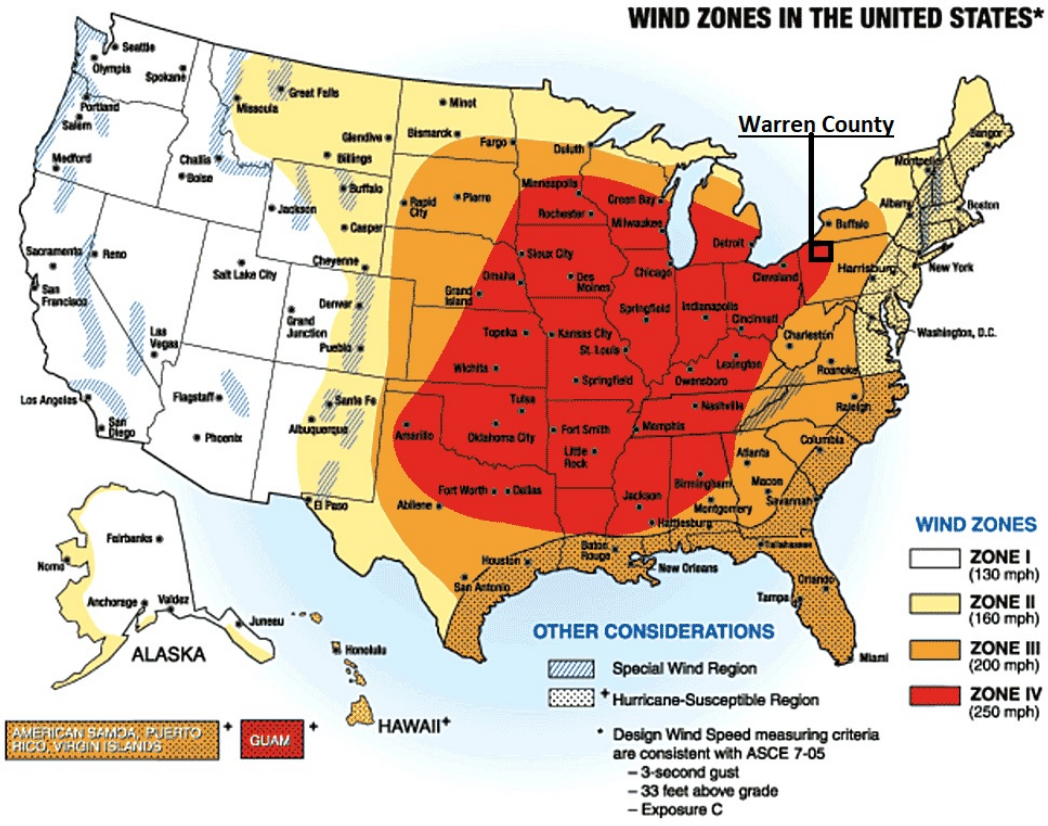
4.3.6.1 Location and Extent

Tropical depressions are cyclones with maximum sustained winds of less than thirty-nine miles per hour (mph). The system becomes a tropical storm when the maximum sustained winds reach between thirty-nine to seventy-four mph. When wind speeds exceed seventy-four mph, the system is considered a hurricane. Tropical storms impacting Warren County develop in tropical or sub-tropical waters found in the Atlantic Ocean, Gulf of Mexico or Caribbean Sea. Another type of tropical storm is a nor'easter, which is a large cyclone that rotates clockwise and is typically associated with the Atlantic Ocean and the East Coast of the United States between North Carolina and Massachusetts. The name nor'easter comes from the direction that the strongest winds typically blow from the cyclone.

While Warren County is located over 350 miles inland of the East Coast of the United States, tropical storms can track inland and cause heavy rainfall and strong winds. Warren County is located just inland of the East Coast region designated by FEMA as being Hurricane-Susceptible (see *Figure 26 – Wind Zones in the United States).* Warren County falls within the wind Zone IV, which suggests that shelters and functional needs facilities should be able to withstand a three-second gust of wind up to two hundred fifty miles per hour (*Figure 26 – Wind Zones in the United States*). All communities within Warren County are equally subject to the impacts of hurricanes and tropical storms that track near the county. Areas in Warren County which are subject to flooding, wind and winter storm damage are particularly vulnerable.

Interested readers may find a good reference on cyclones, tropical depressions, hurricanes and the United States National Hurricane Center (NHC) here: https://www.nhc.noaa.gov/outreach/presentations/2014-nhcL311-notes.pdf.

Figure 26 - Wind Zones in the United States



4.3.6.2 Range of Magnitude

The impact tropical storm or hurricane events have on an area is typically measured in terms of wind speed. Expected damage from hurricane force winds is measured using the Saffir-Simpson Scale (*Table 26).* The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential (characteristic of tropical storms and hurricanes, but not a threat to inland locations like Warren County). Categories three, four, and five are classified as "major" hurricanes. While major hurricanes comprise only twenty of all tropical cyclones making landfall, they account for over seventy percent of the damage in the United States. While hurricanes can cause high winds and associated impacts, it is also important to recognize the potential for flooding events during hurricanes, tropical storms and nor'easters; These storms have the ability to produce high volumes of rainfall that cause flash flooding initially and then follow with stream and river flooding. The risk assessment and associated impact for flooding events is included Section 4.3.4.5.

Table 26 - Saffir-Simpson Scale

Saffir-Simpson Hurricane Scale		
Category	Wind Speed	
	mph	knots
5	≥156	≥135
4	131-155	114-134
3	111-130	96-113
2	96-110	84-95
1	74-95	65-83
Non-Hurricane Classifications		
Tropical Storm	39-73	34-64
Tropical Depression	0-38	0-33

4.3.6.3 Past Occurrence

The impact that tropical storm or hurricane events have on an area is typically measured in terms of wind speed. Expected damage from hurricane force winds is measured using the Saffir-Simpson Scale (*Table 26*). The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential (characteristic of tropical storms and hurricanes, but not a threat to inland locations like Warren County). Categories three, four, and five are classified as "major" hurricanes. While major hurricanes comprise only 20% of all tropical cyclones making landfall, they account for over 70% of the damage in the United States. Though hurricanes can cause high winds and associated impacts, it is also important to recognize the potential for flooding events during hurricanes, tropical storms and nor'easters; these storms have the ability to produce high volumes of rainfall that can cause flash flooding initially and then follow with stream and riverine flooding. The risk assessment and associated impact for flooding events is included Section 4.3.4.5.

Hurricane Agnes was a severe coastal storm event in June 1972 that impacted Warren County. After making first landfall as a hurricane near Panama City, Florida, Agnes weakened and exited back into the Atlantic off the North Carolina coast. The storm skirted along the coast and made a second landfall near New York City as a tropical storm and merged with an extra-tropical low-pressure system over northern Pennsylvania. This brought extremely heavy rains to Pennsylvania, and a very high risk of severe flooding in the Pittsburgh District Watershed. News reports credited the newly constructed Kinzua Dam with saving over 247 million dollars in flooding damages – paying for itself in one event. The highest concentration of rain was in the Susquehanna River Basin where catastrophic flooding occurred: Pennsylvania incurred $2.1 billion in damages and forty-eight deaths statewide; fire and flood destroyed 68,000 homes and 3,000 businesses and left 220,000 Pennsylvanians homeless. The event triggered a Presidential Disaster Declaration. Rainfall of seven to ten inches was noted across the Commonwealth, with some areas reporting as much of eighteen inches locally. Many roadways in Warren County were damaged.

In September 2004, Tropical Storm Ivan caused extensive flooding as well, also resulting in a Presidential Disaster Declaration for regions in Pennsylvania. Ivan produced flooding somewhat less than 100-year event crests in some locations.

Hurricane Sandy was the deadliest and most destructive hurricane of the 2012 Atlantic hurricane season, and the second-costliest hurricane in U.S. history. Sandy was a Category three storm at its peak intensity when it made landfall in Cuba. It was classified as a Category two storm off the coast of the Northeastern United States, but because of the unusual merge with a frontal system, the hurricane was termed "Superstorm Sandy." At least 285 people were killed along the path of the storm in seven countries. In the United States, there were seventy-two people killed with an additional eighty-seven fatalities as indirect result of the storm. Superstorm Sandy caused an estimated $65 billion in damages in the United States alone.

Table 27 - History of Coastal Storms

History of Coastal Storms Impacting Warren County (HomeFacts)	
Year	**Name**
1955	Hurricane Connie
1959	Hurricane Gracie
1968	Tropical Storm Candy
1972	Tropical Storm Agnes
1979	Hurricane Frederic
1989	Hurricane Hugo
1995	Hurricane Opal
1996	Hurricane Fran
1999	Hurricane Floyd
2002	Hurricane Isidore
2003	Tropical Storm Isabel/Henri
2004	Tropical Depression Ivan/Frances
2012	Hurricane Sandy
2006	Tropical Depression Ernesto
2008	Hurricane Ike
2011	Hurricane Irene
2011	Tropical Storm Lee
2012	Hurricane Sandy
2017	Tropical Storm Cindy

Figure 27 - Tropical Storm Lee Rainfall Totals

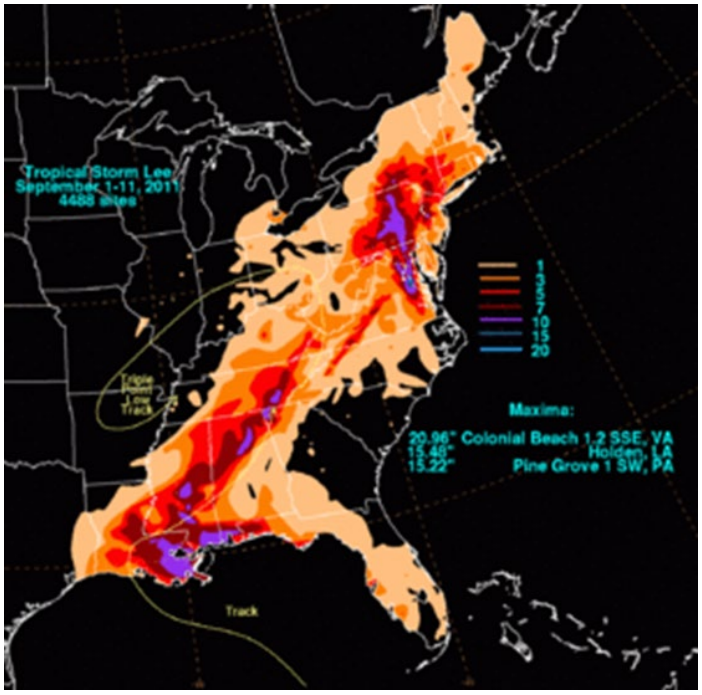
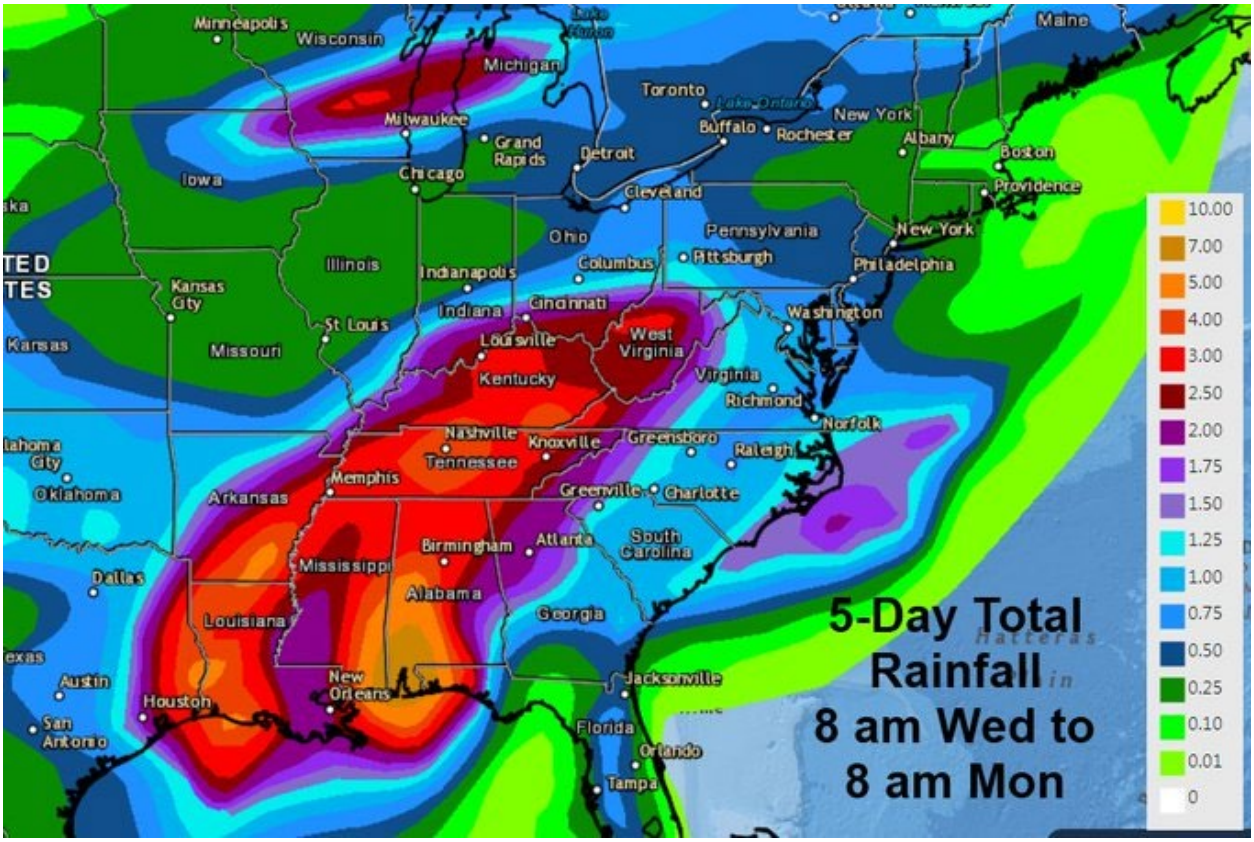


Figure 28 – Tropical Storm Cindy Rainfall Totals



4.3.6.4 Future Occurrence

Although hurricanes and tropical storms can cause flood events consistent with 100- and 500-year flood levels, the probability of occurrence of hurricanes and tropical storms is measured relative to wind speed. *Table 28 – Annual Probability of Wind Speeds* shows the annual probability of winds that reach the strength of tropical storms and hurricanes in Warren County and the surrounding areas based on a sample period of forty-six years. NOAA's Hurricane Research Division estimates that Warren County will experience impacts from a named tropical storm or hurricane up to once every ten years, with a probability between 0 – 10% annually. However according to FEMA, there is a high probability each year that Warren County will experience winds from coastal storms that could cause minimal to moderate damages (*Table 28 – Annual Probability of Wind Speeds*). The probability of winds exceeding 118 mph is less than 0.1 percent annually.

Table 28 - Annual Probability of Wind Speeds

Annual Probability of Wind Speeds *(FEMA, 2000)*		
Wind Speed (mph)	**Saffir-Simpson Scale**	**Annual Probability of Occurrence (%)**
45-77	Tropical Storms// Category 1 Hurricane	91.59
78-118	Category 1 to 2 Hurricanes	8.32
119-138	Category 3 to 4 Hurricanes	.0766
139-163	Category 4 to 5 Hurricanes	.0086
164-194	Category 5 Hurricanes	.00054
195+	Category 5 Hurricanes	.00001

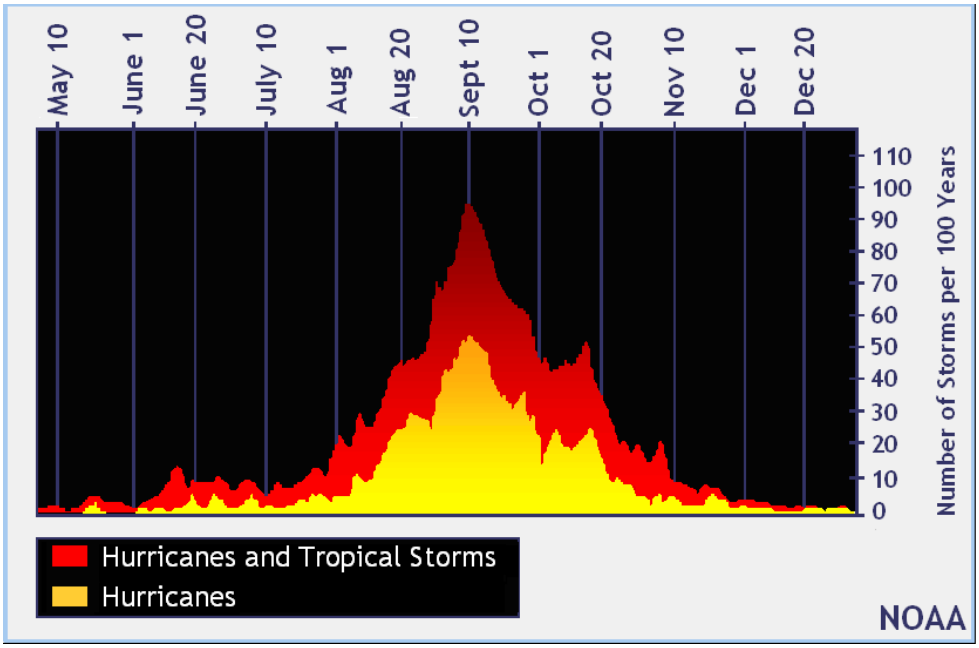
Climate change is causing atmospheric temperatures to rise, which corresponds to a rise in ocean surface temperatures, resulting in warmer and moister conditions where tropical storms develop (Stott et al., 2010). Warmer oceans store more energy, and are capable of fueling stronger storms and it is projected that Atlantic hurricanes will become more intense and produce more precipitation as ocean surface temperatures rise (Trenberth, 2010). There are expected to be more category four and five hurricanes in the Atlantic, and the hurricane season may be elongating.

4.3.6.5 Vulnerability Assessment

The impacts of climate change are no longer hypothetical concepts set in the future, but rather tangible and hazardous realities. The unexpectedly devastating Hurricane Harvey in August 2017 in Houston is widely regarded as an example of a hurricane supercharged by warmer ocean temperatures (Trenberth et al., 2018). The damage Harvey caused to Houston was also exacerbated by urbanization, causing the storm system to stall over Houston with few locations where water could naturally sink into the ground (Zhang et al., 2018). *Figure 29 – Annual Calendar Timing of Cyclone Storms* shows the calendar timing vulnerability of major cyclone storms and can be useful for public outreach and prevention measures.

Hurricanes and tropical storms in Warren County can cause significant secondary impacts such as high winds, flooding, and utility interruption. The assessment for wind-related vulnerability is addressed in Section 4.3.11.5 and discussion of flood-related vulnerability is addressed in Section 4.3.4.5. Additionally, the assessment for utility interruption-related vulnerability can be found in 4.3.22.5.

Figure 29 – Annual Calendar Timing of Cyclone Storms



4.3.7. Invasive Species

4.3.7.1 Location and Extent

An invasive species is a species that is not indigenous to a given ecosystem and that, when introduced to a non-native environment, tends to thrive. The spread of an invasive species often alters ecosystems, which can cause environmental and economic harm and pose a threat to human health. The phenomenon of invasive species is due to human activity. Human society is globalized, and people have the capability to traverse

the globe at rates unparalleled in human history. Either intentionally or unintentionally, other species may accompany people when they travel, introducing the stowaway species to a novel ecosystem. In a foreign ecosystem, a transported species may thrive, potentially restructuring the ecosystem and threatening its health. Common pathways for invasive species introduction to Pennsylvania include (Pennsylvania Invasive Species Management Plan, 2017):

- Contamination of internationally traded products
- Hull fouling
- Ship ballast water release
- Discarded live fish bait
- Intentional release
- Escape from cultivation
- Movement of soil, compost, wood, vehicles or other materials and equipment
- Unregulated sale of organisms
- Smuggling activities
- Hobby trading or specimen trading

Invasive species threats are typically divided into two main subsets:

Aquatic Invasive Species (AIS) are nonnative, invertebrates, fishes, aquatic plants, and microbes that threaten the diversity or abundance of native species, the ecological stability of the infested waters, human health and safety, or commercial, agriculture, or recreational activities dependent on such waters.

Terrestrial Invasive Species (TIS) are nonnative plants, vertebrates, arthropods, or pathogens that complete their lifecycle on land whose introduction does or is likely to cause economic or environmental harm or harm to human health.

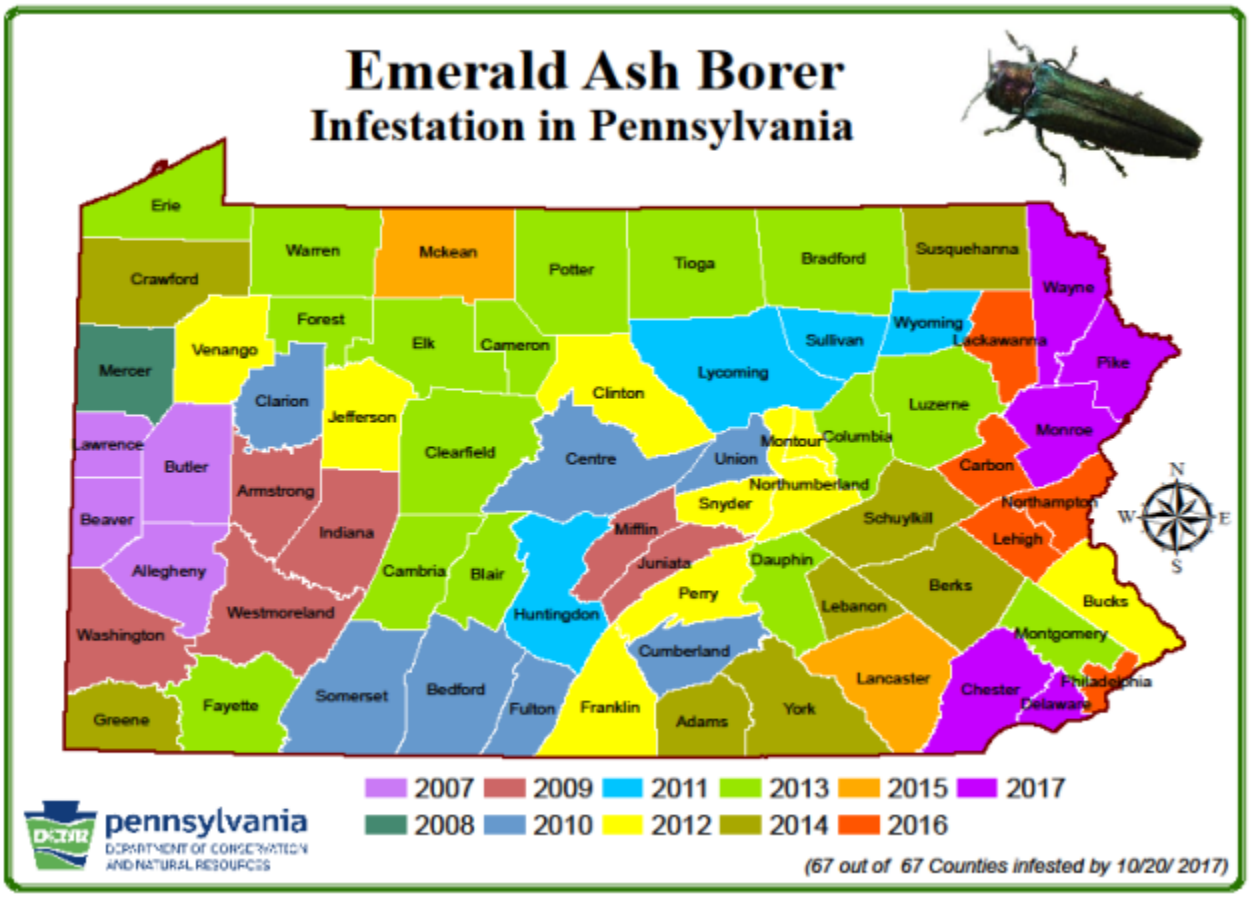
The location and extent of invasive threats is dependent on the preferred habitat of the species, as well as the species' ease of movement and establishment. *Table 29 – Prevalent Invasive Species* lists invasive species that have been found in Warren County.

4.3.7.2 Range of Magnitude

Some invasive species are not considered agricultural pests, and do not harm humans or cause significant ecological problems. Other invasive species can have many negative impacts and cause significant changes in the composition of ecosystems. For example, the Emerald Ash Borer has a 99% mortality rate for any ash tree it infects. Didymo, an aggressive form of algae not yet found in Warren County, can clog waterways and smother native aquatic plants and animals.

The aggressive nature of many invasive species can cause significant reductions in biodiversity by crowding out native species. This can affect the health of individual host organisms as well as the overall well-being of the affected ecosystem. An example of a worst-case scenario for invasive species is the success of the Emerald Ash Borer in Warren County and the surrounding region. The Emerald Ash Borer has already become established in Warren County (see *Figure 30 – Emerald Ash Borer Infestation in Pennsylvania*) and the surrounding region, and there is a high mortality rate for trees associated with this pest.

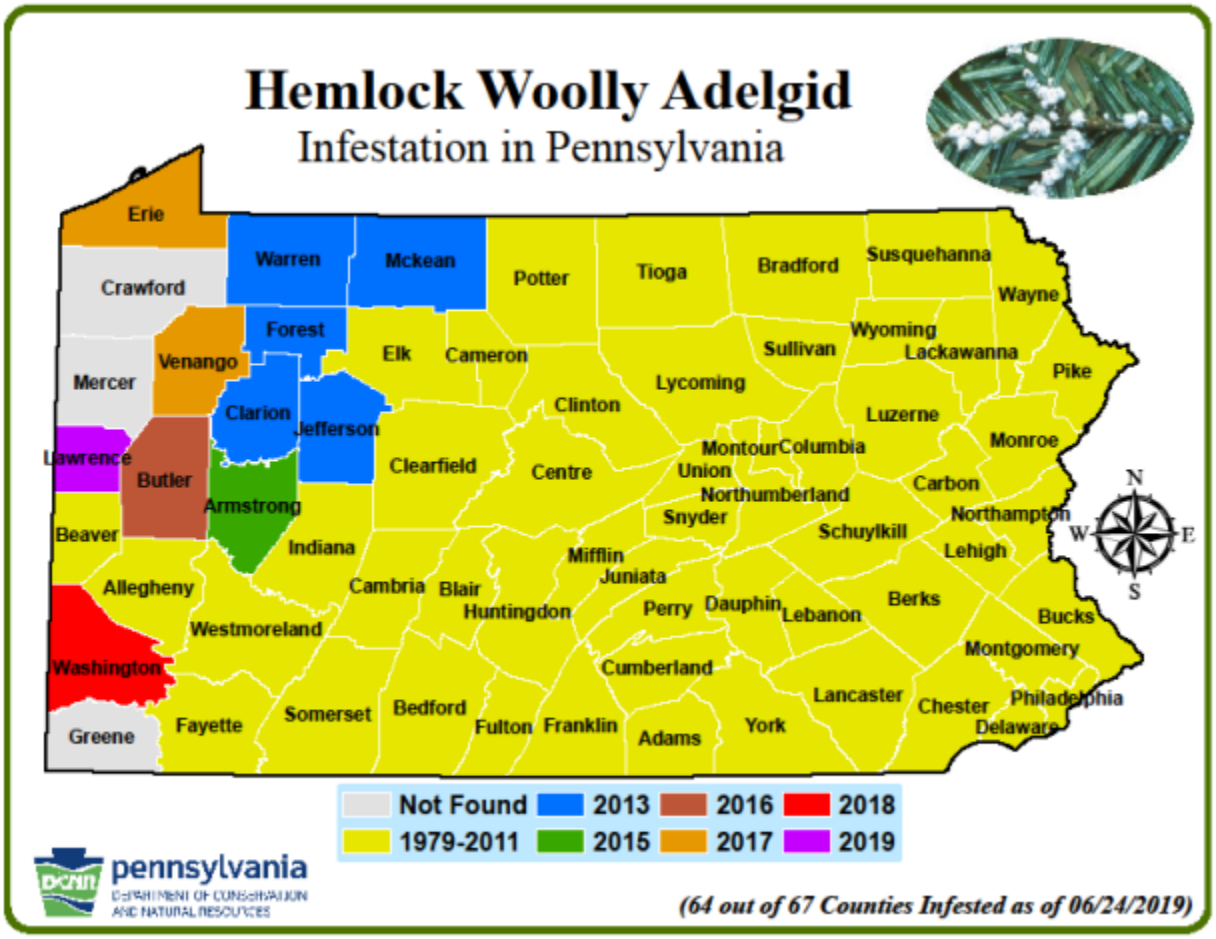
Figure 30 - Emerald Ash Borer Infestation in Pennsylvania



Another example is Adelges tsugae, the hemlock woolly adelgid (HWA). Hemlock woolly adelgid is a fluid-feeding insect that feeds on hemlock trees throughout eastern North America, including Pennsylvania. The egg sacs of these insects look like the tips of cotton swabs clinging to the undersides of hemlock branches.

Hemlock woolly adelgid was introduced from Asia into the Pacific Northwest in 1924. It was probably introduced into the northeastern United States in the 1950s and it was first discovered in Pennsylvania in 1967. This insect has been damaging hemlock ever since and it is spreading. To date, sixty-four counties in Pennsylvania, including Warren County just last year, have been infested with this insect. See *Figure 31 – Hemlock Woolly Adelgid Infestation in Pennsylvania.*

Figure 31 - Hemlock Woolly Adelgid Infestation in Pennsylvania



Eastern hemlock (Pennsylvania's state tree) and Carolina hemlocks (found further south in the Smoky Mountain sections of the Appalachians) are more susceptible to hemlock woolly adelgid damage than Asian and western hemlock trees due to feeding tolerance and predators that protect the latter species. Hemlock woolly adelgid sucks fluid from the base of hemlock needles. It may also inject toxins into the tree as it feeds, accelerating needle drop and branch dieback. Although some trees die within four years, trees often persist in a weakened state for many years. Hemlocks that have been affected by hemlock woolly adelgid often have a grayish-green appearance (hemlocks naturally have a shiny, dark green color).

In recent years, hardwood forests in the county have been increasingly negatively impacted due to these invasive species and there have been many tree fatalities. Degradation of forest health cascades into other problems. Among other benefits, forests prevent soil degradation and erosion, protect watersheds, and sequester carbon from the atmosphere. Forests have a key role in hydrologic systems, so losing a forest amplifies the effects of erosion and flooding. Forest degradation also has adverse economic effects, impacting such activities as logging, tourism, foraging and other production activities dependent on lumber.

The magnitude of an invasive species threat is generally amplified when the ecosystem or host species is already stressed, such as in times of drought. The already weakened state of the native ecosystem causes it to more easily succumb to an infestation. A worst-case example could be the Hemlock Woolly Adelgid

causing reduced biodiversity, increased wildfire potential and thermal harm to small stream cold water fisheries and habitats.

4.3.7.3 Past Occurrence

Invasive species have been entering Pennsylvania since the arrival of European settlers, but not all occurrences require government action.

There are many invasive plants have been widespread in Warren County that are common problems throughout the Commonwealth, some of the most problematic include:

- Commond Reed
- Japancse Barberry
- Japanese Knotwood
- Japanese Stiltgrass
- Multiflora Rose
- Water Chestnut

In the past these species have been cut back to slow their spread and treated with foliar herbicide when they re-sprout. However, when species are so widespread and established, they may not be actively treated unless they are in a project area that is receiving attention otherwise.

Due to the past experiences with invasive plants, there are five primary components which help with managing invasive plants:

Prioritize: Public use areas such as state parks and other healthy forest ecosystems should be prioritized over developed and private areas. Locations with lower densities of invasive plants are often easier to control and should be given quick attention. Locations where humans are disturbing the landscape opens up niche space, and often times the aggressive invasive species move in faster than native species. Such locations include areas around road work, ditch/culvert work, logging activities, stream improvement/stabilization and bridge work. Some species pose a higher risk than others - invasive species are easiest to control before they become widespread and established in an area, and for that reason, species that are less widespread should be prioritized for management.

Locate: Detailed locations should be recorded for invasive plants so sites can be easily relocated, treated, and monitored.

Delineate: The scale and extent of the infestation should be recorded and mapped so that the progress of the infestation can be monitored.

Control: Methods of control depend on the specific infestation, but the most common approaches are mechanical (cutting and hand-pulling) and chemical (herbicide treatments).

Monitor: Identified sites should be monitored and revisited as often as several times in a growing season (depending on the location/species). Monitoring can allow for early detection of spreading infestations. Most importantly, it prevents a relapse towards full-blown infestation.

Not only has invasive plants been a threat in the past there are also several invasive pests that have moved through Warren County and the surrounding region which have resulted in the deaths of many trees. PennDOT summarizes these invasive species:

Pennsylvania has been inhabited by an invasive beetle known as the Emerald Ash Borer. This green-colored insect has infested many ash trees, which has resulted in a pandemic level of dead ash trees. In addition, the

Gypsy Moth Caterpillar defoliated Western Pennsylvania at least twice within the last twenty years. This insect infested the oak tree species and many of those trees have died as well. The Woolly Adelgid and needle blight fungi are also currently affecting the white pine and hemlock trees, resulting in their premature deaths. (PennDOT, 2017)

These occurrences represent lost battles to invasive species. Once a species is established in an area and it causes a change in the ecology, it can be quite difficult if somewhat futile to turn back the clock on the prevalence of the species; however, Warren County can work towards limiting the spread and mitigating the negative impacts of such widespread invasive species. In the case of the Emerald Ash Borer, Hemlock Woolly Adelgid and other tree killing invasive species, PennDOT has identified one way that the threat needs to be mitigated in the wake of the surge of dead trees:

The Emerald Ash Borer, Gypsy Moth and Woolly Adelgid have left tens of thousands of dead trees either within the State Department of Transportation's (PennDOT) right-of-way, on other public property or on private property, but within close proximity to falling on our highways. Although random in nature, several fatalities have been associated with trees falling on motorists or motorists running into downed trees across the highway.

PennDOT has been incorporating select tree removal into roadway construction projects using both federal and state funding. Since July 1, 2016, PennDOT Department Force Crews have also increased their efforts in select manual tree removal. This work is often done during the winter when crews are not engaged in snow removal operations. Dead tree removal is quickly becoming a major focus of PennDOT, however a sustained funding source to remove all of these potential hazards is simply not available. The PA Department of Agriculture has established strict firewood and lumber quarantine areas in some of these districts so additional costs may be incurred.

Table 29 - Prevalent Invasive Species lists problematic non-native species that are established in Warren County. While all species listed here are not native to Warren County, those species highlighted in red are considered to pose a severe ecological threat than some of the others (Rank 1), species highlighted in orange are considered to pose a significant ecological threat but not considered to spread as easily and aggressively (Rank 2), and species highlighted in green are considered to pose a lesser ecological threat (Rank 3).

Table 29 - Prevalent Invasive Species

Prevalent Invasive Species (EDDMaps, 2019; iMapInvasives, 2019; PA DCNR, 2019)			
Scientific Name	**Common Name**	**Type**	**Total Records Found**
Corbicula fluminea	Asiatic Clam	Animal	3
Lonicera spp	Bush Honeysuckle	Plant	80
Cirsium vulgare	Bull Thistle	Plant	105
Cirsium arvense	Canada Thistle	Plant	65
Cyprinus carpio	Common Carp	Animal	39
Phragmites australis ssp. australis	Common Reed	Plant	49
Agrilus planipennis	Emerald Ash Borer	Insect	4

Prevalent Invasive Species (EDDMaps, 2019; iMapInvasives, 2019; PA DCNR, 2019)			
Scientific Name	**Common Name**	**Type**	**Total Records Found**
Trapa natans	European Water Chestnut	Plant	14
Myriophyllum spicatum	Eurasian Watermilfoil	Plant	1
Alliaria petiolata	Garlic Mustard	Plant	8
Heracleum mantegazzianum	Giant Hogweed	Plant	2
Frangula alnus	Glossy Buckthorn	Plant	2
Lymantria dispar	Gypsy Moth	Insect	8
Adelges tsugae	Hemlock Woolly Adelgid	Insect	4
Berberis thunbergii	Japanese Barberry	Plant	38
Polygonum cuspidatum	Japanese Knotweed	Plant	147
Microstegium vimineum	Japanese Stiltgrass	Plant	26
Lonicera morrowii	Morrow's Honeysuckle	Plant	5
Rosa multiflora	Multiflora Rose	Plant	20
Celastrus orbiculata	Oriental Bittersweet	Plant	3
Lythrum salicaria	Purple Loosestrife	Plant	6
Lonicera tatarica	Tatarian Honeysuckle	Plant	1
Ailanthus altissima	Tree-of-Heaven	Plant	6
Elaeagnus umbellata	Autumn Olive	Plant	5
Scolytus schevyrewi	Banded Elm Bark Beetle	Insect	3
Cryptococcus fagisuga	Beech Bark Disease	Disease	9
Rumex obtusifolius	Bitter Dock	Plant	2
Tussilago farfara	Colt's-foot	Plant	2
Potamogeton crispus L.	Curly-leaved Pondweed	Plant	6
Plantago lanceolata	English Plantain	Plant	2
Popillia japonica	Japanese Beetle	Insect	4
Poa pratensis	Kentucky Bluegrass	Plant	1
Choristoneura conflictana	Large Aspen Tortrix	Insect	2
Polygonum caespitosum	Oriental Lady's-thumb	Plant	4

Prevalent Invasive Species (EDDMaps, 2019; iMapInvasives, 2019; PA DCNR, 2019)			
Scientific Name	**Common Name**	**Type**	**Total Records Found**
Phalaris arundinacea	Reed Canary Grass	Plant	3
Poa trivialis	Scribner's Bluegrass	Plant	3
Anthoxanthum odoratum	Sweet Vernal Grass	Plant	2
Myosotis scorpioides	True Forget-me-not	Plant	2
Cronartium ribicola	White Pine Blister Rust	Disease	10
Euonymus alatus	Winged Spindletree	Plant	1
Dreissena polymorpha	Zebra Mussel	Animal	1
Aegopodium podagraria	Bishop's Goutweed	Plant	1
Brassica nigra	Black Mustard	Plant	1
Ophiognomonia clavigignenti-juglandacearum	Butternut Canker	Disease	2
Cryphonectria parasitica	Chestnut Blight or Canker	Disease	1
Solanum dulcamara	Climbing Nightshade	Plant	1
Veronica officinalis	Common Speedwell	Plant	1
Hypericum perforatum	Common St. John's-wort	Plant	1
Holcus lanatus	Common Velvetgrass	Plant	2
Achillea millefolium	Common Yarrow	Plant	1
Discula destructiva	Dogwood Anthracnose	Disease	2
Epipactis helleborine	Eastern Helleborine	Plant	1
Convallaria majalis	European Lily-of-the-valley	Plant	1
Craspedacusta sowerbyi	Freshwater Jellyfish	Animal	2
Reynoutria sachalinensis F. Schmidt ex Maxim	Giant Knotweed	Plant	2
Galega officinalis	Goatsrue	Plant	1
Sorghum halepense	Johnsongrass	Plant	2
Pristiphora erichsonii	Larch Sawfly	Insect	1
Tomicus piniperda	Larger Pine Shoot Beetle	Insect	1
Arctium minus	Lesser Burdock	Plant	1
Vinca minor	Lesser Periwinkle	Plant	2

Prevalent Invasive Species (EDDMaps, 2019; iMapInvasives, 2019; PA DCNR, 2019)			
Scientific Name	**Common Name**	**Type**	**Total Records Found**
Artemisia vulgaris	Mugwort	Plant	5
Hieracium aurantiacum	Orange Hawkweed	Plant	1
Celastrus orbiculatus	Oriental Bittersweet	Plant	2
Mentha x piperita	Peppermint	Plant	2
Rumex acetosella	Sheep Sorrel	Plant	2
Sirex noctilio	Sirex Woodwasp	Insect	2
Centaurea stoebe ssp. micranthos	Spotted Knapweed	Plant	3
Melilotus officinalis	Sweetclover	Plant	1
Cardamine impatiens	Touch-me-not Bittercress	Plant	2
Rorippa nasturtium-aquaticum	Watercress	Plant	1
Dipsacus fullonum	Wild Teasel	Plant	1
Salix alba	White Willow	Plant	1

4.3.7.4 Future Occurrence

According to the Pennsylvania Invasive Species Council (PISC), the probability of future occurrence for invasive species threats is growing due to the increasing volume of transported goods, increasing efficiency and speed of transportation, and expanding international trade agreements. Expanded global trade has created opportunities for many organisms to be transported to and establish themselves in new counties and regions. Climate change is contributing to the introduction of new invasive species. As maximum and minimum seasonal temperatures change, pests are able to establish themselves in previously inhospitable climates. This also gives introduced species an earlier start and increases the magnitude of their growth, possibly shifting the dominance of ecosystems in the favor of non-native species.

In order to combat the increase in future occurrences, the PISC (a collaboration of state agencies, public organizations and federal agencies) released the Invasive Species Management Plan in April 2010 and updated the plan in 2017. The plan outlines the Commonwealth's goals for managing the spread of nonnative invasive species and creates a framework for responding to threats through research, action, and public outreach and communication. More information can be found here: https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/GISC/Pages/default.aspx.

There are several invasive species that are found near Warren County but have not yet been detected inside the county (see *Table 30 – Vulnerable Species*). Especially in cases like this, control efforts, heightened awareness, and public outreach and education can help prevent an invasive species from becoming established. Once a species is established, it is much more difficult to eradicate it from an ecosystem meaning prevention is very important. Bush Honeysuckle species, the Spotted Lanternfly, Mile-A-Minute Vine and the Asian Long-Horned Beetle are all widespread and highly problematic in nearby counties but have not

been reported in Warren County. The forests of Warren County would greatly benefit if these species can be kept out of the area. For a more inclusive list of invasive plants found in Pennsylvania and a list of invasive plants on the Pennsylvania watch list, see the referenced PA DCNR publication DCNR Invasive Plant List (PA DCNR, 2016 at: http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_20033786.pdf).

The Spotted Lanternfly is a harmful invasive pest with a healthy appetite for our plants and can negatively impact the quality of life and enjoyment of the outdoors. According to the Penn State Extension, the Spotted Lanternfly is a significant threat to Pennsylvania agriculture, landscapes and natural ecosystems, including grape, tree-fruit, hardwood, and nursery industries, which collectively are worth nearly $18 billion to the state's economy, outdoor recreation, and biodiversity. The Spotted Lanternfly is currently found in twenty-six counties in Pennsylvania, all of which are under a state-imposed quarantine. The Spotted Lanternfly is undoubtedly traveling west as the State Department of Agriculture announced on March 3, 2020 that an additional twelve counties in Pennsylvania were added to the quarantine area. At the writing of this plan, Warren County is not among them.

Table 30 - Vulnerable Species

Vulnerable Species (EDDMaps, 2019; PA DCNR, 2019; iMapInvasives, 2019)		
Scientific Name	**Common Name**	**Type**
Trachemys scripta elegans	Red-eared Slider	Amphibian
Typha x glauca Godr	Hybrid Cattail	Aquatic Plant
Hydrilla verticillata	Hydrilla	Aquatic Plant
Humulus japonicus	Japanese Hop	Aquatic Plant
Ophiostoma novo-ulmi	Dutch Elm Disease	Disease
Ceratocystis fagacearum	Oak Wilt	Disease
Emaravirus RRD	Rose Rosette Disease (RRD)	Disease
Anoplophora glabripennis	Asian Longhorned Beetle	Insect
Phyllaphis fagi	Beech Woolly Adelgid	Insect
Fenusa pusilla	Birch Leafminer	Insect
Otiorhynchus sulcatus	Black Vine Weevil	Insect
Halyomorpha halys	Brown Marmorated Stink Bug	Insect
Dryocosmus kuriphilus	Chestnut Gall Wasp	Insect
Hylastes opacus	European Bark Beetle (H. Opacus)	Insect
Epinotia nanana	European Spruce Needleminer	Insect
Lepidosaphes ulmi	Oystershell Scale	Insect
Caliroa cerasi	Pear Sawfly	Insect

Vulnerable Species (EDDMaps, 2019; PA DCNR, 2019; iMapInvasives, 2019)		
Scientific Name	**Common Name**	**Type**
Taeniothrips inconsequens	Pear Thrips	Insect
Scolytus multistriatus	Smaller European Elm Bark Beetle	Insect
Lycroma delicatula	Spotted Lanternfly (Lycorma)	Insect
Drosophila suzukii	Spotted Winged Drosophila	Insect
Dendroctonus rufipennis	Spruce Beetle	Insect
Otiorhynchus ovatus	Strawberry Root Weevil	Insect
Commelina communis	Asiatic Dayflower	Plant
Hydrocharis morsus-ranae	Common Frogbit	Plant
Linaria dalmatica	Dalmatian Toadflax	Plant
Akebia quinata	Five-leaf Akebia	Plant
Lonicera japonica	Japanese Honeysuckle	Plant
Pueraria montana var. lobata	Kudzu	Plant
Euphorbia esula	Leafy Spurge	Plant
Persicaria perfoliata	Mile-A-Minute Vine	Plant
Carduus nutans	Musk Thistle	Plant

4.3.7.5 Vulnerability Assessment

Warren County's vulnerability to invasion depends on the species in question. Human activity and mobility are ever increasing, and combined with the prospects of climate change, invasive species are becoming increasingly threatening. Invasive species can have adverse economic effects by impacting agriculture and logging activities. Natural forest ecosystems provide clean water, recreational opportunities, habitat for native wildlife, and places to enjoy the tranquility and transcendence of nature. The balance of forest ecosystems and forest health are vulnerable to invasive species threats. While there is significant acreage of state park and game lands in Warren County where forest managers can impact invasive species, private lands can provide refuge for invasive species if landowners are unaware of or apathetic towards the threat.

Since there are large swatches of public land in Warren County, there is great risk of future damage from invasive species that are present in the area. With about 575,000 acres of total land in Warren County, there is a great amount of vulnerable land which include but not limited to Allegheny National Forest (shared among Elk, Forest, and McKean County) with around 517,000 acres, Chapman State Park with 862 acres, and ten state game lands. The state game lands (SGL) in Warren County include: SGL 029 with 9,800 acres, SGL 086 with 14,320 acres, SGL 143 with 8,500 acres, SGL 197 with 1,555 acres, SGL 263 (also shared with Erie County) with total 668 acres, SGL 272 with 185 acres, SGL 282 with 495.6, SGL 291 with 1,260

acres, SGL 306 with 1,038.15 acres, and SGL 309 with 992 acres. Therefore, a great amount of land and native wildlife within Warren County are at risk with the presence of invasive species.

An interesting facet of the invasive species problem in Pennsylvania is that deer do not eat many invasive plants, giving invasive species a competitive advantage over the native species that deer prefer. As such, the management of deer populations in Warren County has a significant impact on the vulnerability of an ecosystem to invasive species, where overpopulation of deer favors invasive species.

The Governor's Invasive Species Council of Pennsylvania (PISC), the lead organization for invasive species threats, has identified over 100 species threats that are or could potentially become significant in Pennsylvania. Of these threats, county and municipal leaders believe that the most significant are invasive forest pests like the Emerald Ash Borer, Hemlock Woolly Adelgid, the Gypsy Moth and vascular plants, especially Purple Loosestrife, Japanese Knotweed, Garlic Mustard, Bull Thistle, and Multi-flora Rose which all been identified red in *Table 29 - Prevalent Invasive Species* for priority species in Warren County.

It is best to take action before a species can become established in the county, so management should be aware of invasive species found nearby Warren County but not yet present in the county (priority species in *Table 30 - Vulnerable Species*). Public outreach and education are important for these species to improve identification and prevention of invasion. Without action, due to the instances and extent of the current infestations, it is reasonable to project that the county's vulnerability will increase.

4.3.8. Landslides

4.3.8.1 Location and Extent

Rock falls and other slope failures usually occur in areas of Warren County with moderate to steep slopes and high precipitation. Many slope failures are associated with precipitation events – periods of sustained above-average precipitation, specific rainstorms, or snowmelt events. Areas experiencing erosion, decline in vegetation cover, and earthquakes are also susceptible to landslides. Human activities that contribute to slope failure include altering the natural slope gradient, increasing soil water content, and removing vegetation cover.

A landslide, which is a natural geologic process, is the movement of unstable rock, unconsolidated earth, or debris down a slope. The volume of earth moved in these events can be large or small. Natural factors affecting slope stability include:

- Rock and soil characteristics and strength
- Slope steepness and orientation
- Precipitation and other sources of water
- The presence of old landslides
- Oversteepening of slopes by stream or lake erosion.

Human-caused factors affecting slope stability include:

- Removal of support on lower slopes
- Alteration of surface and subsurface drainage

The Department of Conservation and Natural Resources (DCNR) describes landslide susceptibility in Warren County as generally low but includes local areas of high to moderate. The majority of Warren County

has a low susceptibility to landslides however portions of the southeastern corner of the county which includes Mead Township, Sheffield Township, Cherry Grove Borough and Watson Township have high susceptibility with low incidence of occurrence.

Specific areas including Route 62 south from Route 6 to Tidioute, Route 59 toward Kinzua Dam, and Hemlock Road east of Warren city limits are the three major locations where falling rock and/or mudslides might occur.

4.3.8.2 Range and Magnitude

Landslides can cause damage to utilities as well as transportation routes, resulting in road closure or travel delays. Fortunately, deaths and injuries due to landslides are rare in Pennsylvania and Warren County. Most reported deaths due to landslides have occurred when rockfalls or other slides along highways have involved vehicles. Storm-induced debris flows can also sometimes cause death and injury. As residential and recreational development increases on and near steep mountain slopes, the hazard from these rapid events will also increase. Most Pennsylvania landslides are moderate to slow moving and damage property rather than people.

Pennsylvania DCNR has identified three types of moves, these are falls, slides, and flows. *Table 31 – Types of Landslides in Pennsylvania* outlines these.

Table 31 – Types of Landslides in Pennsylvania

Types of Landslides in Pennsylvania				
Type of movement		**Type of material**		
		Bedrock	Engineering soil	
			Coarse-grained	Fine-grained
Fall		Rockfall		
Slide	Translational	Rockslide	Debris slide	
	Rotational	Rock slump	Slump	
Flow	Rapid	Rock creek	Debris avalanche	Mudflow
			Debris flow	Earthflow
	Slow		Talus creep	Soil creep

The Pennsylvania Department of Transportation and large municipalities incur substantial costs due to landslide damage and extra construction costs for new roads in known landslide-prone areas. A 1991 estimate showed an average of $10 million per year is spent on landslide repair contracts across the Commonwealth and a similar amount was spent on mitigation costs for grading projects (DCNR, 2009).

No serious injury, death or property damage has occurred in Warren County because of a landslide incident. Typically, landslides in the county cause minor property damage and may result in temporary road closures.

4.3.8.3 Past Occurrence

Minor landslides in the form of falling rock and/or mudslides have occurred in Warren County. Most landslides occur along road and highway cuts through the mountains. In 2002 a landslide caused the closure of portions of Route 6 and Route 62 in the City of Warren after heavy rains. Between 2008 and March 2020 there were only four landslide events in Warren County as identified on the county's 911 reporting tool, Corvena (formerly known as Knowledge Center™). These are outlined in *Table 32 – Landslide events in Warren County*.

Table 32 – Landslide Events in Warren County

Landslide Events in Warren County		
Date	**Location**	**Details**
04/09/2008	Mead Township	A large rockslide one mile north of Kinzua dam on State Route 59
05/06/2013	Mead Township	Rockslide in are of the Kinzua Dam, shutting down State Route 59 to less than one lane.
04/10/2015	Pittsfield Township	Road closure on Page Hollow Road, just south of Freehold Township. Caused by a drainage problem.
04/15/2019	Mead Township	Rockslide with road closure along Powerhouse Drive and Longhouse Scenic Drive
Source: Corvena (Formerly Knowledge Center™)		

4.3.8.4 Future Occurrence

Based on historical events, landslide events resulting in loss of life and property damage are unlikely in Warren. However, mismanaged intense development in steeply sloped areas could increase the frequency of occurrence.

4.3.8.5 Vulnerability Assessment

Except for the areas such as those mentioned in Section 4.3.8.1, communities in Warren County are not particularly vulnerable to landslides. However, transportation routes throughout the county located at the base or crest of cliffs should be considered vulnerable to this hazard. An inventory of these areas is not available. Based on parcel data there are 456 addressable structures located in the High Susceptibility/Low Incidence Landslide area that exists in the southern portion of the county. This makes up approximately two percent of structures in the county. Structure type GIS information is not available for Warren County. The municipalities with structures in the High Susceptibility/Low Incidence landslide area are shown in *Table 33 - Landslide Vulnerable Structures*. Also noted in this table are Tier II facilities that are in the involved areas.

Table 33 – Landslide Vulnerable Structures

Landslide Vulnerable Structures		
Municipality	**Total Structures**	**Tier II facilities**
Cherry Grove Township	1	1
Glade Township	4	0
Mead Township	88	1
Sheffield Township	360	4
Watson Township	3	0

The remainder of the county is in the Moderate Susceptibility/Low Incidence (less than 1.5% of the area is involved).

4.3.9. Lightning Strike

4.3.9.1 Location and Extent

Lightning is a massive electrostatic discharge between electrically charged regions within clouds, or between a cloud and the Earth's surface. The charged regions within the atmosphere temporarily equalize themselves through a lightning flash, commonly referred to as a strike if it hits an object on the ground. There are three primary types: from a cloud to itself (intra-cloud or IC); from one cloud to another cloud (CC); and, finally, between a cloud and the ground (CG). Lightning is always accompanied by the sound

of thunder, although distant lightning may be seen but be too far away for the thunder to be heard. Thunder is *caused* by lightning. The bright light of the lightning flash caused by the expansion of electrons (called the "return stroke") represents a great deal of energy. This energy heats the air in the channel to above 50,000°F in only a few millionths of a second. The air that is now heated to such a high temperature had no time to expand, so it is now at a very high pressure. The high-pressure air then expands outward into the surrounding air compressing it and causing a disturbance that propagates in all directions away from the stroke. The disturbance is a shock wave for the first ten yards, after which it becomes an ordinary sound wave, or thunder.

Warren County is subject to lightning strikes and thunderstorm activity throughout the year. Overall, the most active time for lightning strikes is from early spring to early fall seasons. While the impact of flash events is highly localized, strong storms can result in numerous widespread events over a broad area. In addition, the impacts of an event can be serious or widespread if lightning strikes a particularly significant location such as a power station, a campground or large public venue.

4.3.9.2 Range of Magnitude

Severe thunderstorms have lightning risks and can cause significant damage and be life threatening, though only a small percentage of thunderstorms become severe. Western Pennsylvania sits clearly in a region of the country susceptible to lightning strikes but not in the high danger zones of the southeastern or central parts of the country (see *Figure 32 - National Lightning Detection Network 2018*). The 2019 Commonwealth of Pennsylvania All Hazards Mitigation Plan states that Pennsylvania ranks 9th among the fifty states in the country's number of lightning deaths and western Pennsylvania has a higher flash density than the rest of the Commonwealth – the risk is very real. (see *Figures 32 and 33, 2018 National Lightning Detection Network* and *U.S. Lightning Strike Fatalities*). Warren County experiences twenty-five to thirty-two days per year of thunderstorms with lightning that produces three to six flashes per square mile per year. Lightning can cause severe injury and is fatal in some cases, though most fatal strikes are not direct strikes to persons but the result of ground current and most people survive them (see *Figure 34 - Lightning Strikes in the U.S.*). Deaths and injuries to livestock and other animals from ground current, thousands of forest and brush fires, and millions of dollars in damage to buildings, communications systems, power lines and electrical systems across the country are also the result of lightning.

Figure 32 - National Lightning Detection Network 2018

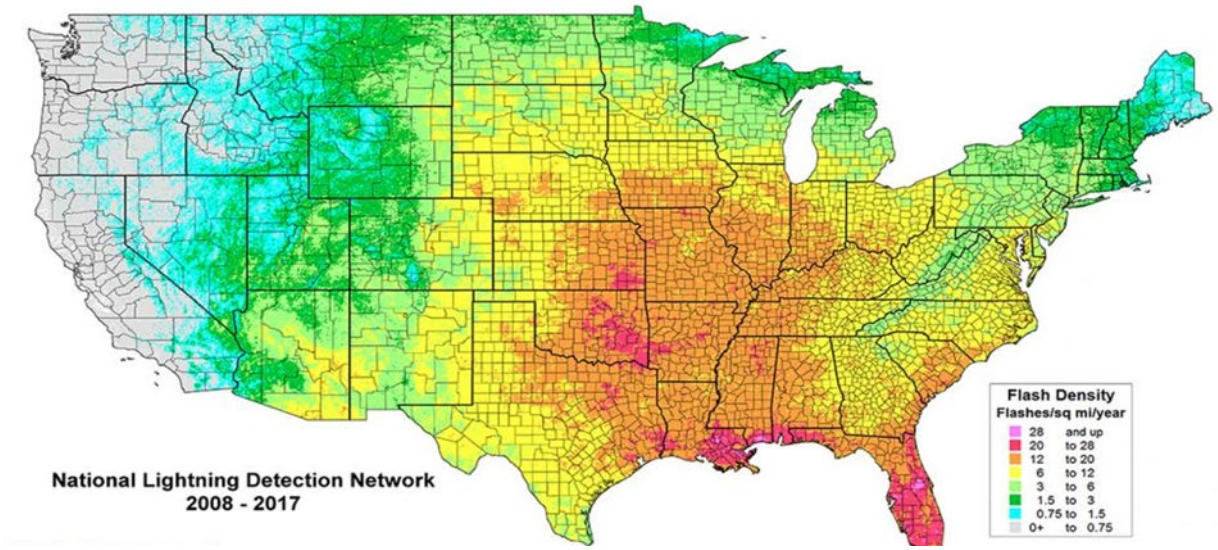


Figure 33 - U.S. Lightning Strike Fatalities

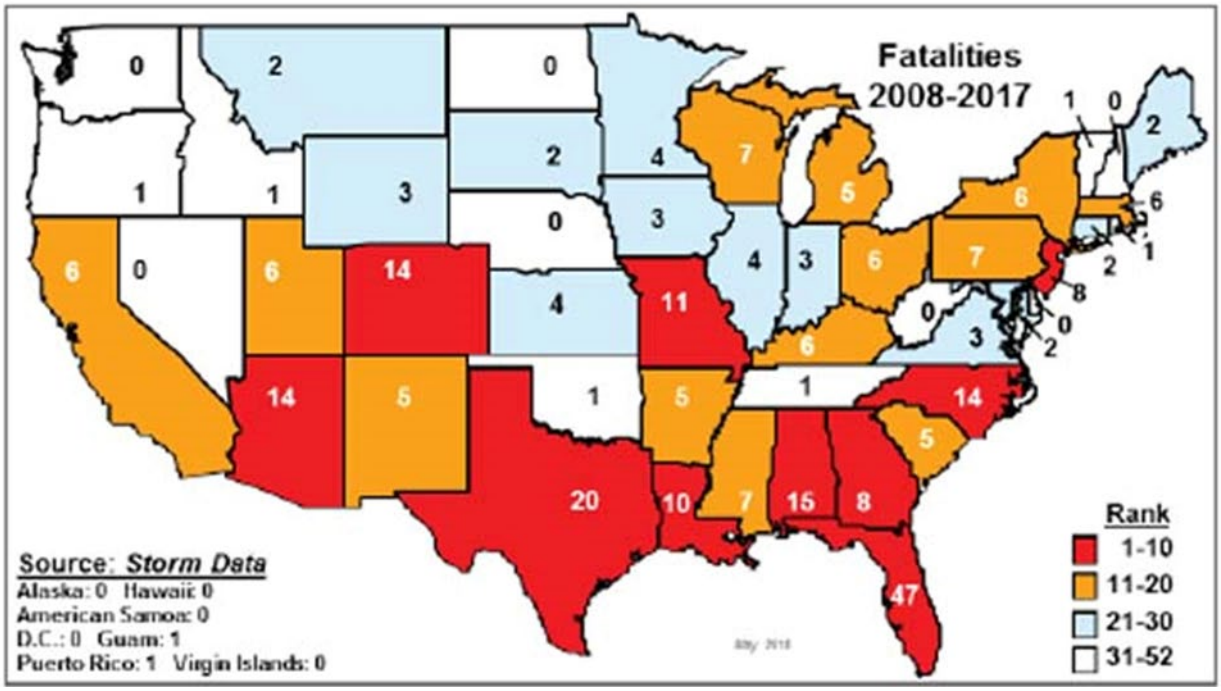
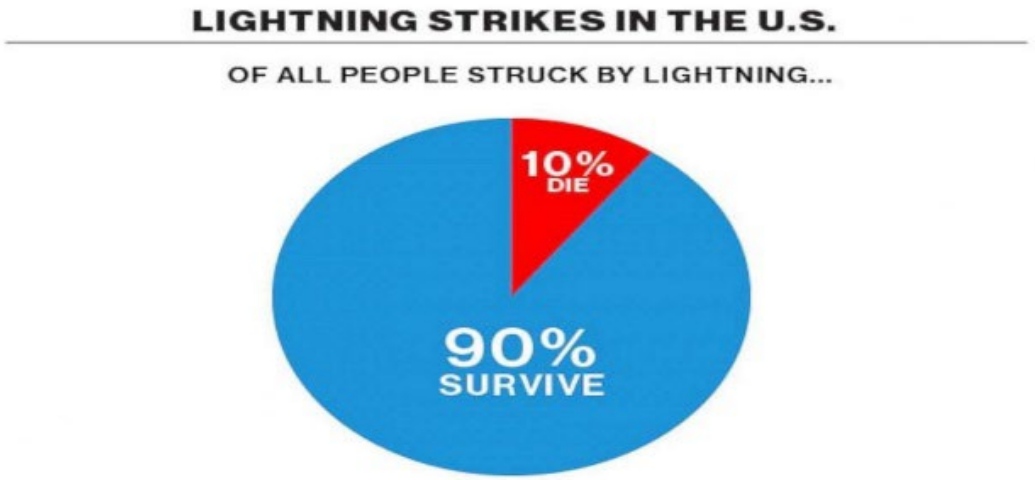


Figure 34 – Lightning Strikes in the U.S.



4.3.9.3 Past Occurrence

Thunderstorms and lightning occur many times each year in Pennsylvania. Lightning was responsible for eleven deaths and 312 injuries in Pennsylvania between the years of 2003-2012. In 2016, one fatality from lightning occurred on a golf course and in 2019, two people were killed under a tree by lightning. In July of 2020, two men were killed by lightning in north central Pennsylvania, also while under a large tree.

During 2018, the National Lightning Detection Network (NLDN) recorded 197,654 cloud-to-ground flashes in the Commonwealth. During that year, Pennsylvania dropped in rank from 26th to 27th in the United States of cloud-to-ground flash densities.

4.3.9.4 Future Occurrence

Lightning strikes and thunderstorms are expected during and around the spring and summer months. These events have occurred in Warren County in the past and will continue to occur in the future, although multiple casualties or deaths are highly unlikely given the hazard's recorded history of casualties in the county. The table above has some data prediction quality for future occurrence, though it cautions its imagery is experimental and in its evaluation stage. The chart will be revisited with the next annual plan update.

4.3.9.5 Vulnerability Assessment

The odds of being struck by lightning in a person's lifetime are 1 in 15,300, according to the National Oceanic and Atmospheric Administration's National Severe Storms Laboratory. Nine out of every ten people in the United States who are struck survive, according to a 2016 study presented at the International Lightning Detection Conference and International Lightning Meteorology Conference. However, lightning strikes can leave a person with many long-term health problems, including muscle soreness, headaches, cognitive problems and nausea.

The potential for lightning strikes and thunderstorms exists in all municipalities in Warren County. Events being held outdoors during the summer months are particularly vulnerable to lightning strikes. Due to the recreational land and waterways use in Warren County, the potential for death or injury will remain present, although the risk may on a downward trend based on the reduced number of cloud-to-ground flashes reported in the Commonwealth in the five-year span since the last assessment.

4.3.10. Pandemic and Infectious Disease

4.3.10.1 Location and Extent

Pandemic & Epidemic

A pandemic is a disease that attacks or affects the population of an extensive area. This is sometimes an entire country or continent. In 2020, a pandemic encompassed the entire planet. An epidemic is an outbreak or disease affecting or tending to affect a disproportionately large number of individuals within a population, community, or region at the same time. It is characterized by very widespread growth or extent that spreads quickly and affects many individuals at the same time. A pandemic is a type of epidemic (one with greater range and coverage), an outbreak of a disease that occurs over a wide geographic area and affects an exceptionally high proportion of the population. While a pandemic may be characterized as a type of epidemic, an epidemic is not a type of pandemic. Pandemics travel more effectively than epidemics.

Each year, different strains of influenza are labeled as potential pandemic threats. Pandemics happen when novel (new) viruses emerge and can infect people easily and spread efficiently and are sustained from person to person. The spread of a disease depends on the mode of transmission of the disease, how contagious it is, and the amount of contact between infected and non-infected persons. In the event of a pandemic occurring in the eastern United States, the entirety of Warren County would likely be affected. Strains of influenza, or the flu, are highly contagious, have caused epidemics and pandemics, and they commonly attack the respiratory tract in humans. Influenza pandemic planning began in response to the H5N1 (avian) flu outbreak in Asia, Africa, Europe, the Pacific, and the Near East in the late 1990s and early 2000s. Avian flu did not reach pandemic proportions in the United States, but the country began planning for flu outbreaks. The Pennsylvania Department of Health (PADOH) Influenza Pandemic Response Plan states that "an influenza pandemic is inevitable and will probably give little warning" (PADOH, 2005).

The 2009 H1N1 flu virus resulted in seventy-eight deaths in Pennsylvania by the time the pandemic ended. Studies after the 2009 H1N1 influenza pandemic showed that the strain disproportionately impacted people younger than twenty-four years old (CIDRAP, 2010). Schools have potential to become outbreak centers due to their large young adult populations, high levels of close social contact, and permeable boundaries. During a pandemic or disease outbreak, the population affected may exceed the seasonal norm of one-third of the student population. Because universities and schools can be sites of transmission, they may cause a virus to spread among the surrounding community as well.

On March 11, 2020 the World Health Organization (WHO) characterized the outbreak of a coronavirus disease as a pandemic. The virus has been named "SARS-CoV-2" and the disease it causes is named "coronavirus disease 2019" (COVID-19). Coronaviruses are common in people and many different species of animals to include camels, cattle, cats, and bats. The disease is believed to have started in Wuhan Province, China in late 2019 and spread around the globe. At the epicenter in China, the virus was linked to a large seafood and live animal market; however, community spread of the virus rapidly ensued.

Infectious Disease

Infectious diseases include influenza, pneumonia, tuberculosis, rabies, Middle East Respiratory Syndrome (MERS), Lyme Disease, Zika, Ebola, and HIV/AIDS.

West Nile virus is contracted through a mosquito bite and is aided by warm temperatures and wet climates conducive to mosquito breeding, with most cases occurring between April and October. West Nile virus is a vector-borne disease. This means an animal, usually an insect or a tick, transmits parasitic microorganisms to people and animals, and therefore, the diseases they cause. The disease causes headaches, high fever, neck stiffness, disorientation, tremors, convulsions, muscle weakness, paralysis, and death in its most serious form.

Lyme Disease, spread by the bite of infected blacklegged ticks, is a bacterial disease with symptoms including fever, headaches and characteristic skin rash (erythema migrans). Untreated, Lyme Disease can spread to joints, the heart and the nervous system (CDC, 2016). To prevent the disease, it is recommended to use insect repellent, removing ticks promptly, applying pesticides, and reducing tick habitat.

The Zika virus is another infectious disease that is spread by mosquito bites and it is related to West Nile virus. Zika virus can also be spread through sexual intercourse, blood transfusion, or passed from mother to child in the womb. The virus was first identified in 1947, but largely came to the attention of the United States in 2015 when there was an outbreak of Zika in Brazil. The direct illness caused by Zika can include fever, red eyes, joint pain, headache and a rash, or sometimes have no symptoms at all. Zika is troubling for pregnant mothers as the virus can result in microcephaly or cause other problems for brain development. For adults, the virus can be linked to increased incidence of Guillain-Barré syndrome.

Although brought under control in 2004, Severe Acute Respiratory Syndrome (SARS) has shown the potential of becoming a pandemic. Neither the WHO nor the Centers for Disease Control and Prevention (CDC) has classified SARS.

4.3.10.2 Range of Magnitude

Pandemic & Epidemic

Public health emergencies typically occur on a regional basis. Sources include infected animals, contaminated food, and improperly prepared food. As evidenced during the 2019/2020 COVID-19 pandemic, the whole county, Commonwealth, country and world are vulnerable to a public health emergency. The likely source of a severe infection may be a farm, animal market or restaurant; see Location and Extent.

Advancements in medical technologies have greatly reduced the number of deaths caused by influenza over time. In the early 1900s, flu pandemics could cause tens of millions of deaths, while the 2009 swine flu caused fewer than 20,000 deaths world-wide, and many people infected with swine flu in 2009 recovered without needing medical treatment. However, the modern flu viruses are still quite dangerous. About seventy percent of those who were hospitalized with the 2009 H1N1 flu virus in the United States belonged to a high-risk group (CDC, 2009). High risk populations for influenza include children, the elderly, pregnant women, and patients with reduced immune system capability.

While there are limited secondary hazards related to public health emergencies, an outbreak could cause a variety of general secondary effects. Civil disorder is the most likely hazard to result from a public health emergency. Further potential secondary effects could include a shortage of medical supplies and personnel; hoarding of household paper and cleaning supplies; school, business, and government closings; government restrictions on travel; low attendance at places of employment, as well as slowed productivity.

The WHO has six phases of pandemic alert for incorporation of new recommendations and approaches for preparedness and response plans. These phases are listed below in *Table 34 – Pandemic Influenza Phases.*

Table 34 - Pandemic Influenza Phases

Phase	Characteristics
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.
Phase 4	Characterized by verified human-to-human transmission of an animal or human-animal influenza reassortant virus able to cause "community-level outbreaks".
Phase 5	Characterized by human-to-human spread of the virus into at least two countries in one WHO region.
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 http://www.who.int/en/	

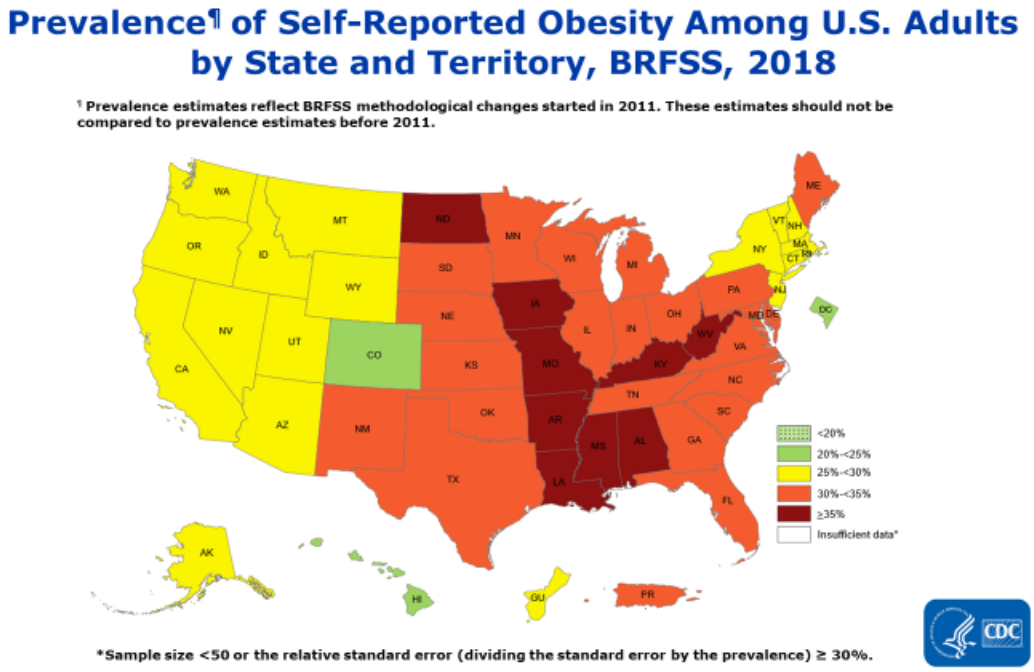
At the writing of this plan, the United States was in an Opioid epidemic. The opioid epidemic specifically refers to the growing number of deaths and hospitalizations from opioids, including prescriptions, illicit drugs, and analogues. In recent years, death rates from these drugs have ramped up to over 40,000 a year, or 115 a day, across the country. In 2020 drug overdose was the leading cause of accidental death in the United States, largely due to the opioid epidemic. The opioid epidemic first gained notoriety around 2010, but the factors behind it had begun several years earlier.

Obesity is a serious health problem in the United States: nearly thirty-five percent of Americans have obesity. Obesity is not just a problem of "girth control"; it is now considered a chronic disease by the American Medical Association, the American Association of Clinical Endocrinologists, the American College of Endocrinology, the Endocrine Society, the Obesity Society, the American Society of Bariatric Physicians, and the National Institutes of Health (NIH).

It is, in fact, a national epidemic according to the Centers for Disease Control and Prevention (CDC). And it is not just a weight problem: it can have serious effects on a person's physical, metabolic and psychological health. And it affects some populations more than others.

The global nature of the obesity epidemic was formally recognized by a World Health Organization consultation in 1997.

Figure 35 - Prevalence of Self-Reported Obesity



Infectious Disease

Smallpox

This was an infectious disease unique to humans, caused by either of two virus variants, Variola major and Variola minor. The last naturally occurring case of smallpox (Variola minor) was diagnosed in October 1977 in Somalia. The last reported case in the United States was in 1949. Variola major is the more severe and has an overall mortality rate of 30% - 35%. Variola minor only has a mortality rate of one percent. Long-term complications of Variola major include characteristic scars. Less common complications are blindness, and limb deformities due to arthritis and osteomyelitis.

West Nile Virus

This is found in temperate and tropical regions of the world and is a mosquito-borne zoonotic arbovirus. It was first identified in the West Nile sub-region in the East African nation of Uganda in 1937. It was considered a minor risk to humans until an outbreak in Algeria in 1994. At that time there were cases of West Nile virus that caused encephalitis. The virus has spread globally. In 2019, West Nile virus infected 326 people and killed fifteen people in the United States, a significant decrease from previous years. Pennsylvania infections were seven with zero deaths (CDC, 2019.) Most West Nile infections in humans are subclinical, causing no symptoms. Approximately twenty percent of infections cause symptoms and less than one percent of cases result in severe neurological disease or death. Symptoms typically appear between two and fifteen days after infection and there is currently no vaccine for West Nile virus. Person to person transmission of West Nile is less prevalent than person to person transmission of influenza.

Lyme Disease

Since 2011, Pennsylvania has led the country in the number of Lyme disease cases, according to the CDC. Each year since 2005, the number of confirmed cases of Lyme disease in Pennsylvania has grown, with 10,208 confirmed cases in 2018. This number was well below the number of cases reported in 2016 and 2017, perhaps as a result of a reduced number of acorns available to feed field mice, one of the lead carriers of the disease; and/or perhaps as a result of public awareness due to the actions of a Pennsylvania Task Force formed to focus on prevention, education, awareness, and surveillance of the tick-borne illness. In 2015, the state Department of Conservation and Natural Resources placed signs in the 120 state parks and twenty state forest districts warning visitors and staff about the presence of ticks. (PA DOH June 2019). While most cases of Lyme disease can be treated over a few weeks with antibiotics, undetected Lyme disease can seriously damage a body's musculoskeletal and nervous systems, sometimes resulting in death.

Zika Virus

Zika virus has spread to Pennsylvania primarily by persons from Pennsylvania traveling to locations where the virus is a transmission risk. These places include certain countries in South America, Central America, the Caribbean, the Pacific Islands, Africa and Southeast Asia. No locations within the United States are considered to have significant risk of Zika virus transmission (PA DOH, 2019). If a Pennsylvania resident does contract Zika virus, preventing the spread of the disease is important. If an infected individual is bitten by a mosquito within three weeks of infection, the mosquito can transmit the virus to anyone else it bites. Infected individuals should strictly avoid any possibility of mosquito bites to prevent the spread of Zika virus. Additionally, Zika can be transmitted through sexual intercourse, so infected individuals should use condoms or abstain from sex while they have the virus.

4.3.10.3 Past Occurrence

Pandemic & Epidemic

Influenza

H1N1

Warren County was impacted with the H1N1 virus during 2009. The Pennsylvania Department of Health set up clinics throughout the county to administer vaccines.

Spanish Flu

Prior to the COVID-19 world-wide pandemic, the 1918 influenza (Spanish Flu) pandemic was classified as the "Mother of all Pandemics". An estimated one third of the world's population was infected and had clinically apparent illnesses during the 1918 - 1919 influenza pandemic. Pennsylvania was one of the hardest hit states in the country because influenza tended to strike cities very hard. The impact of the 1918 - 1919 influenza is not limited to that time frame. All Influenza-A pandemics since that time have been caused by 1918 virus descendants (including "drifted" H1N1 viruses and reasserted H2N2 and H3N2 viruses). Only Influenza Type A viruses are known to have caused pandemics.

Table 35 - Notable Influenza A Events in the United States lists past Influenza A events.

Year(s)	Common Name
1889	Russian Flu
1918 - 1919	Spanish Flu
1957	Asian influenza
1968	Hong Kong influenza
1976	Swine Flu
2009	Novel H1N1 "swine flu"
2020/2021	COVID-19
Sources: WHO and CDC	

Legionella

The CDC estimates about 25,000 annual cases of pneumonia due to Legionella bacteria (Legionella pneumophila) in the United States. Only 5,000 cases are reported, however, because of the disease's nonspecific signs and symptoms. About ten percent of people infected with Legionella bacteria will die from the infection. Legionella is also known as Legionnaires' disease.

Legionnaires' disease outbreaks and clusters have been linked to a number of sources, including: water systems, such as those used in hospitals, nursing homes, and hotels; large plumbing systems; hot-water tanks and heaters; cooling towers of air conditioning systems; showers and faucets; mist machines and hand-held sprayers; swimming pools; hot tubs and whirlpools; equipment used in physical therapy; decorative fountains.

In August of 2013, Legionella bacteria were found in the Liberty Mutual Insurance Co. building in Warren County, PA during routine HVAC system maintenance and testing. The company acted promptly and contacted the state and county boards of health to ensure appropriate protocol. The building has been closed and the employees were notified of the situation (www.WPXI.com).

In June of 2020, the Pennsylvania Health Alert Network warned of an anticipated increase in Legionellosis cases due to the summer season and building re-openings as the Commonwealth relaxed its risk mitigation strategies for COVID-19. See below.

COVID-19

This is an on-going pandemic at the time of the writing of this plan, so websites are used to provide the most up-to-date statistics. The first cases in Pennsylvania were reported on March 6, 2020 in Delaware and Wayne counties. The first confirmed case of COVID-19 in Warren County was on March 25, 2020.

The June 12, 2020 CDC *COVIDView*, a weekly surveillance summary of U.S. COVID-19 activity, reports that:

- The overall cumulative COVID-19 associated hospitalization rate is 89.3 per 100,000, with the highest rates in people 65 years of age and older (273.8 per 100,000) followed by 50-64 years (136.1 per 100,000). Hospitalization rates are cumulative and will increase as the COVID-19 pandemic continues.
- Non-Hispanic American Indian or Alaska Native persons have a rate approximately five times that of non-Hispanic White persons; non-Hispanic Black persons have a rate approximately 4.5 times that of non-Hispanic White persons, and Hispanic or Latino persons have a rate approximately four times that of non-Hispanic White persons.

- Cumulative hospitalization rates for COVID-19 in adults (18-64 years) at this time are higher than cumulative end-of-season hospitalization rates for influenza over each of the past five influenza seasons.
- For people 65 years and older, current cumulative COVID-19 hospitalization rates are within ranges of cumulative influenza hospitalization rates observed at comparable time points during recent influenza seasons.
- For children (0-17 years), cumulative COVID-19 hospitalization rates are much lower than cumulative influenza hospitalization rates at comparable time points during recent influenza seasons.

Infectious Disease

2019/2020 Influenza Season

As of week thirteen, ending March 28, 2020, the PA DOH stopped updating its 2019-2020 influenza data page when influenza activity was known to have decreased significantly and was below epidemic limits. At that juncture, Warren County had reported a combined total of 619 cases of influenza A and B. The PA DOH also reports that during the same time frame a total of 102 Pennsylvanians have died from influenza. Of this number, those aged 65 and older had the highest mortality rate.

West Nile Virus

West Nile virus reached the United States in 1999 and a year later was detected in Pennsylvania when mosquito pools, dead birds, and/or horses in nineteen counties tested positive for the virus. A comprehensive network has been developed in Pennsylvania that includes trapping mosquitoes, collecting dead birds and monitoring horses, people and, in past years, sentinel chickens. *Table 36 – West Nile Virus Control Program in Warren County Since 2015.* outlines the West Nile Virus within Warren County since 2015.

Table 36 - West Nile Virus Control Program in Warren County Since 2015

West Nile Virus Control Program in Warren County Since 2015				
Year	**Total Positives**	**Human Positives**	**Mosquito Positives**	**Bird Positives**
2020	0	0	0	0
2019	8	0	8	0
2018	101	0	100	1
2017	34	0	34	0
2016	2	0	2	0
2015	11	0	11	0

Source: http://www.depgis.state.pa.us/WNV/index.html

Lyme Disease

The PA DOH lists the following information regarding cases in Warren County, *Table 37 – 2018 Lyme Disease Data for Warren County*. The case count shows an alarming and consistent rise in cases over the past several years, although it should be noted that information represented for each county "may vary with respect to the resources they have to devote to investigation of Lyme cases". It should also be noted that these figures represent a rough estimate of the Lyme disease burden in Warren County.

Table 37 - 2018 Lyme Disease Data for Warren County

2018 Lyme Disease Data for Warren County			
Year	**Number of cases**	**Year**	**Number of cases**
1980	0	2000	0
1981	0	2001	<4
1982	0	2002	<4
1983	0	2003	0
1984	0	2004	<4
1985	0	2005	<4
1986	0	2006	0
1987	0	2007	<4
1988	<4	2008	5
1989	<4	2009	8
1990	<4	2010	7
1991	<4	2011	<4
1992	0	2012	6
1993	0	2013	13
1994	<4	2014	18
1995	<4	2015	31
1996	<4	2016	56
1997	<4	2017	82
1998	<4	2018	112
1999	0	2019	Not available
Source: https://www.health.pa.gov/topics/disease/Pages/Lyme-Disease.aspx			

4.3.10.4 Future Occurrence

Pandemic & Epidemic

The probability of a widespread pandemic public health emergency is every ten years or less with varying degrees of severity. Minor outbreaks of less serious communicable disease, such as influenza, occur much more frequently. Warren County is vulnerable to these diseases and infections since people commute to the larger urban areas outside the county for employment and from the larger urban areas to the county for recreation and sport related activities.

There is useful prediction data in a report released by Carnegie Mellon University during the COVID-19 pandemic in May 2020. The report, inclusive of employment travel patterns that may aid in prevention protocols or early stay-at-home/work-from-home orders, may be found here:

https://www.governor.pa.gov/wp-content/uploads/2020/05/20200529-CMU-Risk-Based-Decision-Support-Tool-05-28-2020.pdf

Infectious Disease

West Nile Virus
The best defense against West Nile virus is to remove mosquito breeding locations – stagnant water sources. Another defense is to prevent insect bites by wearing shoes, socks, long pants and a long-sleeved shirt when outdoors for long periods of time, or when mosquitoes are most active. Also, mosquito repellent can be considered whenever people are outside.

Influenza
It is estimated that 5% - 20% (600,000 to 2,400,000) of Pennsylvanians get the flu each year, and 120 to 2,000 die from complications of influenza (PA DOH 2020). The CDC recommends that everyone six

months and older get a flu vaccine every season. People who are at a high risk of serious flu illness should take flu antiviral drugs as soon as they get sick.

Lyme Disease
Lyme disease is best combated using insect repellent, removing ticks promptly, applying pesticides, and reducing tick habitat. Once a person realizes they have been bitten by a tick, they should seek medical attention, as undetected Lyme Disease can seriously damage a body's musculoskeletal and nervous systems or result in death.

4.3.10.5 Vulnerability Assessment

It is extremely difficult to predict a pandemic or an epidemic. The National Institute on Drug Abuse estimates the epidemic of opioid use and overdose is estimated to cost the country annually $78.5 billion in healthcare costs, addiction treatment, lost productivity and criminal justice involvement. The Harvard School of Public Health estimates the obesity epidemic costs the country annually $190 billion in obesity-related healthcare costs alone.

The severity of the next pandemic cannot be predicted, but modeling studies suggest the impact of a pandemic on the United States could be substantial. In the absence of any control measures (vaccination or drugs), it is estimated that a "medium-level" pandemic could cause 89,000-207,000 deaths, 314,000-734,000 hospitalizations, eighteen to forty-two million outpatient visits, and another twenty to forty-seven million sick people in the United States. Between 155 - 35% of the U.S. population could be affected by an influenza pandemic, and the economic impact could range between $71.3 - $166.5 billion. These data for the 2020 pandemic have fluctuated widely but, at the time of the writing of this plan, were on pace for "medium level" or greater pandemic. The COVID 19 virus, however, has severely affected populations over the age of 65 – especially those in nursing homes – disproportionately; it has also severely affected different races disproportionately, e.g. non-Hispanic American Indian and Black people. The CDC reports that long-standing systemic health and social inequities have put some members of racial and ethnic minority groups at increased risk of getting COVID-19 or experiencing severe illness, regardless of age.

As of November 18, 2020, according to the Johns Hopkins Coronavirus Resource Center, there were 55,793,403 confirmed cases of COVID-19 resulting in nearly 1,341,455 deaths world-wide. The most up-to-date United States information, including data by county, may be found here:

https://coronavirus.jhu.edu/us-map

Influenza pandemics are different from many of the threats for which public health and health-care systems were currently planning. A pandemic will last much longer than most public health emergencies and may include "waves" of influenza activity separated by months (in 20th Century pandemics, a second wave of influenza activity occurred three to twelve months after the first wave). The numbers of healthcare workers and first responders available to work will likely reduce as they will be at high risk of illness from exposure in the community and healthcare settings. Some may have to miss work to care for ill family members. Resources in many locations could be limited depending on the severity and spread of an influenza pandemic. These limited resources could also be affected by unrelated shortages.

Because of these differences and the expected size of an influenza pandemic, it is important to plan preparedness activities that will permit a prompt and effective public health response. The U.S. Department of Health and Human Services (DHHS) supports pandemic influenza activities in the areas of surveillance (detection), vaccine development and production, strategic stockpiling of antiviral medications, research, and risk communications. In May 2005, the U.S. Secretary of DHHS created a multi-agency National Influenza Pandemic Preparedness and Response Task Group. This unified initiative involves CDC and many

other agencies (international, national, state, local, and private) in planning for a potential pandemic. Its responsibility includes revision of a U.S. National Pandemic Influenza Response and Preparedness Plan.

Elderly individuals, children and immune deficient individuals are most vulnerable to influenza. Nursing facilities, personal care facilities, daycares, schools and hospitals are considered more vulnerable since there are normally groups of these functional-needs population present at the facilities. Spread of disease is at an increased risk due to the vulnerability and density of these populations. Correctional institutions would also be at an increased risk due to the lack of social distancing required to help stop the spread of a pandemic. During the early and middle stages of the COVID-19 pandemic, nursing homes and personal care homes in Pennsylvania suffered staggering numbers of cases and deaths and several county jails and state correctional institutions reported wide community spread.

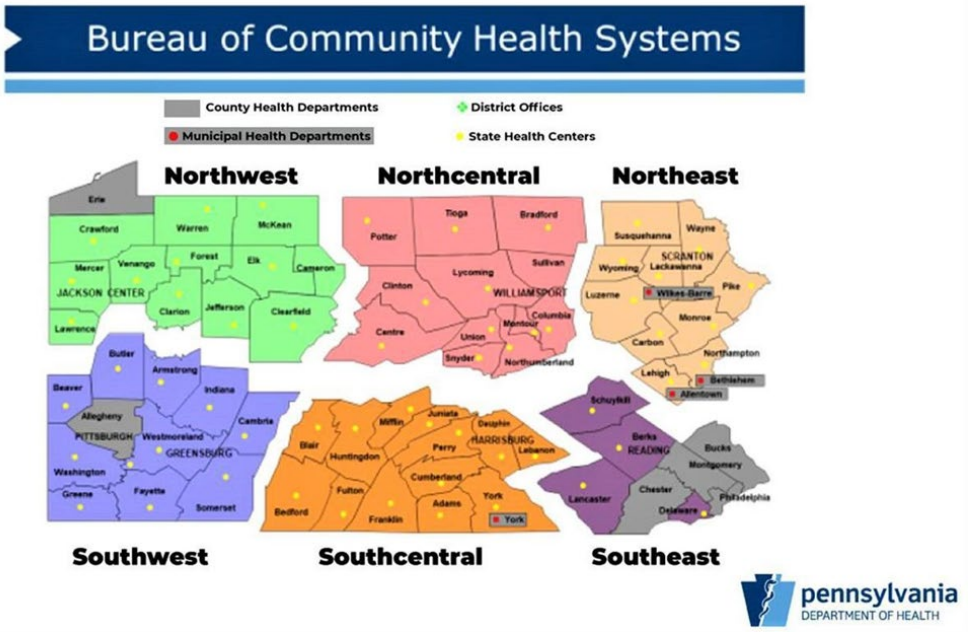
Table 38 - Warren County Congregated Populations

Warren County Congregated Populations	
Location	**Number of Beds**
Warren General Hospital	85
Warren State Hospital	152
Kinzua Healthcare and Rehabilitation Center	106
Rouse-Warren County Home	176
Warren Manor	121
Cambridge Warren	75
Ruth M Smith Centers	40
Suites at Rouse	120
Watson Memorial Home	25
Warren County Jail	139
Warren General Hospital	85
Total	**1,039**

It is important to plan preparedness activities that will permit a prompt and effective public health response. During a public health emergency, the PA DOH may open emergency medicine centers called Points of Dispensing (PODs) to ensure that medicine, supplies, vaccines, and information reach Pennsylvania residents during a public health emergency. An open POD is where the general public goes to receive free emergency medicine and supplies from public health officials, while a closed POD provides free emergency medicine and supplies to a specific community, like a university, including faculty, staff and students. Dispensing of medications/vaccines is a core function of the Strategic National Stockpile's Mass Dispensing of Medical Countermeasures Plan.

PODs are coordinated with county emergency managers by the PA DOH with through the six regional healthcare districts (see *Figure 36 – Pennsylvania Health Districts*). Warren County is in the northwest district. At the time of the writing of this plan, POD planning for mass vaccinations against COVID-19 was occurring; no vaccine had yet been announced.

Figure 36 - Pennsylvania Department of Health Districts



Health-care workers and those working in direct-care situations (such as correctional institutions or those who cannot social distance due to their jobs) are more likely to be exposed to a pandemic disease. Those that work outdoors for extended periods of time in warm months may be more vulnerable to West Nile, Lyme disease or the Zika virus.

4.3.11. Tornadoes and Windstorms

4.3.11.1 Location and Extent

Tornadoes occur in the Commonwealth most frequently during the spring and summer months and are most likely at the warmest times of the day. In the past sixty-nine years, records show that 960 tornadoes have been reported across the sixty-seven counties in Pennsylvania during the period of 1950 – December 2019 (NOAA NCEI, 2019). The National Weather Service estimates that the Commonwealth will experience ten tornadoes annually. According to the National Centers for Environmental Information (NCEI), wind speeds in tornadoes range from values below that of hurricane speeds to more than 300 miles per hour. The NCEI continues by reporting that, "the maximum winds in tornadoes are often confined to extremely small areas and vary tremendously over short distances," which explains why one house may be completely demolished by a tornado and a neighboring house could be untouched. The width of tornadoes can vary greatly, from one hundred feet wide to over a mile, and the forward motion of tornadoes can range from speeds between zero and fifty miles per hour.

Windstorms may be caused by thunderstorms, hurricanes and tornadoes, but the most frequent cause of windstorms in western Pennsylvania is thunderstorms. Straight-line winds and windstorms are experienced on a more regional scale. While such winds usually also accompany tornadoes, straight-line winds are caused by the movement of air from areas of high pressure to low pressure. Windstorms are generally defined with sustained wind speeds of forty miles per hour or greater, lasting for at least one hour, or winds of fifty-eight miles per hour or greater lasting for any du-ration. A microburst is a very-localized column of sinking air, capable of producing damaging opposing and straight-line winds at the surface. A wind shear is usually found when a violent weather front is moving through; wind speeds have been recorded up to

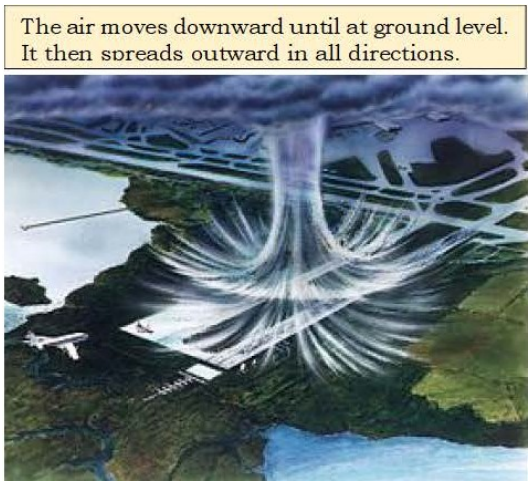
one-hundred miles per hour. Wind shear is defined as a difference in wind speed and direction over a relatively short distance in the atmosphere.

4.3.11.2 Range of Magnitude

Each year, tornadoes account for $1.1 billion in damages and cause over eighty deaths nationally. 2011 was the second worst year on record for deadly tornadoes, the worst being 1936. The number of tornado reports has increased by fourteen percent since 1950. While the extent of tornado damage is usually localized, the vortex of extreme wind associated with a tornado can result in some of the most destructive forces on earth.

Rotational wind speeds can range from one hundred mph to more than 250 mph. In addition, a tornado's speed of forward motion can range from zero to fifty miles per hour. Therefore, some estimates place the maximum velocity (combination of ground speed, wind speed, and upper winds) of tornadoes at about 300 mph. The damage caused by a tornado is a result of the high wind velocity and wind-blown debris, also accompanied by lightning or large hail. The most violent tornadoes have rotating winds of 250 mph or more and are capable of causing extreme destruction and turning normally harmless objects into deadly projectiles.

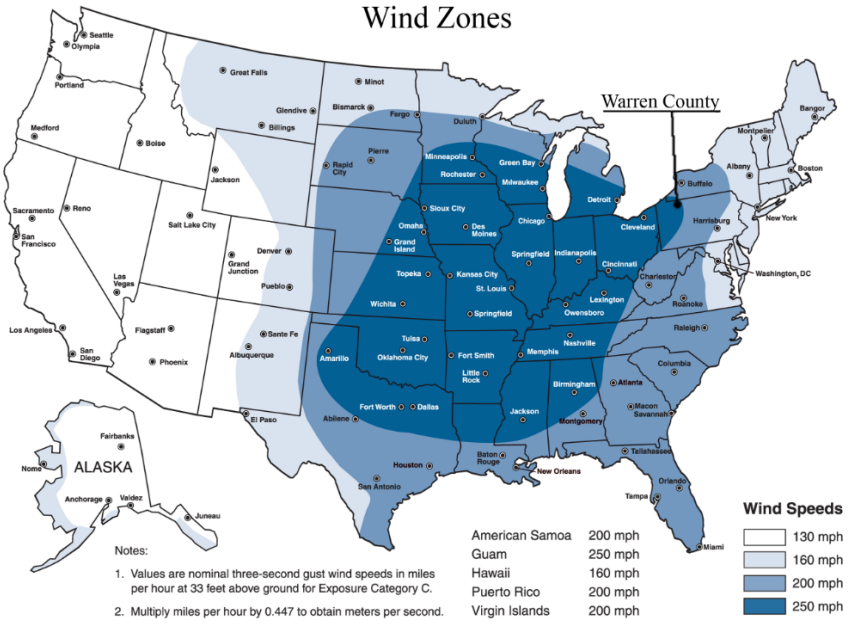
Figure 37 - Microburst



Damages and deaths can be especially significant when tornadoes move through populated, developed areas. The destruction caused by tornadoes ranges from light to inconceivable depending on the intensity, size and duration of the storm. Typically, tornadoes cause the greatest damages to structures of light construction. The Enhanced Fujita Scale, also known as the "EF-Scale," measures tornado strength and associated damages. The EF-Scale is an update to the earlier Fujita Scale, also known as the "F-Scale," that was published in 1971. It classifies United States tornadoes into six intensity categories based upon the estimated maximum winds occurring within the wind vortex (*Table 39 – Enhanced Fujita Scale*). Since its implementation by the National Weather Service in 2007, the EF-Scale has become the definitive metric for estimating wind speeds within tornadoes based upon damage to buildings and structures. Previously recorded tornadoes are reported with the older F-Scale values, but *Table 39 – Enhanced Fujita Scale* shows F-Scale categories with corresponding EF-Scale wind speeds.

Figure 26 - Wind Zones in the United States in Section 4.3.6.1 depicts the wind speed zones developed by the American Society of Civil Engineers based on tornado and hurricane historical events. These wind speed zones are intended to guide the design and evaluation of the structural integrity of shelters and critical facilities.

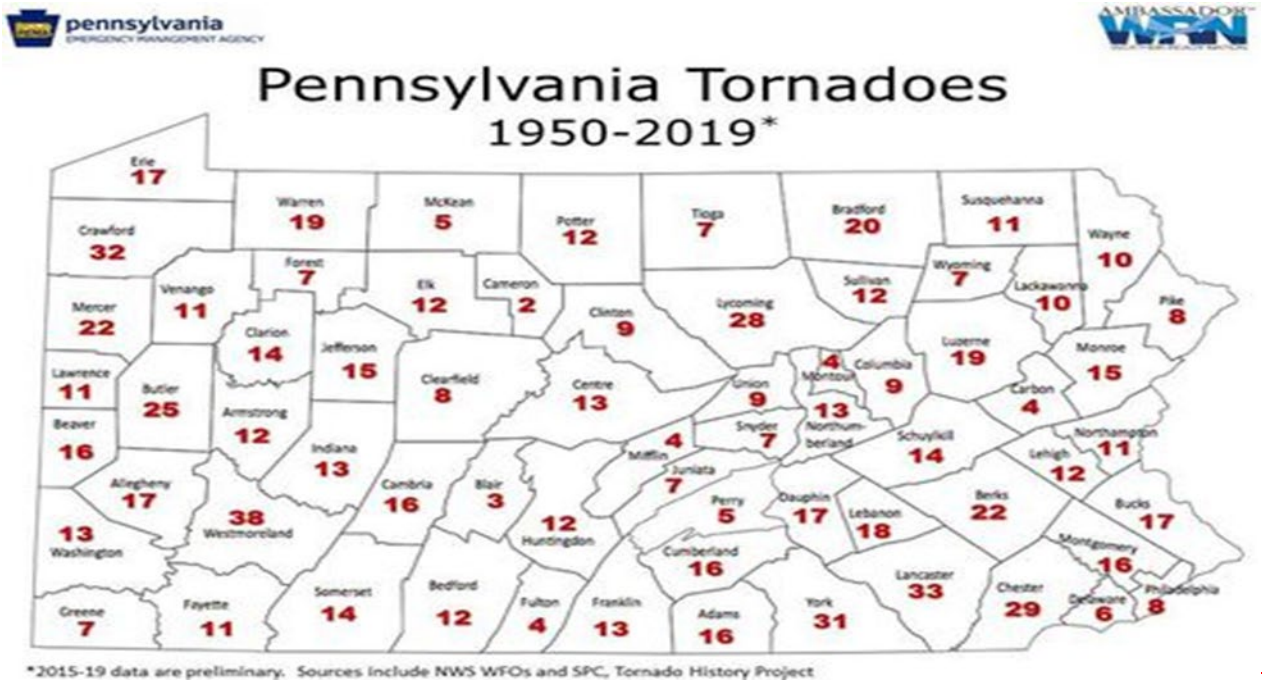
Figure 38 – Wind Zones



SOURCE: Revised From FEMA 361, 2015 Edition

Warren County falls within Zone IV, meaning shelters and critical facilities should be designed to withstand a three-second gust of up to 250 mph, regardless of whether the gust is the result of a tornado, coastal storm, or windstorm event. Therefore, these structures should be able to withstand the wind speeds experienced in an EF4 tornado event. While it is difficult to pinpoint the exact locations at the greatest risk of a tornado, the southeast, southwest and northwest sectors of the Commonwealth are most prone to tornadoes.

Figure 39 - Pennsylvania Tornadoes 1950-2019



Tornadoes can have varying secondary effects. The most common is power failure. The severe wind can dismantle power sources and cause significant structural damage. Hazardous material spills can occur if a tornado comes near a holding tank, or the spill stems from a traffic accident caused by high winds.

Windstorms of all types have caused the following problems within Warren County:

- Power failures lasting four hours or longer;
- Loss of communications networks lasting four hours or more;
- Residents requiring evacuation or provision of supplies or temporary shelter;
- Severe crop loss and or damage;
- Trees down or snapped off high above the ground/tree debris-fire fuel; and
- Toppled high profile vehicles, including those containing hazardous materials.

Table 39 - Enhanced Fujita Scale

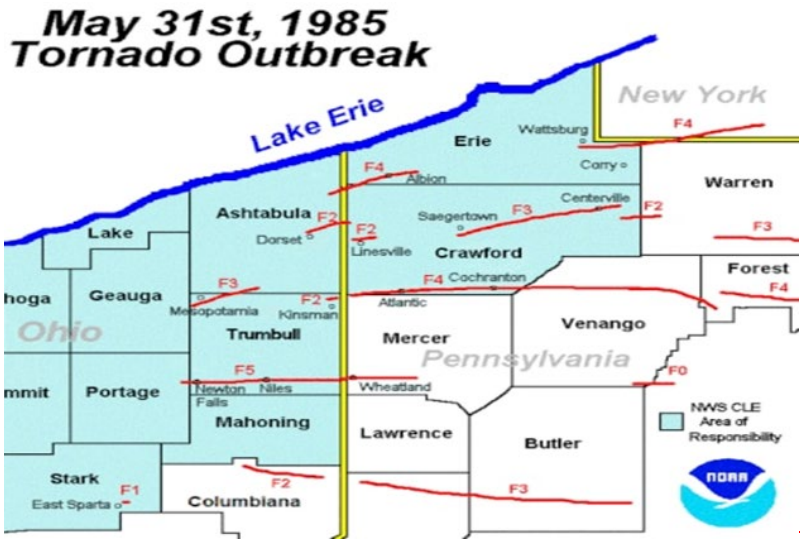
Enhanced Fujita Scale			
EF-Scale Number	**Wind Speed (MPH)**	**F-Scale Number**	**Description of Potential Damage**
EF0	65–85	F0-F1	**Minor damage**: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86-110	F1	**Moderate damage**: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.

Enhanced Fujita Scale			
EF-Scale Number	**Wind Speed (MPH)**	**F-Scale Number**	**Description of Potential Damage**
EF2	111–135	F1-F2	**Considerable damage**: Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.
EF3	136–165	F2-F3	**Severe damage**: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166–200	F3	**Devastating damage**: Well-constructed houses and whole frame houses completely leveled; cars thrown and small projectiles generated.
EF5	>200	F3-F6	**Extreme damage**: Strong frame houses leveled off foundations and swept away; automobile-sized projectiles fly through the air in excess of 100 m (300 ft.); steel reinforced concrete structure badly damaged; high-rise buildings have significant structural deformation.

4.3.11.3 Past Occurrence

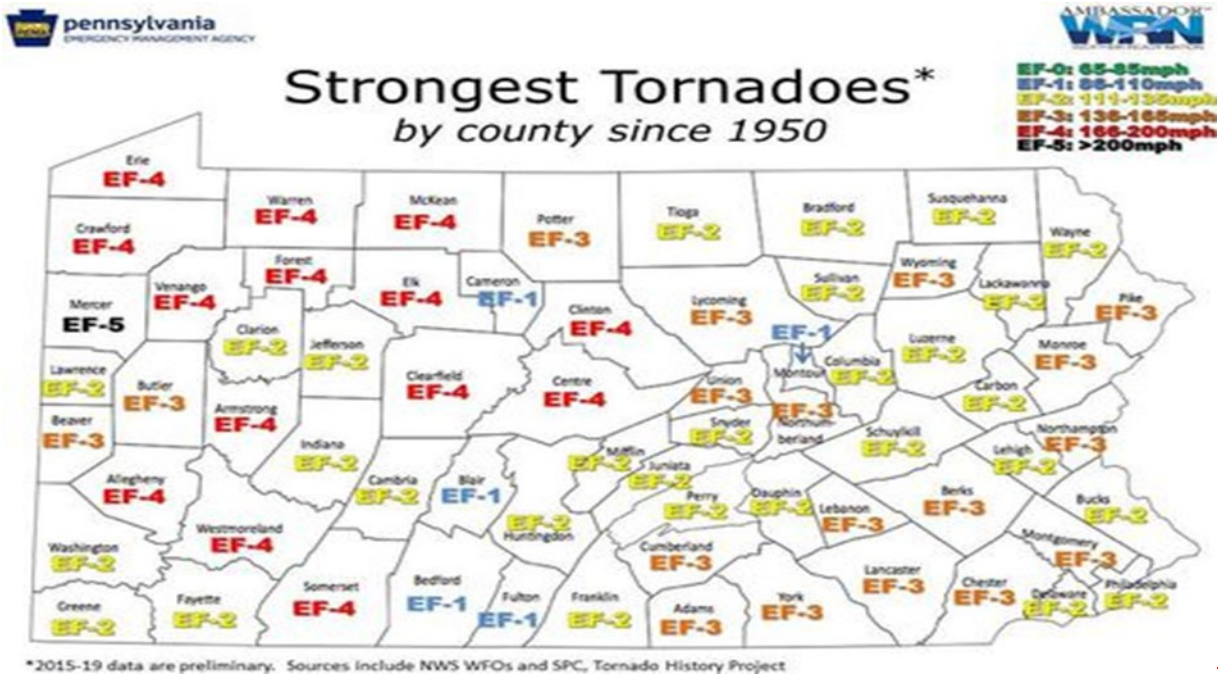
Warren County has experienced sixteen tornadoes since 1970 (see *Table 40 – Warren County Tornado History*). One of the deadliest tornado events in Pennsylvania history occurred on May 31, 1985, with a total of twenty-one tornadoes in the Ohio and Northwest Pennsylvania region (three of which affected Warren County). This tornado event resulted in seventy-six deaths, upwards of 1,000 injuries, and hundreds of millions of dollars in property damage.

Figure 40 - May 31, 1985 Tornado Outbreak



The most recent tornado impacts in Warren County occurred in April 2019 when an EF2 was reported in the community of Irvine, causing an estimated one million dollars in damages.

Figure 41 - Strongest Tornadoes by County Since 1950



Aside from tornadoes, Warren County has had seventeen severe wind reports from 1996 through 2019 causing minor property damage over the years (NOAA NCEI, 2019). Most often these are the result of intense thunderstorms, which often fell trees and damage power lines, causing power outages in some areas.

See *Table 40 – Warren County Tornado History* and *Table 41 – High Wind History* below.

Table 40 – Warren County Tornado History

Warren County Tornado History *(NOAA NCEI, 2019 and Knowledge Center)*			
Location	**Date**	**Magnitude**	**Estimated Property Damage**
Brokenstraw Township	07/15/1970	F1	$25,000.00
Columbus Township	05/31/1985	F4	0
Pittsfield Township	05/31/1985	F1	0
Triumph Township, Limestone Township, Watson, Township, Cherry Grove Township	05/31/1985	F3	UNK
Sheffield Township	05/31/1985	F4	0
Youngsville Borough	06/22/1985	F1	0
Tidioute Borough	07/09/1999	F1	$150,000.00
Pittsfield Township	07/28/2002	F1	$35,000.00
Sheffield Township	06/17/2004	F1	0
Tidioute Borough	09/26/2007	F1	0
Mead Township	07/26/2008	F1	0
North Warren	06/05/2016	EF1	$100,000.00
Scandia	09/17/2016	EF1	$20,000.00
Chandlers Valley	04/20/2017	EF0	$10,000.00

Location	Date	Magnitude	Estimated Property Damage
Wrightstone	10/02/2018	EF1	$5,000.00
Irvine	04/14/2019	EF2	$1,000,000.00
Totals			**$1,320,000.00**

Table 41 - High Wind History

Warren County High Wind History *(NOAA NCEI, 2019 and Knowledge Center)*					
Location	**Date**	**Mag. (knots)**	**Deaths**	**Injuries**	**Property Damage**
Countywide	03/25/96	52	0	0	NP
Countywide	02/22/97	60	0	0	NP
Countywide	09/29/99	60	0	0	$100,000.00
Countywide	02/01/02	63	0	0	$5,000.00
Youngsville Borough	06/05/02	60	0	0	NP
Cherry Grove Borough	07/21/03	60	0	0	$100,000.00
Countywide	11/13/03	71	0	0	$50,000.00
Countywide	12/01/04	60	0	0	NP
Countywide	02/17/06	53	0	0	$20,000.00
City of Warren	06/22/06	55	0	0	NP
Countywide	01/30/08	52	0	0	NP
Tidioute Borough	07/26/08	80	0	0	NP
Countywide	03/28/2016				
Countywide	03/28/2017				
Countywide	04/04/2018	52	0	0	0
Countywide	02/24-25/2019	52	0	0	0
Countywide	04/14/2019				
Totals			0	0	**$275,000.00**

4.3.11.4 Future Occurrence

It is possible for a disastrous tornado to hit Warren County, given the fact that one EF2 tornado recorded in the county caused over one million dollars in 2019. While the chance of being hit by a devastating tornado is somewhat small, the damage that results when the tornado arrives can be catastrophic. An EF5 tornado with a 0.019 percent annual probability of occurring can carry wind velocities of 200 mph, resulting in a force of more than one hundred pounds per square foot of surface area. This is a "wind load" that exceeds the design limits of most buildings.

Additionally, based on historic patterns, tornadoes are unlikely to remain on the ground for long distances, especially in areas of the county with hilly terrain. However, the high historical number of windstorms with winds at or over fifty knots (see *Table 41 – High Wind History*) indicates that the annual chance of a windstorm in the county is higher.

According to FEMA (See the Hurricane Profile, Section 4.3.6 (*Table 28 – Annual Probability of Wind Speeds*), there is high probability (~92%) each year that Warren County will experience winds of 45-77 mph; however, there is under a ten percent chance of winds of 78-118 mph and the risk declines even more dramatically as higher wind speeds are calculated.

The number of days when tornadoes occur in the United States has decreased; how-ever, there has been an increase in tornado activity on those days. The tornado season has also been lengthening, with the season starting earlier than it has historically. Pennsylvania had, for example, a record number of tornadoes in April and May 2019 compared to any other April or May on record. Climate change is causing temperatures and air moisture to increase, and it is thought that these changes could result in an increase in frequency and intensity of tornadoes and severe windstorms; however, there is somewhat low confidence in these conclusions and there is still much uncertainty (Kossin et al., 2017).

4.3.11.5 Vulnerability Assessment

Tornadoes can occur at any time of the year, though they are more likely during peak months, which are during the summer for the northern part of the United States. Tornadoes are most likely to occur between 3:00 p.m.. and 9:00 p.m. but have been known to occur at all hours of the day or night. Factors that impact the amount of damage caused by a tornado are the strength of the tornado, the time of day and the area of impact. Usually such distinct funnel clouds are localized phenomena impacting a small area; however, the high winds of tornadoes make them one of the most destructive natural hazards. There can be many secondary impacts of tornadoes and windstorms, including transportation accidents, hazardous material spills, flooding, and power outages. A proper warning system is vital for the public to be informed of what to do and where to go.

Dangers that accompany thunderstorms which can produce tornadoes:

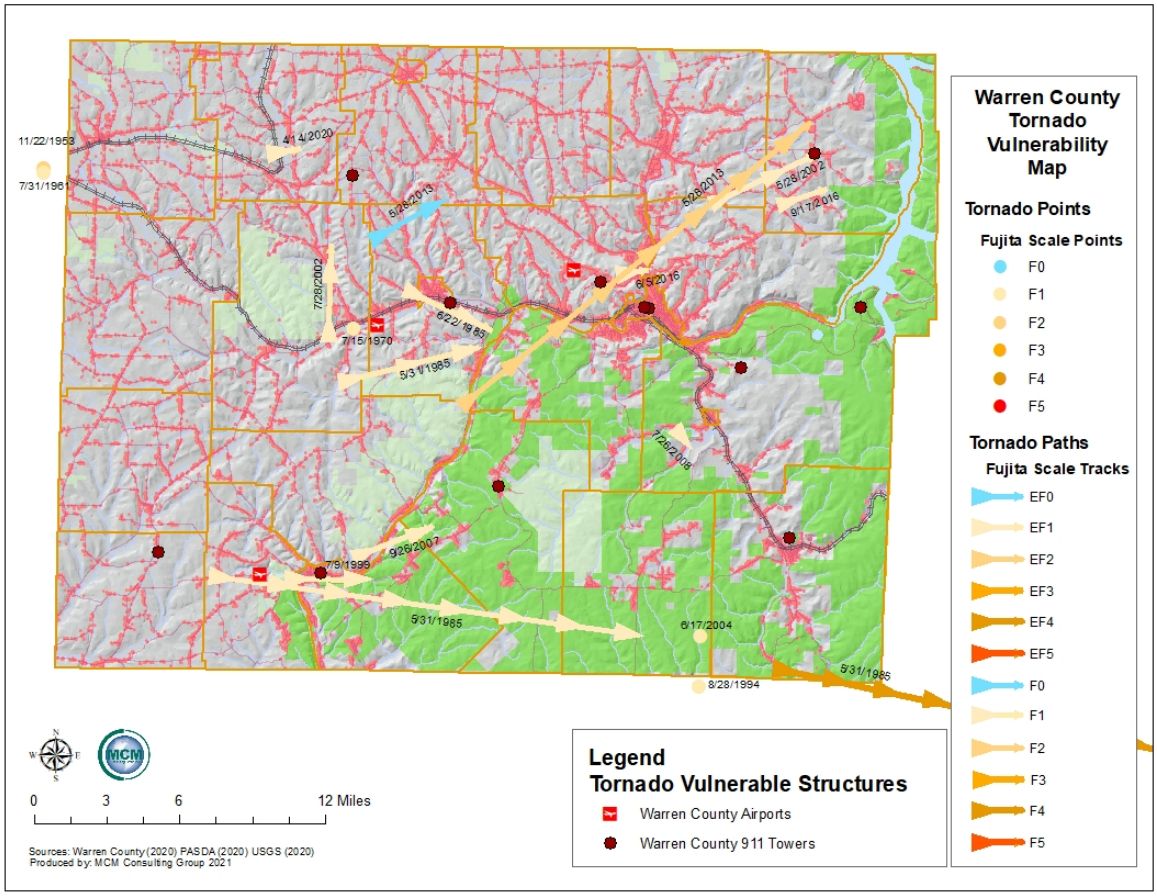
- Flash floods – with 146 deaths annually nationwide;
- Lightning – 75 to 100 deaths annually nationwide;
- Damaging straight-line winds – reaching 140 mph wind speed; and
- Large hail – can reach the size of a grapefruit and causes several hundred million dollars in damages annually to property and crops.

Critical facilities are highly vulnerable to high windstorms. Critical facilities include airports, hospitals, schools, fire stations, public safety buildings, and others. While many severe storms can cause exterior damage to structures, tornadoes can also completely destroy structures, along with their surrounding infrastructure, abruptly halting operations. Tornadoes are often accompanied by severe storms which can be

threatening to critical facilities within the county in their own right. Many critical facilities are particularly vulnerable to power outages which can leave facilities functionless, potentially crippling infrastructure supporting the population of the county. With a storm's ability to destroy structures, citizens and their possessions are often left at the will of the storm. The elderly and disabled people and non-English speaking residents are at risk when faced with tornadoes. Without assistance to evacuate or difficulty understanding public information, they may be unable to prepare themselves or their homes and other possessions to safely weather the storm. Airports and 911 towers are also particularly vulnerable to tornadoes and windstorms, and locations of each in Warren County can be found in *Figure 42 – Warren County Tornado Vulnerability Map* however, this is not a comprehensive list of buildings vulnerable to strong windstorms. It should also be noted that the state parks and state forests in Warren County have designated camping locations where visitors often pitch tents and can be vulnerable to severe windstorms.

The local economy can also be crippled by tornadoes and windstorms and their secondary effects when buildings and supporting infrastructure are destroyed in the storm. Power outages can create work stoppages while transportation accidents and road closings can limit the transportation of goods and services. Additionally, flooding cannot be discounted as it can destroy the physical structures, merchandise and equipment essential for business operation. In the case of hazardous material spills caused by windstorms, the local environment can also be negatively impacted, requiring extensive clean-up and mitigation efforts.

Figure 42 – Warren County Tornado Vulnerability Map



4.3.12. Wildfire

4.3.12.1 Location and Extent

The most prevalent causes of devastating wildfires are droughts, lightning strikes, arson, human carelessness, and in rare circumstances, spontaneous combustion. Most fires in Pennsylvania are caused by anthropogenic fires such as debris burns that spread and get out of control. A fire, started in somebody's backyard, could travel through dead grasses and weeds into bordering woodlands starting a wildfire. Major urban fires can cause significant property damage, loss of life, and residential or business displacement. While wildfires are a natural and essential part of many native Pennsylvania ecosystems (e.g. pitch pine – scrub oak woodlands), wildfires can also cause devastating damage if they are undetected and allowed to propagate unfettered. Wildfires most often occur in less developed areas such as open fields, grass, dense brush or forests where they can spread rapidly by feeding off of vegetative fuels. Wildfires are most prevalent under prolonged dry and hot spells, or general drought conditions. The greatest potential for wildfires (83% of all Pennsylvania wildfires) occur in the spring months of March, April, and May, and the autumn months of October and November. In the spring, bare trees allow sunlight to reach the forest floor, drying fallen leaves and other ground debris and increasing wildfire vulnerability. In the fall, the surplus of dried leaves is fuel for fires. *Figure 43 – Seasonal Wildfire Percentage* shows the wildfire percentage occurrence during each month occurring in Pennsylvania.

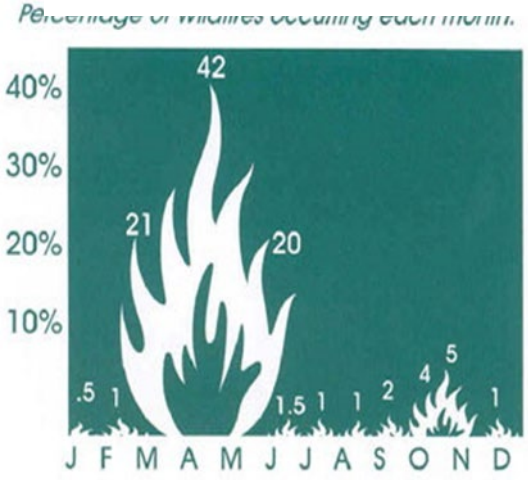
Because more than 80% of Warren County is covered by high quality hardwood forests and the Allegheny National Forest (23,000 acres) makes up one quarter of the county's total land area, the potential geographic extent of wildfire in Warren County is quite high. Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands. Approximately 98% of wildfires in Pennsylvania are caused by people, most frequently by debris burns (DCNR, 2017 and 2016 HMP).

For recreational enjoyment, the county boasts one state park of 862 acres (Chapman), several local parks, 24,788 acres of State Game Lands (29, 86, 263) and a series of trail systems – all at risk for wildfire (DCNR, State Game Commission).

4.3.12.2 Range of Magnitude

Forested areas, croplands and properties that are at the interface between wild lands and human development are most at risk for being impacted by and causing wildfires. If an urban fire or wildfire is not contained, secondary impacts such as power outages may result. Other negative impacts of wildfires include killing people, livestock, fish and wildlife and destroying valuable property, timber, forage, recreational and scenic values. Wildfires can also cause severe erosion, silting of stream beds and reservoirs, and flooding due to a loss of ground cover.

Figure 43 - Season Wildfire Percentage



The county's 2005 comprehensive plan cites two goals that may affect the range of magnitude of wildfire: preserve agricultural activities and promote the wise use of natural resources. The plan also notes "the people of Warren County prize their unparalleled environment of hills, forest (and streams)" and the rural character of the county.

Almost all of the wildland fires in the county occur in remote areas or areas away from residential structures. Unlike the wildland fires that occur in other parts of the country and affect vast areas of land and residential areas, most of the fires in Warren County are contained before they cause any damage or

extensive property loss (2016 Hazard Mitigation Plan). However, the county recognizes that wildfires of some magnitude will continue to occur in Warren County and will have more devastating effects if development in or around wildlands increases – in contradiction to the stated goals of the 2005 comprehensive plan.

The United States Forest Service utilizes the Forest Fire Assessment System to classify the dangers of wildfire. *Table 42 – Wildland Fire Assessment System* identifies each threat classification and provides a description of the level.

Table 42 - Wildland Fire Assessment System

Wildland Fire Assessment System *(U.S. Forest Service)*	
Rank	**Description**
Low (L)	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering and burn in irregular fingers. There is little danger of spotting.
Moderate (M)	Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur but is not persistent. Fires are not likely to become serious and control is relatively easy.
High (H)	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
Very High (VH)	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.
Extreme (E)	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.

4.3.12.3 Past Occurrences

The state department of natural resources (DCNR) has an extensive history of reported wildfires in its state forestry system and districts. Warren County is located in the Cornplanter State Forest (District 14). Not all the reported fires are necessarily wildfire hazards as many occurred in lightly urban environments. District 8 reports the following sixteen-year wildfire summary, which indicates wide fluctuations between years, and no observed downward or upward trend:

- Warren County has experienced three brush fires at the time of the writing of this plan.
- In 2019, there were twenty-three wildfires burning 36.2 acres.

- In 2018, there were forty-three wildfires burning 116.1 acres.
- In 2017, there were thirteen wildfires burning 10.3 acres.
- In 2016, there were fifty-nine wildfires burning 149.3 acres.
- In 2015, there were twenty-four wildfires burning 44 acres.
- In 2014, there were fourteen wildfires burning 5.5 acres.
- In 2013, there were seventeen wildfires burning 21.9 acres.
- In 2012, there were seventeen wildfires burning 123.5 acres.
- In 2011, there were three wildfires burning 9.1 acres.
- In 2010, there were seventeen wildfires burning 225.2 acres.
- In 2009, there were three wildfires burning 59.7 acres.
- In 2008, there were six wildfires burning 9.3 acres.
- In 2007, there were three wildfires burning 4.6 acres.
- In 2006, there were eleven wildfires burning 52.5 acres.
- In 2005, there were five wildfires burning 19.3 acres.
- In 2004, there was one wildfire burning 2 acres.
- In 2003, there were eight wildfires burning 85.1 acres.

Far and away, the primary cause of the wildfires is consistently listed as "debris burning". See more detail at the following link:
http://www.docs.dcnr.pa.gov/cs/groups/public/documents/document/dcnr_20033433.pdf

In recent years, the number of prescribed burns in Pennsylvania has been increasing. This corresponds to an embrace of the need for fire in many natural ecosystems and management strategies for reducing vulnerability to wildfire; it also improves hunting opportunities. In July 2020 there were dozens of prescribed burns in state game lands at the time of the writing of this plan, but only one on game lands in Warren County was listed (PA Prescribed Fire Council, 2020).

4.3.12.4 Future Occurrences

Annual occurrences of urban and wildfires in Warren County are expected. Urban fires are most often a result of human errors, outdated wiring or occasionally malintent (arson). The occurrence of large scale and intensity wildfires is somewhat unpredictable and highly dependent on environmental conditions and human response. Weather conditions play a major role in the occurrence of wildfires, so in the event of drought conditions, wildfire caution should be heightened. Any fire without the quick response or attention of firefighters, forestry personnel, or visitors to the forest, has the potential to become a wildfire. The Warren County Emergency Management Agency coordinates county-wide burn bans when the conditions are ideal for wildfires. Public information and press releases are issued to help decrease the risk of a major fire thus reducing the possibility of future occurrences. Warren County Emergency Management Agency disseminates all red flag warnings.

Climate change is expected to bring an elongated wildfire season and more intense and long-burning fires (Pechony & Shindell, 2010). Unfortunately in some regions of the United States, this is not a hypothetical, but a devastating reality – Northern California has experienced unprecedentedly devastating wildfires in 2017, 2018 and 2019, and the fires are thought to be burning faster and hotter due to worsening drought conditions caused by climate change (Cvijanovic et al., 2017). Wildfire conditions in Pennsylvania are not nearly as severe as in Northern California currently, but the intensification is a signal that the changes brought by climate change are not to be ignored. In Pennsylvania, higher air temperatures and earlier warming in the spring are expected to continue, resulting in more wildfire prone conditions in the summer and

fall (Shortle et al., 2015).

4.3.12.5 Vulnerability Assessment

The size and impact of a wildfire depends on its location, climate conditions and the response of firefighters. If the right conditions exist, these factors may often mitigate the effects of wildfires; however, during a drought, wildfires can be devastating. The highest risk for wildfires in Pennsylvania occurs during the spring (March–May) and fall (October–November) months and 98% of all wildfires in Pennsylvania are caused by people (DCNR). Firefighters and other first responders can encounter life-threatening situations due to forest fires. Traffic accidents during a response and the impacts of fighting the fire once on scene are examples of first responder vulnerabilities.

The Wildland Urban Interface (WUI) was nationally mapped by a United States Department of Agriculture Forest Service effort in 2015 that used data from 1990-2010 to develop a robust dataset that relates housing density and vegetative density. The dataset provides a way to help identify locations where larger numbers of humans are living in or near natural areas that could be at risk in the event of a wildfire. The WUI defines two types of communities – interface and intermix: intermix WUI refers to areas where housing and wildland vegetation intermingle, and interface WUI refers to areas where housing is in the vicinity of a large area of dense wildland vegetation (Martinuzzi et al., 2015). The WUI was the fastest-growing land use type in the United States between 1990 and 2010. Factors behind the growth include population shifts, expansions of cities into wildlands, and new vegetation growth. The primary cause has been migration of people, not vegetation growth. Of new WUI areas, 97% were the result of new housing.

Pennsylvania is among the states with the largest area of WUI and the most housing units in a WUI designated area. Pennsylvanians desire the proximity of natural beauty in their daily lives, and the growth in WUI housing noted above shows it. *Table 43 – Buildings in Wildfire Hazard Areas* shows the total Warren County addressable structures and critical facilities that are located in, near, adjacent to or among state game lands, state parks, state forests and local parks and other locations designated by the Wildland Urban Interface. Wildfire hazard is defined based on conditions that affect wildfire ignition and/or behavior such as fuel, topography and local weather. Cells in the chart that have a zero numerical entry had zero vulnerable addressable structures or critical facilities according to this analysis at that time. The many addressable structures in the Wildland Urban Interface and Intermix zone are broken up by assessed parcel use codes – the "other" land use is comprised of Industrial, Agriculture, Service, Transportation, Communication, Utility, Natural Resources and other Land uses.

Several citations, including one from the U.S. Department of Agriculture Forest Service, indicate a better data-driven WUI model will be available soon; if available, that data will be included in the 2022 Warren County Hazard Mitigation Plan Annual Update. As a complement to that upcoming data, *Figure 44 – Wildland Urban Interface with Fire Stations* shows the locations of fire departments in relative proximity (or lack thereof) to state owned natural areas which represent vast swatches of forests within the county.

There are twenty-seven fire departments that service Warren County, a list of which can be found in *Table 51 – Emergency Responders* in the Emergency Services profile. Each fire department conducts its own schedule of in-house training sessions for its members.

However, the likelihood that fire services will fail is a real threat to county communities' safety. Many communities have already experienced the unfortunate fact that services have failed. It is recommended that each municipality assess their own vulnerabilities by maintaining and building a relationship with their local providers to make the determination and begin to plan accordingly if a local service was to shut down its operation. The statistics, response times and call times associated with all units dispatched are easily obtainable from the local 911 center.

These departments must be supported to create and or discover new ways to not only recruit but to retain volunteers. If left unattended, the issues will continue and the lack of response will grow, leaving the community more vulnerable to loss of life and loss of property to the threat of wildfire.

At the time of this writing, it is possible that the continuing or resurgent COVID-19 pandemic will impact the availability of firefighters, too.

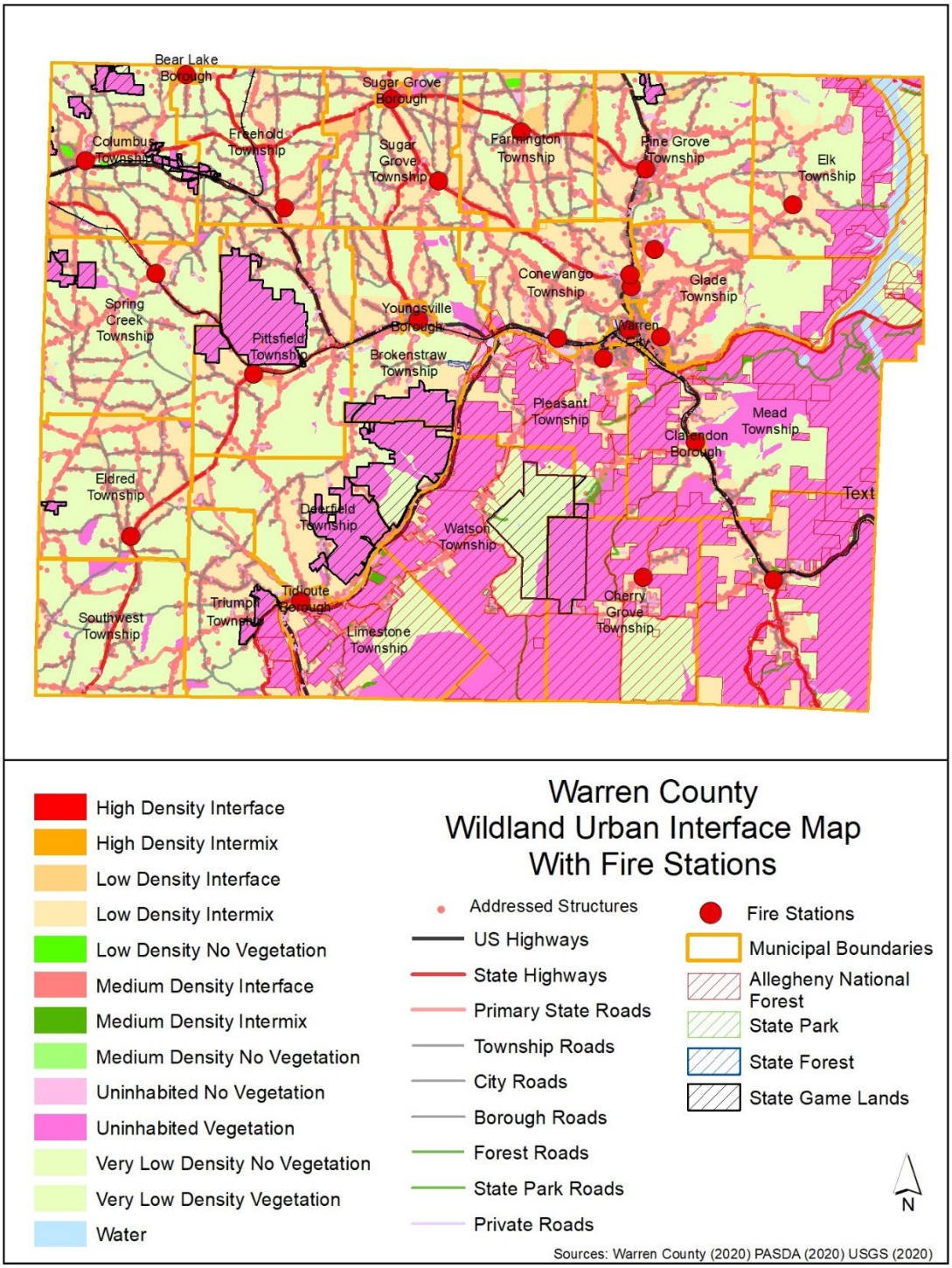
It is recommended that the entire community is educated on the perpetual needs associated with providing these services. In addition, continued support and efforts to inform the state legislature could prove to be paramount in assuring these services remain in operation into the future. At the time of the writing of this plan, a flurry of bills has been introduced in both the House of Representatives and the Senate as a result of a two-year study initiated by Senate Resolution 6 (SR 6). The final report can be found here: http://pehsc.org/wp-content/uploads/2014/05/SR-6-REPORT-FINAL.pdf

Table 43 - Buildings in Wildfire Hazard Areas

Buildings in Wildfire Hazard Areas *(Warren Co GIS, 2019; Radeloff et al. 2016)*						
Municipalities	**Wildland Urban Interface**			**Wildland Urban Intermix**		
	High Density	**Medium Density**	**Low Density**	**High Density**	**Medium Density**	**Low Density**
Bear Lake Borough		12	16		44	14
Brokenstraw Township	71	184	13	25	156	351
Cherry Grove Township					49	320
Clarendon Borough	56	108			81	7
Columbus Township		28	129		37	269
Conewango Township	246	706	83		96	705
Deerfield Township		12			174	259
Eldred Township		14	7		1	244
Elk Township		5			27	212
Farmington Township		5	122		1	303
Freehold Township		39	42		2	229
Glade Township	4	141	3	15	251	717
Limestone Township	4	441	2		366	279
Mead Township	5	192	11		327	318
Pine Grove Township	19	379	63		258	221
Pittsfield Township	18	127	114		62	291
Pleasant Township		757	26		165	452
Sheffield Township	186	298	16		233	537
Southwest Township		4			11	131
Spring Creek Township		19	22		50	232

Buildings in Wildfire Hazard Areas *(Warren Co GIS, 2019; Radeloff et al. 2016)*						
Municipalities	**Wildland Urban Interface**			**Wildland Urban Intermix**		
	High Density	**Medium Density**	**Low Density**	**High Density**	**Medium Density**	**Low Density**
Sugar Grove Borough		225	41		5	492
Sugar Grove Township		31	131		9	
Tidioute Borough	60	137	35		137	1
Triumph Township		2	1		51	236
Warren City	3231	12	24	50	44	
Watson Township		73	7		412	260
Youngsville Borough	155	614	6		91	8
Totals	**4055**	**5522**	**914**	**90**	**3172**	**7088**

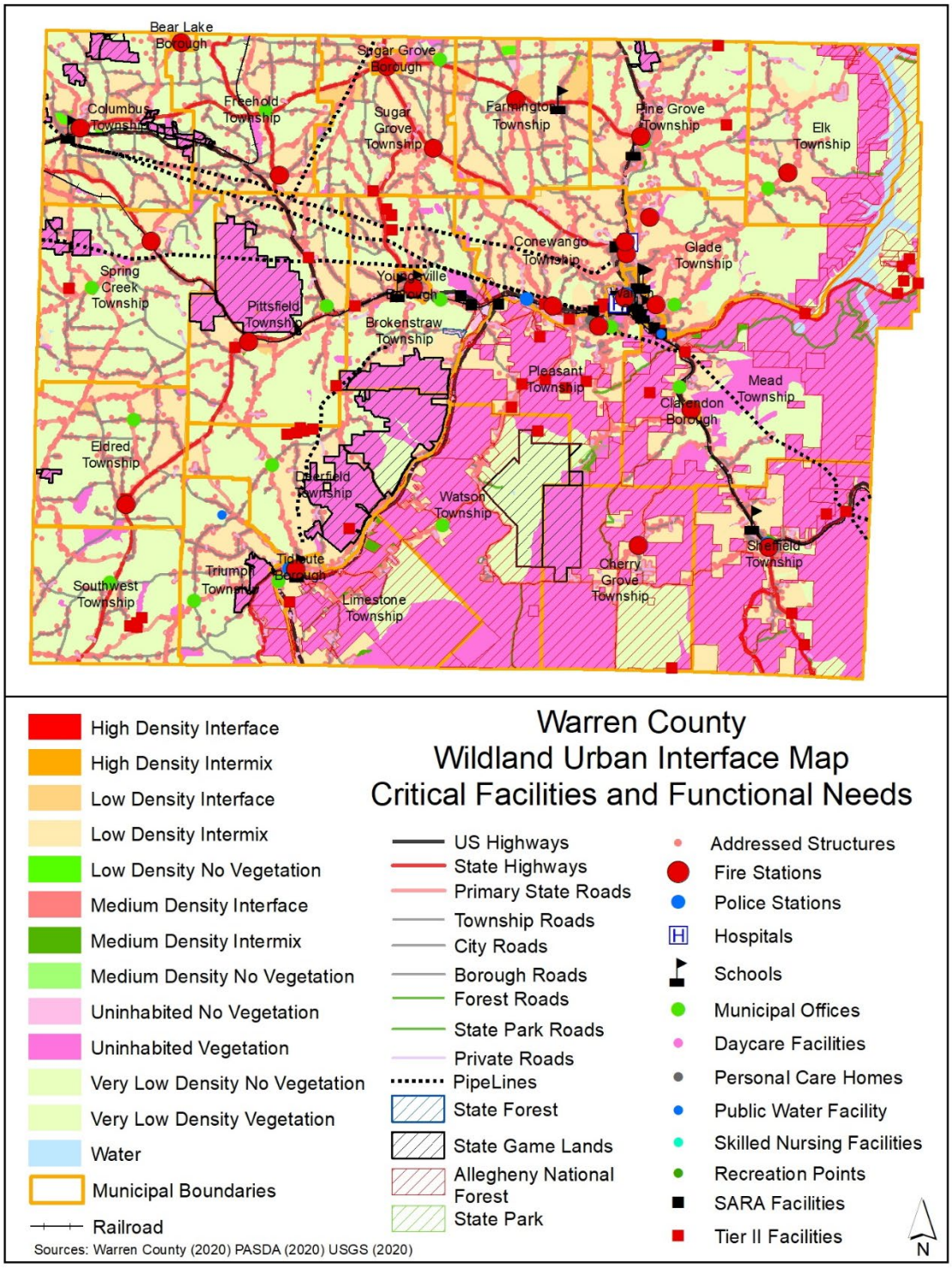
Figure 44 - Wildland Urban Interface with Fire Stations



There are several critical and functional needs facilities located in Warren County and throughout the Commonwealth of Pennsylvania. The location of these facilities in proximity to fire departments is crucial to the amount of time it takes to respond to an incident. *Figure 45 – Warren County Wildland Urban Interface Map Critical Facilities and Functional Needs* depicts where fire stations are located in relation to critical

and functional needs facilities in Warren County.

Figure 45 – Warren County Wildland Urban Interface Map Critical Facilities and Functional Needs



4.3.13. Winter Storms

4.3.13.1 Location and Extent

There is an average of thirty-five winter weather events that impact Pennsylvania each year. Such winter storms are regional events, so each county in Pennsylvania shares these hazards; however, the northern tier, western counties and mountainous regions generally experience storms more frequently and with a greater severity due to lake effects and geographic influence. Within Warren County there are variations in the average amount of snowfall that is received throughout the county because of differences in terrain; higher elevations experience greater snowfalls than lower-lying areas, especially the elevated sections of the Allegheny Plateau. The northeastern portion of the county experiences lake effect snow from the Great Lakes which is discussed in greater detail in Section 4.3.11.3. As expected, the average annual snowfall in the county increases from south to north.

On occasion Warren County can be affected by a Nor'easter, depending on its track. A Nor'easter is a storm characterized by a central low-pressure area that deepens dramatically as it moves northward along the U.S. East Coast. The name came from the strong northeast winds that precede and accompany the storm as it passes over New England. Nor'easters are notorious for producing heavy snow in the Central and Northeastern Mountains (including the Alleghenies), but typically make lighter snow (or even no snow) for counties in the west. Nor'easters will ordinarily produce a heavy, wet snow. There is usually a fairly consistent demarcation between rain, mixed precipitation, and snow which moves along with the storm and generally parallel to the track of the surface low. The demarcation typically pivots with the storm as the track changes direction. The mixed precipitation and rainfall are generated when warmer marine air is pulled into the storm. The heaviest snow in a Nor'easter falls to the north and west of the track of the surface low (NWS).

4.3.13.2 Range of Magnitude

Winter storms consist of cold temperatures, heavy snow or ice and sometimes strong winds. Descriptions of types of winter storms can be found in *Table 44 - Winter Weather Events.* Warren County generally experiences one or more significant winter storms each year. The storms come in the form of snow, freezing rain, and sub-zero temperatures lasting for several days. Winter storms have caused power failures, loss of communications networks, road closings, disruption of EMS and fire response capabilities and losses of water supplies throughout the county.

Power outages, sometimes caused by large amounts of snow or ice weighing on and breaking power lines, can result in a loss of heat for residential customers, potentially posing a threat to human life.

Long cold spells can cause rivers and lakes to freeze over. A subsequent thaw and rise in the water level break the ice into large chunks and can result in ice jams when the ice begins to flow. The ice jams can act as dams and result in flooding. Environmental impacts often include damage to shrubbery and trees due to heavy snow loading, ice build-up and/or high winds which can break limbs or even bring down large trees. While gradual melting of snow and ice provides excellent groundwater recharge, high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flooding. *Figure 46 - Pennsylvania Annual Snowfall 1981-2010* shows mean annual snowfall in Warren County to be between sixty-nine and eighty-five inches. *Table 45 - Recent Annual Snowfall by Snow Station* summarizes annual snowfall accumulation for recent years not covered in *Figure 46 - Pennsylvania Annual Snowfall 1981-2010* as recorded in the weather stations at Chandlers Valley and Warren.

The mean annual snowfall in Warren County is between sixty and 100+ inches. The higher mean annual snowfall is in the northern sections of the county and the lower mean annual snowfall is in the southern portions of the county.

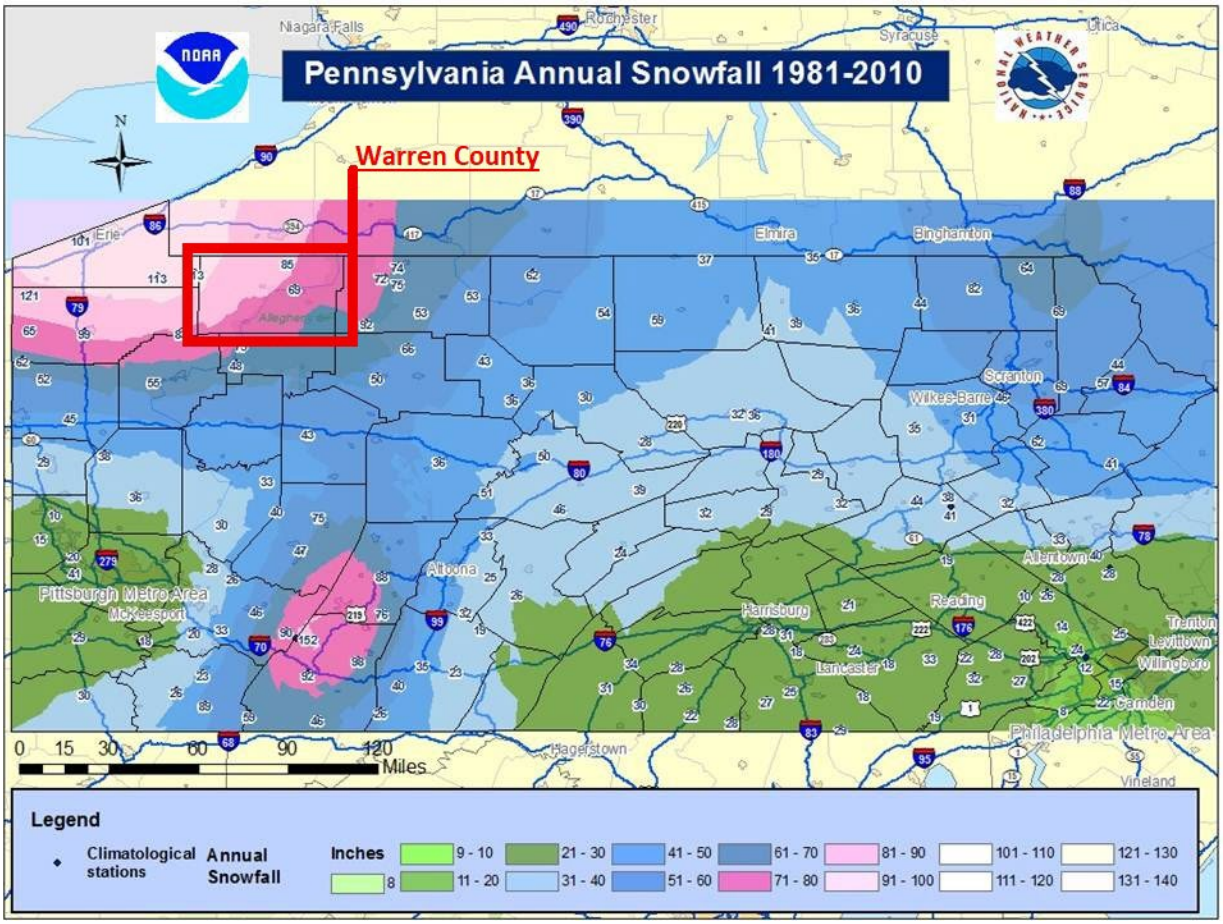
Table 44 - Winter Weather Events

Winter Weather Events	
Weather Event	**Classification**
Heavy Snowstorm	Accumulations of four inches or more in a six-hour period, or six inches or more in a twelve-hour period.
Sleet Storm	Significant accumulations of solid pellets which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces posing hazards to pedestrians and motorists.
Ice Storm	Significant accumulations of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from the sheer weight of ice accumulation.
Blizzard	Wind velocity of thirty-five miles per hour or more, temperatures below freezing, considerable blowing snow with visibility frequently below one-quarter mile prevailing over an extended period of time.
Severe Blizzard	Wind velocity of forty-five miles per hour, temperatures of 10˚F or lower, a high density of blowing snow with visibility frequently measured in feet prevailing over an extended period time.

Table 45 - Recent Annual Snowfall by Snow Station

Recent Annual Snowfall by Snow Station *(NOAA, 2020)*		
Winter Season	**Warren**	**Chandlers Valley**
2010-2011	54.5”	93.1”
2011-2012	116.3”	156.0”
2012-2013	59.8”	75.1”
2013-2014	69.2”	126.9”
2014-2015	74.2”	120.0”
2015-2016	51.3”	101.0”
2016-2017	84.9”	145.5”
2017-2018	82.0”	140.9”
2018-2019	45.3”	91.1”
2019-2020	69.1”	106.4”

Figure 46 - Pennsylvania Annual Snowfall 1981-2010



4.3.13.3 Past Occurrence

Winter storms occur on the average of five times a year in Warren County.

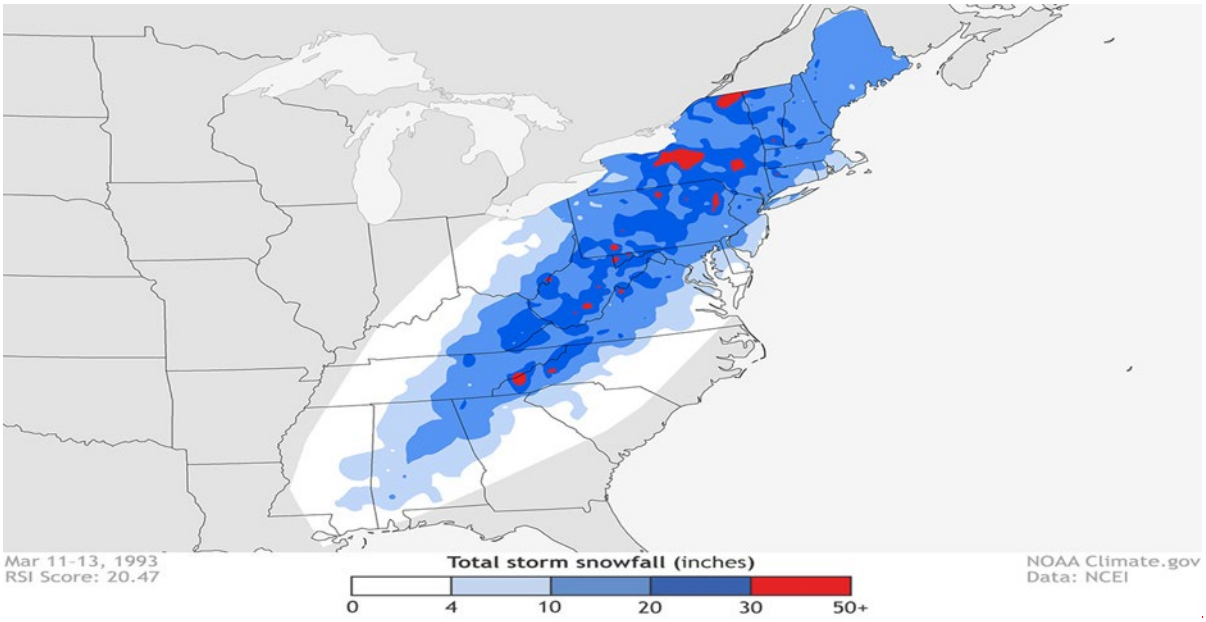
In January 1996, a series of severe winter storms with 27" - and 24" accumulated snow depths across the Commonwealth were followed by 50°F - 60°F temperatures resulting in rapid melting and flooding.

Another severe winter event in the county's history was in the winter of 1993 – 1994 when the state was hit by a series of protracted winter storms. The severity and nature of these storms combined with accompanying record-breaking frigid temperatures posed a major threat to the lives, safety and well-being of Commonwealth residents and caused major disruptions to the activities of schools, businesses, hospitals, and nursing homes. One of these devastating winter storms occurred in early January 1994 with record snowfall depths in many areas of the Commonwealth, strong winds and sleet/freezing rains. Numerous storm-related power outages were reported and as many as 600,000 residents were without electricity, in some cases for several days at a time. A ravaging ice storm followed which closed major arterial roads and downed many trees and power lines. Utility crews from a five-state area were called to assist in power restoration repairs. Officials from PPL Corporation stated that this was the worst winter storm in the history of the company – related damage-repair costs exceeded $5,000,000.00. Serious and sporadic power supply outages continued through mid-January in many locations due to record cold temperatures. The entire

Pennsylvania-New Jersey-Maryland grid and its partners in the District of Columbia, New York and Virginia experienced 15-30 minute rolling blackouts, threatening the lives of people and the safety of the facilities in which they resided. Power and fuel shortages affecting Pennsylvania and the East Coast power grid system required the governor to recommend power conservation measures be taken by all commercial, residential and industrial power consumers. The record cold conditions (with temperatures as low as -31˚F) resulted in numerous water-main breaks and interruptions of service to thousands of municipal and city water customers throughout the Commonwealth. The extreme cold in conjunction with accumulations of frozen precipitation resulted in acute shortages of road salt. Trucks were dispatched to haul salt from New York to expedite deliveries to Pennsylvania Department of Transportation storage sites.

The year prior, the country's so-called "Storm of the Century" clobbered the east coast. See *Figure 47, Storm of the Century Total Storm Snowfall.*

Figure 47 - Storm of the Century Total Storm Snowfall



On March 12–14, 1993, a massive storm system bore down on nearly half of the U.S. population. Causing approximately $5.5 billion in damages ($9.9 billion in 2020 dollars), America's "Storm of the Century," as it would become known, swept from the Deep South all the way up the East Coast. With a central pressure usually found in Category 3 hurricanes, the storm spawned tornadoes and left coastal flooding, crippling snow, and bone-chilling cold in its wake. Of the more than 250 weather and climate events with damages exceeding $1 billion since 1980, this storm remains the country's most costly winter storm to date.

The great blizzard of January 1978 (also known as The Cleveland Superbomb) dumped nearly twenty-seven inches of snow on western and southwestern Pennsylvania and closed schools and businesses for days.

All recorded winter weather events in Warren County from 1993 - 2019 are summarized in *Table 46 - Winter Weather Occurrences*. No direct deaths or injuries were reported for the following winter weather events in Warren County but detailed reports of each event can be found on NOAA's Storm Events Database (www.ncdc.noaa.gov/stormevents). These storms can result in closure of businesses and schools, blockages and damage to roadways, and loss of electricity and telephone service. The main transportation

routes in the county (U.S. Routes 6 and 62, State Routes 27, 59, 69, 127, 200, 346, 426, 666, 948, 957, and 958) are normally opened immediately for emergency traffic, but secondary roads can remain impassable for days. Most residents and travelers in Warren County are aware of the winter weather reputation in the county and avoid travel when under a winter storm watch.

Warren County is vulnerable to an array of winter weather. This weather has the ability to close businesses, close schools and block and damage roadways throughout the county.

Table 46 - Winter Weather Occurrences

LOCATION	DATE	TYPE
Multiple Counties	February 1993	Heavy Snow
Multiple Counties	February 1993	Heavy Snow
Countywide	February 1993	Heavy Snow
Multiple Counties	March 1993	Heavy Snow
Countywide	March 1993	Heavy Snow
Multiple Counties	October 1993	Heavy Snow
Countywide	December 1993	Heavy Snow
Countywide	December 1993	Heavy Snow
Statewide	January 1994	Heavy Snow
Statewide	January 1994	Heavy Snow
Multiple Counties	January 1994	Ice Storm
Statewide	March 1994	Heavy Snow/Blizzard/Avalanche
Multiple Counties	March 1994	Heavy Snow
Multiple Counties	January 1995	Heavy Snow
Multiple Counties	January 1995	Ice Storm
Multiple Counties	February 1995	Heavy Lake Effect Snow
Multiple Counties	February 1995	Ice
Countywide	November 1995	Heavy Lake Effect Snow/Squalls
Countywide	November 1995	Heavy Lake Effect Snow/Squalls
Countywide	November 1995	Snow
Multiple Counties	November 1995	Winter Storm
Countywide	November 1995	Heavy Snow/Squalls
Countywide	December 1995	Heavy Lake Effect Snow/Squalls
Multiple Counties	December 1995	Winter Storm
Countywide	December 1995	Heavy Lake Effect Snow/Squalls
Multiple Counties	January 1996	Heavy Snow
Countywide	November 1996	Heavy Snow
Multiple Counties	November 1996	Heavy Snow
Northern Warren County	December 1996	Heavy Lake Effect Snow
Countywide	March 1997	Heavy Lake Effect Snow
Multiple Counties	March 1997	Ice Storm
Multiple Counties	November 1997	Heavy Snow
Countywide	December 1997	Heavy Snow
Multiple Counties	December 1997	Heavy Snow
Countywide	December 1997	Heavy Lake Effect Snow
Northeastern Warren County	December 1998	Heavy Lake Effect Snow
Multiple Counties	January 1999	Winter Storm
Multiple Counties	January 1999	Winter Storm
Multiple Counties	January 1999	Winter Storm

LOCATION	DATE	TYPE
Multiple Counties	March 1999	Heavy Snow
Multiple Counties	March 1999	Heavy Snow
Northwestern Warren County	December 1999	Heavy Lake Effect Snow
Northwestern Warren County	December 1999	Heavy Lake Effect Snow
Countywide	November 2000	Heavy Lake Effect Snow
Countywide	December 2000	Heavy Lake Effect Snow
Multiple Counties	December 2000	Winter Storm
Western Warren County	December 2000	Heavy Lake Effect Snow
Countywide	February 2001	Heavy Lake Effect Snow
Multiple Counties	March 2001	Heavy Snow
Multiple Counties	January 2002	Ice Storm
Countywide	November 2002	Heavy Snow
Multiple Counties	December 2002	Heavy Snow
Multiple Counties	December 2002	Ice Storm
Multiple Counties	December 2002	Heavy snow
Countywide	November 2003	Heavy Lake Effect Snow
Countywide	January 2004	Heavy Lake-Effect Snow
Northern Warren County	January 2004	Heavy Lake-Effect Snow
Statewide	February 2004	Ice Storm
Statewide	March 2004	Heavy Snow
Multiple Counties	December 2004	Heavy Snow
Statewide	January 2005	Winter Storm
Countywide	January 2005	Heavy Lake-Effect Snow
Multiple Counties	January 2005	Heavy Lake-Effect Snow
Statewide	January 2005	Winter Storm
Northern Warren County	April 2005	Heavy Snow
Countywide	November 2005	Heavy Lake-Effect Snow
Multiple Counties	December 2005	Heavy Lake-Effect Snow
Northwestern Warren County	December 2005	Heavy Lake-Effect Snow
Statewide	December 2005	Winter Storm
Multiple Counties	January 2006	Winter Storm
Multiple Counties	February 2006	Winter Storm
Multiple Counties	February 2007	Heavy Snow
Multiple Counties	March 2007	Heavy Snow
Statewide	December 2007	Winter Storm
Statewide	February 2008	Winter Storm
Multiple Counties	March 2008	Ice Storm
Multiple Counties	October 2008	Heavy Lake-Effect Snow
Multiple Counties	November 2008	Winter Storm/Ice Event*
Statewide	December 2008	Winter Storm
Multiple Counties	January 2009	Winter Storm
Statewide	January 2009	Winter Storm
Statewide	October 2009	Winter Storm*
Multiple Counties	February 2011	Winter Storm
Multiple Counties	December 2012	Heavy Lake-Effect Snow
Multiple Counties	December 2012	Winter Storm
Statewide	November 2013	Winter Storm*
Multiple Counties	February 2015	Winter Storm

LOCATION	DATE	TYPE
Multiple Counties	February 2016	Winter Storm
Statewide	March 2017	Winter Storm Stella*
Multiple Counties	March 2018	Winter Storm – six to nine inches in a 12-hour period
Multiple Counties	January 2019	Winter Storm

4.3.13.4 Future Occurrence

There is a high probability of winter weather and winter storms occurring in Warren County, with expected annual events. The county is located geographically in a section of the Commonwealth that commonly equals or exceeds total snow depths of sixty inches – primarily due to lake effects. An analysis of the past occurrences indicates that this trend will continue annually in the future.

Meanwhile, climate change is expected to bring changes to the future of winter storms impacting Pennsylvania. Climate scientists believe that extreme winter storms are expected to occur more frequently – there have been about twice as many extreme snow events in the United States in the latter half of the 20th century as occurred in the first half (NOAA, 2018). This uptick is caused in part by higher than normal ocean surface temperatures that result in an increased source of moisture for storms that develop over the Atlantic Ocean. Conditions for severe winter storms are particularly heightened in the eastern United States due to changes in atmospheric circulation patterns caused by higher temperatures and melting Arctic sea ice (Francis & Vavrus, 2012). Winters in 2000 and 2001 were mild in Pennsylvania and led to spring-like thunderstorms during the winter months rather than snowstorms. Such thunderstorms can be followed by cold fronts and winter storms resulting in temperature drops of 50˚F in a few short hours. With warmer average temperatures, more precipitation is expected to fall as rain rather than snow, and data from NOAA show that Warren County has experienced a significant decrease in the amount of snowfall relative to the amount of rainfall, with a change of -10% to -20% from 1949 to 2016 (NOAA, 2016; PA HMP, 2018). Even though average temperatures are expected to be higher overall and there are expected to be fewer extreme cold days, those that do occur are expected to more often reach record setting low temperatures (Vose et al., 2017).

Winter storms are a regular, annual occurrence in Warren County and should be considered highly likely. Approximately thirty-five winter storm events occur across Pennsylvania annually and about four to six are estimated to impact Warren County each year.

4.3.13.5 Vulnerability Assessment

Based on the information available, all communities in Warren County are essentially equally vulnerable to the direct impacts of winter storms. Residents of the northern sector of the county, roughly 10,000 people, may be more susceptible due to the mountainous terrain, especially when emergency medical assistance is required.

Because of the frequency of winter storms, strategies have been developed to respond these events. Snow removal and utility repair equipment is present to respond to typical events. The use of auxiliary heat and electricity supplies such as wood burning stoves, kerosene heaters and gasoline power generators reduces the vulnerability of humans to extreme cold temperatures commonly associated with winter storms but can increase their vulnerability to other hazards. People residing in structures lacking adequate equipment to protect against cold temperatures or significant snow and ice are more vulnerable to winter storm events. Even for communities that are prepared to respond to winter storms, severe events involving snow accumulations that exceed six or more inches in a twelve hour period can cause a large number of traffic

accidents, interrupt power supply and communications, and cause the failure of inadequately designed and/or maintained roof systems.

Icy and snow-covered roads often result in increases in traffic incidents. Residents of the mountainous and more rural areas of the county may be more susceptible during severe storms, especially when emergency medical assistance is required due to the location's potential for isolation. The economic impacts from snow removal, road and infrastructure repair and other secondary effects impart a great strain on the budgets and material resources of local municipalities.

Even for communities that are prepared to respond to winter storms, severe events involving snow accumulations that exceed six or more inches in a twelve-hour period can cause a large number of traffic accidents, strand motorists due to snow drifts, interrupt power supply and communications, and cause the failure of inadequately designed and/or maintained roof systems. Similar to the vulnerability assessment discussion for tornados and severe wind, vulnerability to the effects of winter storms on buildings is dependent on the age of the building, construction material used and condition of the structure. Unfortunately, no comprehensive database of these variables could be identified for Warren County.

4.3.14. Dam/Levee Failure

4.3.14.1 Location and Extent

Pennsylvania has over 83,000 miles of streams and rivers, with every county having at least 100 miles of streams, and averages 1,239 linear miles of waterways. The number of waterways within the county provides many needs for dams and levees. Dams have several purposes: hydroelectric, flood control, water source, recreation, or agricultural.

Dams
Dam failures are usually a secondary effect of massive rainfall and flooding and occur when too much water enters the spillway system. This will occur with little or no warning. Spring thaws, severe thunderstorms, and heavy rainfall are also contributory factors. Poor engineering or poor maintenance may also cause dam failures. The Pennsylvania Department of Environmental Protection and the U.S. Army Corps of Engineers award permits for dams and shares inspection responsibilities. Inspection results are characterized as either safe or unsafe. Dams are evaluated in categories such as slope instability, excessive seepage, and inadequate spillways.

Major dams are categorized as being fifty feet tall with a storage capacity of at least 5,000-acre feet, or of any height with a storage capacity of 25,000-acre feet. Dams are classified in terms of hazard potential as: high, significant, or low, with high-hazard dams requiring Emergency Action Plans.

The Kinzua Dam is considered a major dam and is one of the largest dams in the United States east of the Mississippi river and is located on the Allegheny River within the Allegheny National Forest. The dam created Pennsylvania's deepest lake, the Allegheny Reservoir, also known as Kinzua Lake. There is a boat marina and beach located within the dam boundaries. Along with flood control the dam provides hydropower and recreation.

Congress authorized construction of the dam under the Flood Control Acts of 1936 and 1938. Construction did not begin until 1960 by the US Army Corps of Engineers and was completed in 1965. Kinzua controls drainage on a watershed of 2,180 square miles. The lake extends twenty-five miles to the north, nearly to Salamanca, New York. Federal condemnation of tribal lands to be flooded for the project displaced more than 600 Seneca members and cost the reservation 10,000 acres.

The Kinzua Dam is 1,877 feet in length, 179 feet high and is constructed of earth-fill and concrete. There are eight 5'-8"x10' discharge sluices and two hydroelectric penstocks, fifteen feet in diameter. There are 400 megawatts capacity of hydroelectric generated.

Table 47 - Inventory of Dams in Warren County lists dams as found on the U.S. Army Corps of Engineers National Inventory of Dams for the county.

Table 47 - Inventory of Dams in Warren County

Name of Dam	Waterway	Primary Purpose	Hazard Potential
Chapman Dam	Chapman Lake on the West Branch of Tionesta Creek	Recreation	High
Kinzua Dam	Allegheny reservoir on the Allegheny River	Flood control	High
Kinzua upper Reservoir Dike or Seneca Dam	Allegheny River	Hydroelectric	High

Levees
Millions of Americans live or work near levee systems, due to levees being built to reduce the risk of flooding for hundreds of years. Levees are an elongated embankment that is naturally occurring or artificial, which regulates water levels. An artificial levee's main purpose is to prevent flooding along the adjoining land.

The following levees have been identified in Warren County:

- Ellwood National Forge is 1.24 miles in length and is in Brokenstraw Township. There are two structures behind the levee with a zero population. The levee structure is near the Allegheny River along the Brokenstraw Creek.
- Warren – Right Bank Glade Run is 0.64 miles in length and is in Warren City. There are seventy-eight structures behind the levee with a population of 149. The levee structure is near the Allegheny River.

4.3.14.2 Range of Magnitude

The municipalities where these dams are located are at the greatest risk for a dam failure. Flooding is the most common secondary effect of dam failure. If the dam failure is severe, a large amount of water will enter the downstream body of water and overflow the stream banks for miles. Depending on the contents of the water and the path it takes, there may be significant environmental vulnerability.

Dam safety laws are embodied in the Dam Safety and Encroachments Act ("DSE Act") – enacted July 1, 1979 and last amended in 2011. Rules pertaining to dam safety are found in Title 25 – Rules and Regulations; Part 1 – Department of Environmental Resources; Subpart C – Protection of Natural Resources; Article II – Water Resources; Chapter 105 – Dam Safety and Waterway Management ("the Rules") adopted September 16, 1980.

Dams assigned the significant-hazard potential classification are those dams where failure or incorrect operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be in areas with population and significant infrastructure. Dams assigned the high-hazard potential classification are those where failure or incorrect operation has a great possibility of causing loss of human life.

4.3.14.3 Past Occurrence

There have not been any reported dam or levee failures in Warren County.

4.3.14.4 Future Occurrence

Dams
Minor dam failures occur frequently. However, they often go unnoticed and cause little or no harm to the general population. Significant dam failures occur much less frequently. The probability of a significant dam failure in Warren County is unlikely to occur. Dam failures are often a secondary effect, resulting from another hazard, such as heavy rainfall from a hurricane or tropical storm.

Dams assigned the significant-hazard potential classification are those dams where failure or incorrect operation results in no probable loss of human life but can cause economic loss, environmental damage, disruption of lifeline facilities, or other concerns. Significant hazard potential classification dams are often located in predominantly rural or agricultural areas but could be in areas with population and significant infrastructure. Dams' assigned high-hazard potential classification are those where failure or incorrect operation has a great possibility of causing loss of human life.

Levees
Over time, artificial levees can lead to an elevation of the natural riverbed. Both natural and manmade levees can fail. Some factors that cause levee failure include overtopping, erosion, structural failures, and levee saturation. The most frequent and most dangerous is a levee breach. This happens when part of the levee breaks or is eroded away. This leaves a large opening for water to flood the land that was protected by the levee.

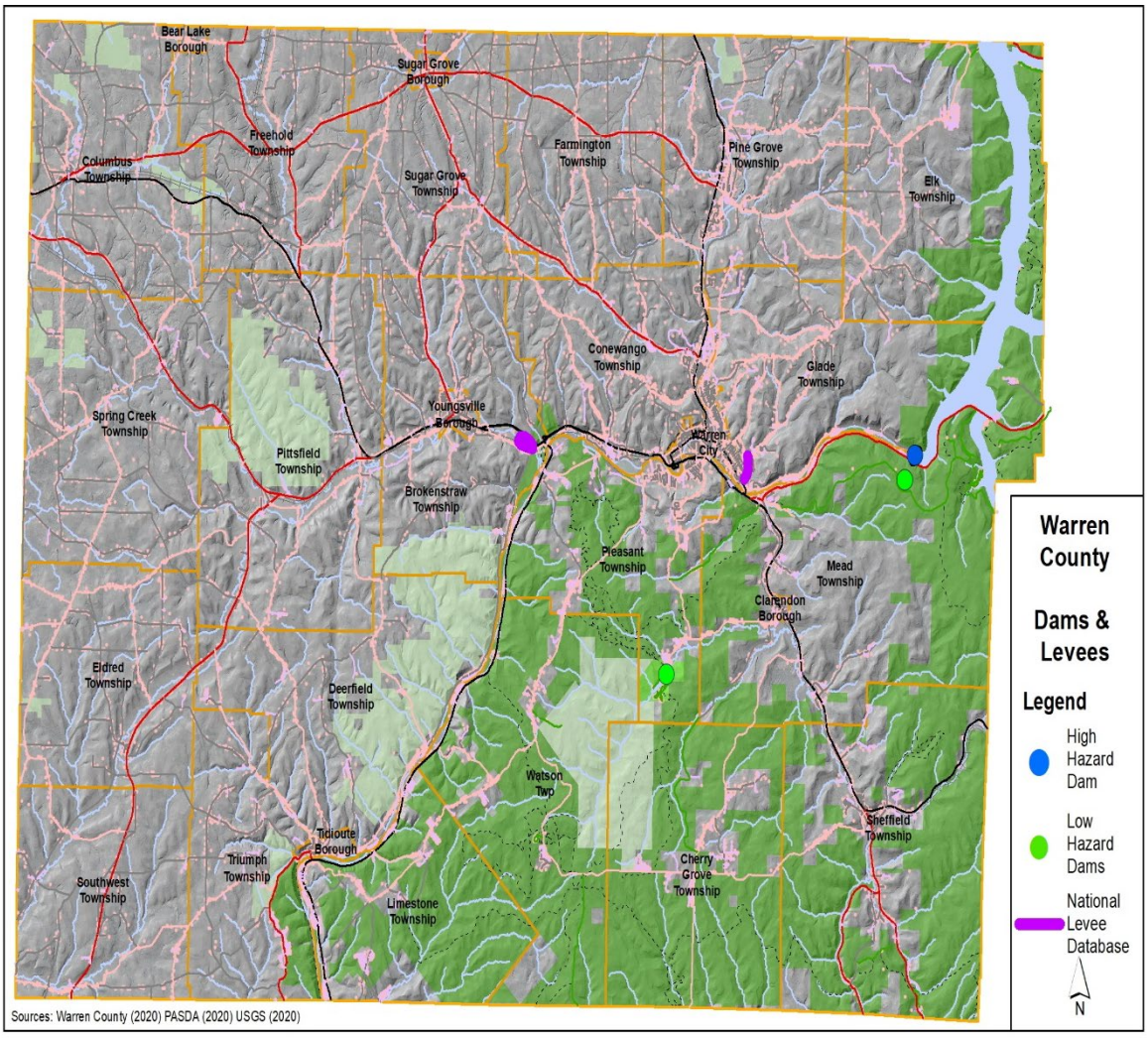
4.3.14.5 Vulnerability Assessment

Dams
There is always the possibility that a dam could fail, however the probability is unlikely in Warren County. According to PEMA, minor dam failures occur every year, but their impact is minimal. Usually a failure is gradual, low volume releases that are unexpected, and do not cause loss of life or damage to the environment. Areas directly downstream from the dam are the most vulnerable areas to a dam break. *Figure 48 – Countywide Map of Dams and Levees* identifies the dams in Warren County and the vulnerable areas downstream from the dam.

The following municipalities are directly downstream from the Kinzua Dam and the most vulnerable municipalities to a failure of this dam. Glade Township, Mead Township, City of Warren, Conewango Township, Pleasant Township, Brokenstraw Township, Deerfield Township, Watson Township, Limestone Township, Tidioute Borough and Triumph Township. Digital inundation data was not available to determine the severity of impact to these municipalities.

Levees
There is always the possibility that a levee could fail. *Figure 48 – Countywide Map of Dams and Levees* identifies levees in Warren County and vulnerable structures in the hazard area.

Figure 48 – Countywide Map of Dams and Levees



4.3.15. Disorientation

4.3.15.1 Location and Extent

Disorientation is the loss of one's sense of direction, position, or relationship with one's surroundings. This can be defined as mental confusion or impaired awareness. Large numbers of people are attracted to Pennsylvania's rural areas for recreational purposes such as hiking, camping, hunting, and fishing. As a result, people can become lost or trapped in remote and rugged wilderness areas. Search and rescue may be required for people who suffer from medical problems or injuries and those who become accidentally or intentionally disoriented. This report also identifies water rescues as persons can become disoriented or lost in small watercraft and while swimming. Search and rescue efforts are focused in and around state forest and state park lands (DCNR 2009).

Most municipalities in Warren County have experienced lost persons however disorientation is most likely to occur in areas of vast, open wilderness. The majority of Warren County's land area is undeveloped, with

the majority being forested. There are over 300 miles of hiking and biking trails in the Allegheny National Forest and each year several people become lost or disoriented in wilderness areas throughout the county.

4.3.15.2 Range of Magnitude

A wide variety of factors can contribute to the outcome of a search and rescue mission, but the most common dangers associated with disorientation are lack of food, water, and shelter. Warren County generally has an abundance of water and during the warmer summer months shelter is less of a necessity than during winter months when extreme temperatures can pose a huge threat. Age, physical fitness, and familiarity with the area can also have a bearing on the outcome. All ranges of the population, from age to social status, would be at a maximum threat to disorientation.

4.3.15.3 Past Occurrence

Each year several people become lost in Warren County's wilderness areas. Wilderness search and rescue has required considerable resources, sometimes resulting in the expenditure of hundreds of man-hours. The table below depicts events that required emergency service personnel to be utilized for search and rescue of disoriented persons. This list is compiled from data gathered on Corvena/Knowledge Center.

Table 48 – Disorientation Events - June 2013 – June 2020 (Corvena/Knowledge Center)

Disorientation Events in Warren County June 2013 – June 2020 (Corvena/Knowledge Center)		
Date	**Event**	**Location**
06/02/2013	Water rescue	Conewango Township
08/13/2013	Missing hikers.	Near Heats Content Campground
09/14/2013	Missing person	Conewango Township
09/23/2013	Search and rescue	Warren City
10/25/2013	Missing hunter.	Mead Township
11/17/2013	Lost hikers (3)	Hearts Content area of ANF
02/17/2014	Search and rescue	Pleasant Township
04/06/2014	Search and rescue, fall victim	Kinzua Dam Tail waters
05/20/2014	Water rescue, 4 kayakers unaccounted for	Pleasant Township
06/15/2014	Search and rescue, water rescue	Conewango Creek
06/15/2014	Missing kayaker at Henry's Mills	Sheffield Township
06/29/2014	Water rescue – two (2) people in the water with an overturned boat	Deerfield Township
07/04/2014	Water rescue – boating accident	Mead Township
10/28/2014	Two (2) missing hikers	Watson Township
10/31/2014	Missing hunter	Cherry Grove Township
12/01/2014	Lost hunter – Hearts Content	Watson Township
12/11/2014	Lost hunter – Sanford Road	Eldred Township
12/12/2014	Lost hunter –FR 179	Cherry Grove Township
12/17/2014	Missing person	Mead Township
05/20/2015	Search detail	Watson Township
05/30/2015	Lost hikers	Cherry Grove Township
06/27/2015	Missing hiker	Pleasant Township
07/04/2015	Two (2) missing 14-year old females	Mead Township
07/10/2015	Water rescue – River Rd.	Conewango Township
07/24/2015	Missing person	Glade Township
07/26/2015	Search detail for a 65-year old male with dementia	Southwest Township
10/14/2015	Missing hunter at Hearts Content	Watson Township
10/21/2015	Missing person	Sheffield Township
11/02/2015	Lost hunter	Limestone Township
11/03/2015	Missing hunter on an oil lease road	Warren County

Disorientation Events in Warren County June 2013 – June 2020 (Corvena/Knowledge Center)		
Date	**Event**	**Location**
11/11/2015	Missing hunter	Watson Township
11/27/2015	Warren State Hospital patient missing	Conewango Township
12/30/2015	Search detail for two on the North Loop	Hickory Creek Wilderness Trail
02/06/2016	Missing person	Pine Grove Township
05/28/2016	Search detail for a lost hunter off Austin Hill on Forest Road 481	Cherry Grove Township
05/28/2016	Water rescue of a 13-year old swimmer at the boat launch behind UniMart. This resulted in a body recovery.	Sheffield Township
07/11/2016	Missing person	Pleasant Township
07/24/2016	Missing person(s) – two females.	Morrison Trail Head in ANF area
07/30/2016	Missing boaters – two adults and one child.	Warren County
11/05/2016	Missing person	Pittsfield Township
11/28/2016	Capsized boat and vehicle at boat launch of Webb's Ferry. County coroner was requested.	Elk Township
12/02/2016	Missing hunter	Warren County
02/23/2017	Missing hiker	Watson Township
03/31/2017	Missing hunter	Watson Township
04/18/2017	A dog with a life jacket was found near a capsized boat between Webb's Ferry boat launch and Roper Hollow boat launch. County coroner was requested.	Elk Township
04/2020/17	Juvenile found sleeping at Country Fair on PA Ave. E.	Warren City
05/05/2017	Over-turned kayak with camping gear floating nearby on Allegheny River near Thompson Island. Victim found and refused treatment.	Deerfield Township
05/07/2017	Missing teens.	Eldred Township
05/10/2017	Water rescue on Scott Run Road, victim was rescued.	Conewango Township
05/11/2017	Search detail for a missing 14-year old male.	Columbus Township
05/13/2017	Missing juveniles	Youngsville Borough
05/14/2017	Wilderness rescue involving a traumatic injury.	Sheffield Township
06/03/2017	Water rescue of four persons from a capsized canoe. No injuries.	Conewango Township
07/02/2017	Water rescue at Wolf Run Marina, male in the water with a head injury. County coroner was requested.	Mead Township
07/02/2017	Water rescue of three females from a capsized canoe.	Warren City
08/20/2017	Search detail for a lost 60-year old male in the Hickory Creek Wilderness area	Hearts Content Camping area
08/30/2017	Fall victim from Alleghany Reservoir	Mead Township
09/18/2017	Search detail for three lost persons	Heart Content Recreation area
10/30/2017	Missing person	Pittsfield Township
02/28/2018	Water rescue, one uninjured, second taken to hospital.	Conewango Township
05/19/2018	Water rescue, overturned kayak, person is on a small patch of land.	Limestone Township
05/20/2018	Missing juvenile	Warren City
07/07/2018	Lost persons	Limestone Township
07/14/2018	Water rescue – female in the water, located and she refused treatment.	Watson Township
07/15/2018	Two jet ski collision on the Kinzua Reservoir, both patients transported to the hospital.	Mead Township
08/26/2018	Stranded person	Conewango Township
08/30/2018	Missing elderly man	Warren City
09/02/2018	Water Rescue on Allegheny River from an overturned canoe. All persons accounted for.	Warren City
09/29/2018	Lost person	Watson Township
10/14/2018	Missing person from a nursing home	Warren City
10/19/2018	Search detail for a child approximate age of 3.	Warren City

Disorientation Events in Warren County June 2013 – June 2020 (Corvena/Knowledge Center)		
Date	**Event**	**Location**
10/24/2018	Missing person	Webbs Ferry Road
10/27/2018	Water rescue for two males holding onto a 17' john boat.	Brokenstraw Township
10/27/2018	Lost persons in the Allegheny National Forest	Watson Township
10/27/2018	Lost hunter	Mead Township
11/05/2018	Lost hunter	Mead Township
11/28/2018	Missing hunter	Watson Township
05/18/2019	Water rescue	Warren City
06/17/2019	Search detail for a missing elderly man with dementia.	Mead Township
06/28/2019	Lost person in the Allegheny National Forest	Mead Township
08/17/2019	Swimmer in distress in the Allegheny River.	Limestone Township
09/27/2019	Lost hikers	Cherry Grove Township
10/04/2019	Search detail for a missing patient from the Warren State Hospital.	Conewango Township
10/21/2019	Lost hunter, an 81-year old male with heart problems.	Pittsfield Township
03/21/2020	Search detail	Pittsfield Township
04/10/2020	Hiker in distress	Cherry Grove Township
06/02/2020	Lost hikers	Limestone Township

4.3.15.4 Future Occurrence

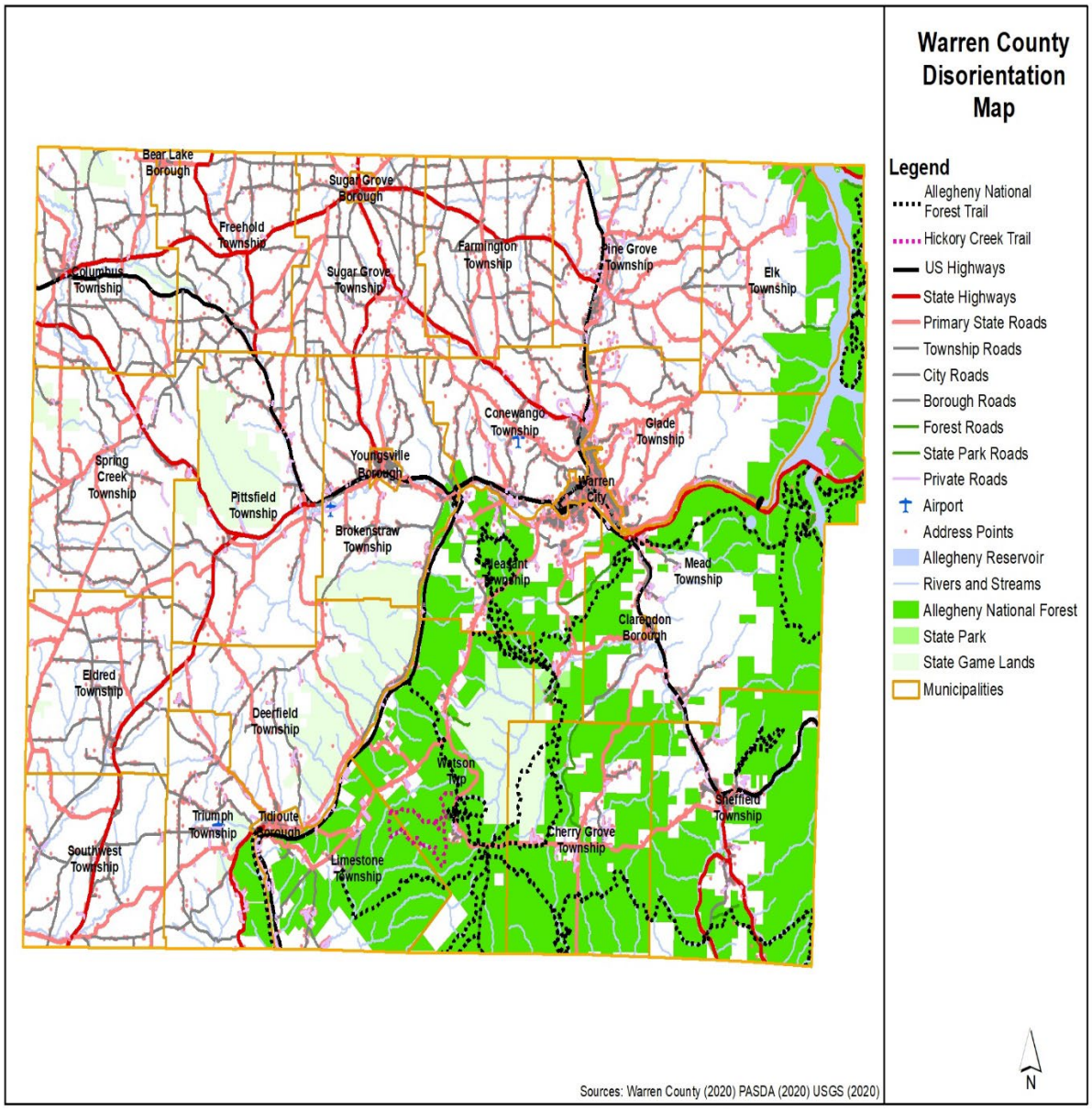
With the significant size of natural lands in Warren County, disorientations will continue to occur. During the warm summer months, as activities such as hiking, biking, and camping increase, so does the likelihood of individuals becoming disoriented. In the fall and winter months, hunters can become disoriented, or overdue; requiring emergency services to search.

Search and rescue operations throughout the county are predicted to continue but can be mitigated with appropriate actions. The very young and those with mental incapacities will always be at a higher risk of disorientation. However, those partaking in recreational activities should always be aware of their surroundings. Maps and other resources would enhance the capabilities of those engaged in recreational activities to navigate safely.

4.3.15.5 Vulnerability Assessment

Individuals are most likely to become disorientated in areas of vast, open wilderness. Children and the elderly are more vulnerable to exposure of the elements (extreme temperatures). The most dangerous period to become lost outdoors is during the winter months when heat and shelter are vital. Warren County regularly experiences winter storms and temperatures below freezing.

Figure 49 – Disorientation Vulnerability Map



4.3.16. Drowning

4.3.16.1 Location and Extent

Drowning can be a significant hazard in communities with numerous bodies of water (e.g. ponds, lakes, rivers, etc.) and extensive outdoor recreational activity. Warren County has been and continues to grow in popularity as a tourist destination. Water related recreational opportunities such as fishing, boating, and swimming are popular among visitors.

One of the most popular tourist destinations in the county is the Kinzua Dam and Allegheny Reservoir. The county is most concerned with the drownings that have occurred in the Allegheny Reservoir. Other popular water bodies in the county include the sixty-eight-acre Chapman Lake located in Chapman State Park on the West Branch of Tionesta Creek, the Allegheny and Clarion Rivers as well as Conewango and Brokenstraw Creeks.

4.3.16.2 Range of Magnitude

Drowning is defined as respiratory impairment because of being in or under a liquid which most often results in death. According to the Center for Disease Control (CDC) drowning rates are particularly high for children ages 1-14.

Near-drowning occurs when you are unable to breathe under water for a significant period. Symptoms following rescue may include breathing problems, vomiting, confusion, or unconsciousness. Occasionally symptoms may not appear until up to six hours following the event.

4.3.16.3 Past Occurrence

There have been thirty-seven deaths due to drowning in the Allegheny Reservoir since 1962. Twenty-one of those drownings occurred in Warren County. The most recent incident occurred in July 2008 when two brothers drowned after one jumped seventy-five feet from the James Morrison Bridge and the other tried to save him. *Table 49 - Allegheny Reservoir Drownings Between 1962 and 2016* lists the activities associated with known drownings in the reservoir and number of deaths in each category. In this same timeframe there was one recorded drowning that occurred in a pond in Sugar Grove Township on 6/28/2014 (Corvena/Knowledge Center™).

Table 49 - Allegheny Reservoir Drownings Between 1962 and 2016

Allegheny Reservoir Drowning Between 1962 and 2016	
Associated Activity	**Number of Deaths**
Boating Accidents	11
Swimming	10
Fishing	6
Automobile Accident	2
Fall or jump from bridge or shore	5
Suicide	2
Plane Crash	1

Since July 14, 2008, the following drowning or potential for drowning incidents have occurred within Warren County, shown in *Table 50 – Drownings or Potential for Drownings in Warren County*. These events were outlined on Corvena (formerly Knowledge Center™), some of these incidents may be outlined in *Table 49 – Allegheny Reservoir Drownings Between 1962 and 2016.* Incidents that had a potential for drowning were included to provide a better understanding of the increased frequency that drownings could have occurred.

Table 50 – Drownings or Potential for Drownings in Warren County

Drownings or Potential for Drownings in Warren County			
Drowning or Potential	**Date**	**Location**	**Event**
Drowning	07/15/2008	Mead Township	Two missing swimmers in Allegheny Reservoir after jumping off a bridge. Coroner was requested to the scene.
Potential	09/27/2008	Mead Township	Vehicle in the water
Potential	08/03/2009	Warren County	Vehicle in the Allegheny River, occupants rescued.
Potential	05/22/2010	Brokenstraw Township	Water rescue
Potential	07/03/2011	Tidioute Borough	Water rescue
Drowning	05/19/2012	Conewango Township	Capsized canoe with one person missing. The body was recovered on 05/25/2012
Potential	05/24/2012	Warren City	Water rescue
Drowning	04/28/2013	Warren City	During a civilian search for a missing person, a body was found in Conewango River. The coroner was contacted.
Potential	06/02/2013	Conewango Township	Water rescue of three individuals from an overturned canoe
Potential	07/13/2013	Tidioute Borough	Vehicle in a small creek
Potential	05/20/2014	Pleasant Township	Water rescue
Potential	06/15/2014	Conewango Township	Water rescue
Potential	06/15/2014	Sheffield Township	Missing kayaker
Drowning	06/28/2014	Sugar Grove Township	Drowning, person fell overboard from a boat in a pond, the body was located.
Potential	06/29/2014	Deerfield Township	Water rescue
Potential	07/10/2015	Conewango Township	Water rescue
Drowning	05/28/2016	Sheffield Township	Juvenile swimming at the boat launch drowned. Search crews made a body recovery.
Potential	07/30/2016	Warren County	Missing boaters
Drowning	11/28/2016	Elk Township	Capsized boat at Webb's Ferry boat launch, coroner requested to the scene.
Potential	05/10/2017	Conewango Township	Water rescue
Potential	06/03/2017	Conewango Township	Water rescue
Drowning	07/02/2017	Mead Township	Male in the water with a head injury, believed to be under a docked boat at Wolf Run Marina. Coroner requested to the scene.
Potential	07/02/2017	Warren City	Water rescue
Potential	07/02/2017	Warren City	Overturned boat, three victims rescued
Potential	08/30/2017	Mead Township	Fall victim at Allegheny Reservoir
Potential	11/18/2017	Warren County	Empty boat floating
Potential	02/28/2018	Conewango Township	Water rescue
Potential	05/19/2018	Limestone Township	Water rescue
Potential	07/11/2018	Elk Township	Vehicle into Kinzua Reservoir
Potential	07/14/2018	Watson Township	Water rescue
Potential	07/15/2018	Mead Township	Boat collision
Potential	09/02/2018	Warren City	Water rescue on Allegheny River
Potential	10/27/2018	Brokenstraw Township	Water rescue
Potential	11/03/2018	Pleasant Township	Possible water rescue
Potential	11/26/2018	Pittsfield	Water rescue
Potential	05/18/2019	Warren City	Water rescue
Potential	08/17/2019	Limestone Township	Swimmer in distress

4.3.16.4 Future Occurrence

During the warm summer months, as activities such as swimming, boating, and fishing increase so does the likelihood of drowning. Based on past occurrence, Warren County can expect to experience one drowning every 2-3 years.

4.3.16.5 Vulnerability Assessment

As tourism continues to increase in the county and number of visitors grows, drowning is likely to continue without mitigation actions in place. On average, there are 3-4 drownings every 5 years in the Allegheny Reservoir alone.

4.3.17. Emergency Services

4.3.17.1 Location and Extent

Warren County subdivisions, townships, boroughs and cities, have assignment of services for their municipalities. Fire, emergency medical services (EMS), emergency management (EMA), and law enforcement service agencies are defined per municipality. In addition to the local services, the county hosts numerous special teams. These county-wide special response teams are for those specialty services like hazardous materials incidents, K9 search, incident command management and auxiliary communications services. Regional and state-wide services are also available.

The county's vast areas increase the travel time for responders to an incident. Most areas are served by volunteers instead of career personnel which can add response time due to the volunteer availability. Agencies do struggle with the availability of personnel depending on the time of day and skills/resources needed. The number of responders in general has decreased due to funding and retention of personnel issues.

4.3.17.2 Range of Magnitude

Finances, changing political climates, leadership, or a significant high-profile event can all trigger a system to be declared as "success" or a "failure". In some cases, a combination of these factors can create a perfect storm. Unfortunately, many "failed" systems are measured by recent events, no matter how successful they may have been in the past. Although financial problems are often blamed on poor leadership, they have many root causes. Labor rates, benefits, poor productivity, operational design, insurance reimbursements and market regulation all have a significant direct impact on the financial viability of an organization.

Two fundamental yet misunderstood topics are the financial and economic variables that drive emergency service systems. These systems typically generate revenue through tax subsidies, memberships, direct sales, diversification into other lines of business, grants or fundraising. They spend most of these revenues on direct and indirect labor and benefits, with the remaining dollars going to infrastructure, fuel, medical supplies, insurances, fleet maintenance, dispatch and other essential items with hopefully some left over for recapitalization or fund balance development.

4.3.17.3 Past Occurrence

Most agencies are private organizations that lack local funding and exist based on tax dollars, fund raisings and donations received from their community. The time demand for fund raising adds to the demands of the struggling availability of volunteers. Past practices are not sustaining the needed funds or manpower.

Without financial support from the community's services may not be able to remain in operation to serve the same communities they have served for decades. Recruitment and personnel retention are a key to success.

4.3.17.4 Future Occurrence

Volunteerism has been a significant component of the fire services. Most, if not all, members of our community fire departments are volunteers. Commonly a problem is recruitment and retention of volunteers to staff both fire and emergency medical services. There has been a decline in volunteerism due to the required training requirements for firefighters and emergency medical technicians (EMTs) in the region.

Today, it is difficult for small communities to have a paid service therefore requiring the use of volunteers. The trend has devastating effects. With fewer volunteers to perform the tasks associated with fires and rescue operations it is imperative to facilitate fundraising. If there are fewer volunteers to raise funds, then the operational needs are impacted as well. Without fundraising and community support these fire departments will experience broader challenges.

The individual volunteers also face many challenges. Most volunteers must address their own needs by providing for their family and, in many cases, are part of a two-income family. In some cases, they may have to have multiple jobs to sustain their needs. It requires hundreds of hours to become certified as a firefighter. With the limitation of time, most members of our society find it personally challenging to find the time to dedicate to a volunteer position. Volunteers are becoming less reliable. Many current volunteers are aging and unable to perform at the same levels they once were.

Fire departments perform many tasks, not just fighting fires. It would perhaps be more appropriate to call these departments "All Hazards Departments" as they respond to various hazards such as vehicle accidents, commercial accidents, flooded basements, wires down, trees down, trench rescues, hazardous material spills, traffic control and sometimes even standbys to support other agencies or events to name only a few.

4.3.17.5 Vulnerability Assessment

The likelihood that EMS agencies and fire services will fail is a real threat to our communities' safety. Many communities have already experienced the unfortunate failure of services. It is recommended that each municipality assess their own vulnerabilities by maintaining and building a relationship with their local providers to make the determination and begin to plan accordingly if a local service was to shut down its operation. The statistics, response times and all times associated with all units dispatched are easily obtainable from the local 911 centers.

These departments must be supported to create and or discover new ways to not only recruit but to also retain volunteers. If left unattended the issues will continue and the lack of response will grow, leaving the community more vulnerable to loss of life and loss of property.

It is recommended that the entire community be educated on the perpetual needs associated with providing these services. In addition, continued support and efforts to inform legislatures could all prove to be paramount in assuring these services remain in operation into the future. At the time of the writing of this plan, a flurry of bills had been introduced in both the House of Representatives and the Senate as a result of a two-year study initiated by Senate Resolution 6 (SR 6). The final report can be found here: http://pehsc.org/wp-content/uploads/2014/05/SR-6-REPORT-FINAL.pdf

Table 51 - Emergency Responders

Emergency Responders *(Warren County)*		
Municipality	**Station Name**	**Address**
Bear Lake Borough	Bear Lake Volunteer Fire Department	315 Center Street, Bear Lake, PA 16402
Cherry Grove Township	Cherry Grove Volunteer Fire Department	6045 Cherry Grove Road, Clarendon, PA 16313
Clarendon Borough	Clarendon Volunteer Fire Department	15 North Main Street – P.O. Box 268, Clarendon, PA 16313
Columbus Township	Columbus Volunteer Fire Department	5 West Main Street – P.O. Box 366, Columbus, PA 16405
Conewango Township	North Warren Volunteer Fire Department	12 South State Street, Warren, PA 16345
Eldred Township	Grand Valley Volunteer Fire Department	M12864 Route 27, Grand Valley, PA 16420
Freehold Township	Wrightsville Volunteer Fire Department	99 Boardman Street, Pittsfield, PA 16340
Glade Township	Glade Volunteer Fire Department	14 Hohman Road – P.O. Box 634, Warren, PA 16365
Pine Grove Township	Lander Volunteer Fire Department	4400 Miller Hill Road., Russell, PA 16345
Pine Grove Township	Russell Volunteer Fire Department	111 Perrigo Lane, Warren, PA 16365
Pine Grove Township	Scandia Volunteer Fire Department	5950 Scandia Road., Russell, PA 16345
Pittsfield Township	Garland Volunteer Fire Department	31 Bailey Lane – P.O. Box 101, Pittsfield, PA 16340
Pleasant Township	Pleasant Volunteer Fire Department	539 Pleasant Dr., Warren, PA 16365
Sheffield Township	Sheffield Volunteer Fire Department	318 South Main Street., Sheffield, PA 16347
Spring Creek Township	Spring Creek Township Volunteer Fire Department	6345 PA-426, Spring Creek, PA 16436
Sugar Grove Township	Sugar Grove Volunteer Fire Department	27 Wilson Street – P.O. Box 259, PA 16350
Tidioute Borough	Tidioute Volunteer Fire Department	224 Main Street – P.O. Box 122, Tidioute, PA 16351
Warren City	Star Brick Fire Department	5 Fireman Street., Warren, PA 16365
Warren City	Warren City Fire Department	318 Third Street, Warren, PA 16365
Youngsville Borough	Youngsville Volunteer Fire Department	29 Fireman Drive – P.O. Box 201, Youngsville, PA 16371

4.3.18. Environmental Hazards

4.3.18.1 Location and Extent

Environmental hazards in Warren County focus mainly on hazardous material releases at fixed facilities or due to transportation accidents, and pollution or fire from oil and gas well drilling. Hazardous material releases can occur at facilities or along transportation routes. These releases can result in injury and death and contaminate air, water, and soils. Activities associated with oil and gas well drilling, can cause fire and pollute streams and drinking water.

Fixed facility
Facilities that use, manufacture, or store hazardous materials in Pennsylvania must comply with both Title III of the federal Superfund Amendments and Reauthorization Act (SARA), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Commonwealth's reporting requirements under the Hazardous Materials Emergency Planning and Response Act (1990-165), as amended. The community right-to-know reporting requirements keep communities abreast of the presence and release of

chemicals at individual facilities. There are fifteen SARA Title III facilities in Warren County (Appendix D). Note that the list of SARA Title III facilities is not an exhaustive, fully-comprehensive inventory of all hazardous material locations within the county and therefore, should not be used as such.

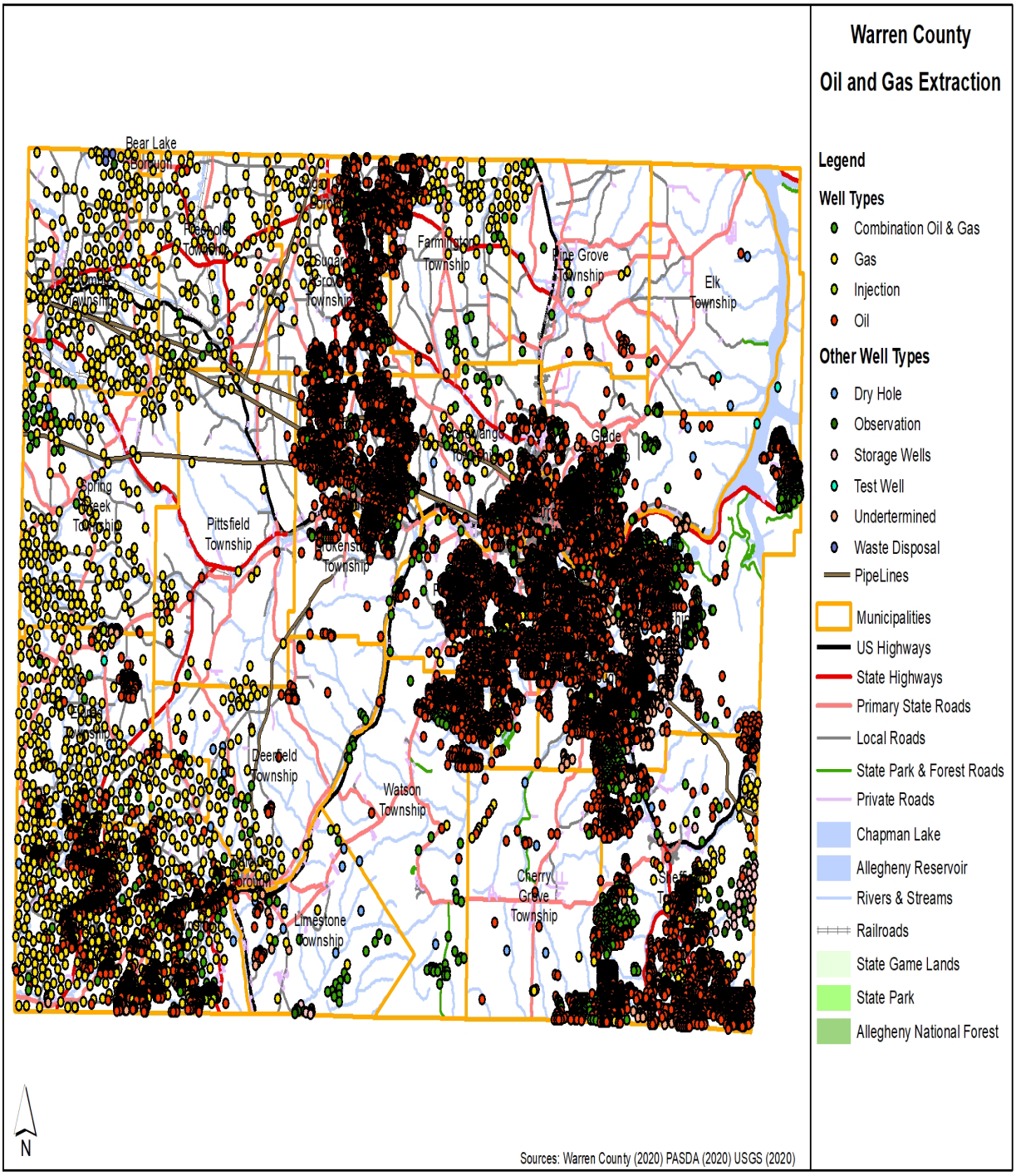
Transportation

The major highways most frequently used by facilities in Warren County to transport hazardous materials are US Routes 6 and 62, State Routes 27, 59, 69, 127, 200, 346, 426, 666, 948, 957, and 958. Potential also exists for a release to occur involving rail lines belonging to Norfolk Southern and CSX, or along the county's pipeline system (spanning four companies).

Oil and Gas Wells

Oil and gas wells exist in every municipality in Warren County. Most existing wells are active; however, clusters of abandoned oil and gas wells remain throughout the county. *Figure 50 – Oil and Gas Well Locations* shows the location of all active, inactive, and abandoned gas wells in the county and their proximity to surface waters.

Figure 50 – Oil and Gas Well Locations



4.3.18.2 Range of Magnitude

Hazardous material releases can contaminate air, water, and soil, with a possibly of resulting in injuries and/or death. Dispersion can take place rapidly when transported by water and wind. However, responders should not approach any problem with the "it's just water" mindset. Some chemicals have violent reactions to water, change their state of matter (physical or chemical), or float on or sink in water.

Fixed facility and Transportation

While often accidental, releases can occur because of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. Hazardous materials can include toxic chemicals, radioactive materials, infectious substances, and hazardous wastes. Such releases can affect nearby populations and contaminate critical or sensitive environmental areas.

With a hazardous material release, whether accidental or intentional, there are several potentially exacerbating or mitigating circumstances that 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 protects people and property from the harmful effects of a hazardous material release. Exacerbating conditions, characteristics that can enhance or magnify the effects of a hazardous material release include:

- Weather conditions affects how the hazard occurs and develops
- Micro-meteorological effects of buildings and terrain alters dispersion of hazardous materials
- Non-compliance with applicable codes (e.g. building or fire codes) and maintenance failures (e.g. fire protection and containment features) can substantially increase the damage to the facility itself and to surrounding buildings

The severity of the incident is dependent not only on the circumstances described above, but also with the type of material released and the distance and related response time for emergency response teams. The areas within closest proximity to the releases are generally at greatest risk, yet depending on the agent, a release can travel great distances or remain present in the environment for a long period of time (e.g. centuries to millennia for radioactive materials), resulting in extensive impacts on people and the environment.

Oil and Gas Wells

Oil and gas well drilling can have a variety of effects on the environment. Abandoned oil and gas wells, not properly plugged can contaminate groundwater and consequently drinking water wells. Surface waters and soil are sometimes polluted by brine, a salty wastewater product of oil and gas well drilling, and from oil spills occurring at the drilling site or from a pipeline breach. This can spoil public drinking water supplies and be particularly detrimental to vegetation and aquatic animals.

Natural gas well fires occur when natural gas is ignited at the well site. Often, these fires erupt during drilling when a spark from machinery or equipment ignites the gas. The initial explosion and resulting flames have the potential to seriously injure or kill individuals in the immediate area. These fires are often difficult to extinguish due to the intensity of the flame and the abundant fuel source.

In 2006 a fire broke out at a natural gas well 200 miles south of Warren County in Grindstone, Pennsylvania injuring six people. This is an extreme case and though rare, is an example of the risk involved with oil and gas well drilling.

4.3.18.3 Past Occurrence

Fixed facility

Since the passage of SARA, Title III facilities which produce, use, or store hazardous chemicals must notify the public through the county emergency dispatch center and PEMA if an accidental release of a hazardous substance meets or exceeds a designated reportable quantity, and affects or has the potential to affect persons and/or the environment outside the plant. SARA, Title III and Pennsylvania Act 165 also require a written follow-up report to PEMA and the county. These written follow-up reports include any known or anticipated health risks associated with the release and actions to be taken to mitigate potential future incidents. In addition, Section 204(a)(10) of Act 165 requires PEMA to staff and operate a 24-hour state emergency operations center (SEOC) to provide effective emergency response coordination.

Transportation

Hazardous materials can be transported by air, sea, and land (over the road or through pipelines). Transportation accidents along roadways is a regular occurrence (see Transportation Accidents hazard profile).

Oil and Gas Wells

Environmental incidents including water contamination and fire spurring from oil and gas well drilling have occurred numerous times in Pennsylvania over the past century. According to information obtained from Warren County EMA and Knowledge Center incidents for Warren County, two well fires were reported in the county between 2004 and 2015. The first incident, at a gas well, took place in Sheffield Township in January 2008. The second, at an oil well, took place in Glade Township in August 2009.

Table 52 – Hazardous Material Incidents for Warren County lists for all reported incidents to include fixed facilities, transportation, as well as oil and gas wells.

Table 52 – Hazardous Material Incidents for Warren County

Hazardous Material Incidents for Warren County		
DATE	**LOCATION/FACILITY**	**DESCRIPTION**
02/26/2004	United Refining Company	Oil release
03/03/2004	Mead Township	Petroleum product spill
03/18/2004	Mead Township	Gasoline spill
04/02/2004	Youngsville Borough	Diesel fuel spill
04/22/2004	United Refining Company	Spill
04/27/2004	City of Warren	Natural gas release
05/02/2004	United Refining Company	Oil spill – Allegheny River
05/15/2004	City of Warren	Petroleum product spill
05/22/2004	Conewango Township	Natural gas release
06/04/2004	Pine Grove Township	Petroleum spill

Hazardous Material Incidents for Warren County		
DATE	**LOCATION/FACILITY**	**DESCRIPTION**
07/19/2004	Mead Township	Fuel spill – roll over accident
08/25/2004	Youngsville Borough	Natural gas release
09/22/2004	Warren County	Oil spill in Conewango Creek
09/29/2004	Warren County	Natural gas release
10/10/2004	United Refining Company	Chemical release
10/31/2004	United Refining Company	Nitrogen dioxide release
12/28/2004	Glade Township	Crude oil spill
12/30/2004	Southwest Township	Petroleum product spill
01/08/2005	United Refining Company	Chemical release
02/05/2005	United Refining Company	Petroleum product spill
02/16/2005	Warren County.	Tractor trailer accident – muriatic
02/24/2005	Brokenstraw Township	Tractor trailer accident – diesel fuel
03/12/2005	Columbus Township	Tanker accident – petroleum spill
03/31/2005	United Refining Company	Chemical release
06/01/2005	OSRAM Sylvania	Oil sheen
06/30/2005	OSRAM Sylvania	Oil sheen
07/06/2005	Warren County.	Petroleum product spill
07/19/2005	United Refining Company	Chemical spill
07/21/2005	OSRAM Sylvania, Warren County	Hydraulic oil spill
07/26/2005	United Refining Co.	Glade Run – crude oil spill.
07/29/2005	Deerfield Township	Crude oil spill
08/02/2005	United Refining Company	Chemical release
09/10/2005	Tidioute Borough	Natural gas leak
10/24/2005	Mead Township	Diesel fuel spill
11/15/2005	Pine Grove Township	Diesel fuel spill
11/25/2005	Conewango Township	Natural gas release
03/09/2006	United Refining Company	SO2 and NO2 release

Hazardous Material Incidents for Warren County		
DATE	**LOCATION/FACILITY**	**DESCRIPTION**
07/12/2006	Warren County	Petroleum product spill
08/29/2006	United Refining Company	Natural phenomenon
07/07/2007	Mead Township	Crude oil spill
08/07/2007	Mead Township	Diesel fuel spill – auto accident
12/04/2007	Crossett Industries	Diesel tanker rollover
01/22/2008	United Refining Company	Chemical release
01/28/2008	Sheffield Township	Well fire – hornburg drilling
01/28/2008	Conewango Township	Propane release
02/17/2008	Tidioute Borough	Carbon monoxide release
05/20/2008	Sheffield Land & Timber Company	Oil sheen
07/24/2008	Limestone Township	Diesel fuel spill – auto accident
10/14/2008	Pittsfield Township	Accident rollover
03/10/2009	Sheffield Township	Natural gas leak
07/09/2009	Warren City	Asphalt spill
08/09/2009	Freehold Township	Gas leak
08/10/2009	Glade Township	Oil well fire
08/26/2009	Glade Township	Natural gas leak with illness
08/31/2009	Warren City	Gas leak
09/24/2009	Brokenstraw Township	Crude oil leak
01/17/2010	Limestone Township	Gas leak/odor investigation with illness
03/13/2010	Brokenstraw Township	Crude oil leak
03/30/2010	Warren City	Natural gas leak in a structure
04/07/2010	Tidioute Borough	Gas leak
04/30/2010	Youngsville Borough	Gas leak
05/26/2010	Eldred Township	Fuel spill
12/10/2010	Conewango Township	Natural gas leak
12/23/2010	Pleasant Township	Oil well leak

Hazardous Material Incidents for Warren County		
DATE	**LOCATION/FACILITY**	**DESCRIPTION**
03/08/2010	Conewango Township	Propane leak
08/05/2011	Warren City	Gas leak
08/24/2011	Conewango Township	Natural gas leak
09/28/2011	Warren City	Unknown gas leak
09/29/2011	Warren City	Natural gas leak
11/05/2011	Mead Township	Fuel oil/diesel spill on RT 59
11/19/2011	Sheffield Township	Residential gas leak
11/21/2011	Columbus Township	Accident with gas main leak
12/20/2011	Conewango Township	Accident with diesel fuel spill
01/04/2012	Warren City	Natural gas leak - Cambridge
01/10/2012	Clarendon Borough	Odor investigation
04/15/2012	Deerfield Township	Kerosene leak
07/30/2012	Mead Township	Oil leak
11/17/2012	Sheffield Township	Natural gas leak
07/15/2013	Conewango Township	Odor investigation at Riverview Terrace
07/31/2013	Warren City	Hand grenade found
10/23/2013	Elk Township	LPG leak
10/26/2013	Clarendon Borough	Carbon monoxide exposure
12/04/2013	South of Tidioute on SR 62	Fuel spill into Allegheny River
12/17/2013	Brokenstraw Township	Accident with hazardous materials
02/24/2014	Warren City	Oil spill
03/12/2014	Brokenstraw Township	Tank explosion
04/02/2014	Warren City	Accident with natural gas line struck
04/14/2014	Warren City	NRC# 1079694
04/21/2014	Glade Township	Asphalt tanker rollover
04/29/2014	Warren City	Strong odor investigation
05/13/2014	Warren City	Accident with high pressure gas line struck

Hazardous Material Incidents for Warren County		
DATE	**LOCATION/FACILITY**	**DESCRIPTION**
09/17/2014	Glade Township	Odor investigation
09/27/2014	Warren City	Oil sheen
11/05/2014	Warren City	Natural gas leak
01/01/2015	Warren City	Well incident
01/29/2015	Conewango Township	Leaking gas well
02/17/2015	Warren City	Natural gas leak
04/07/2015	United Refining Company	Oil sheen on river
06/01/2015	Mead Township	Asphalt tanker rollover
06/19/2015	Elk Township	Oil and gas spill
11/09/2015	Eldred Township	Construction foam fire
12/03/2015	Sheffield Township	Possible gas leak
05/14/2016	Limestone Township	Natural gas line leaking
05/31/2016	Warren County	Diesel fuel spill
06/20/2016	Glade Township	Gas line rupture on Scandia Road
08/01/2016	Warren County	Residential gas leak
08/25/2016	Warren County	Unknown type of spill
10/13/2016	Brokenstraw Township	Possible explosive substance found
10/31/2016	Warren City	Sulfur dioxide release
11/29/2016	Warren County	Meth lab
12/13/2016	Warren County	Gasoline spill
02/14/2017	Warren County	Gas leak
02/13/2017	Brokenstraw Township	Tanker rollover with gasoline leaking
04/10/2017	Brokenstraw Township	NRC#1175303 unknown material release
04/16/2017	Warren County	Residential gas leak
05/31/2017	Warren County	Natural gas odor investigation
06/07/2017	Warren County	Vehicle accident with a gas leak
07/11/2017	Brokenstraw Township	NRC #1183939

Hazardous Material Incidents for Warren County		
DATE	**LOCATION/FACILITY**	**DESCRIPTION**
07/17/2017	Warren City	Chemical release
09/22/2017	Pittsfield Township	Unauthorized access to an ammonia tank
10/04/2017	Pine Grove Township	Gas line struck
02/05/2018	Brokenstraw Township	Tanker rollover
03/15/2018	Warren City	Flaring activity
04/18/2018	Warren City	Gas leak
04/22/2018	Warren City	Chemical release
06/05/2018	Mead Township	NRC #1214351 Hydraulic oil spill
06/10/2018	Warren City	Asphalt spill
06/28/2018	Columbus Township	Ruptured gas line
07/05/2018	Warren City	Oil sheen on river
07/16/2018	Youngsville Borough	Gas leak
10/03/2018	Brokenstraw Township	Anhydrous ammonia release
10/30/2018	Warren City	CO alarm
01/24/2019	Warren City	SO2 release at refinery
01/26/2019	Pine Grove Township	Gasoline tanker fire
03/16/2019	Warren City	Hazardous materials release
03/18/2019	Warren City	Flaring operation
04/14/2019	Brokenstraw Township	Fuel tanker leak
04/14/2019	Conewango Township	Gas leak with evacuation
05/02/2019	Sheffield Township	Fuel spill
06/20/2019	Conewango Township	Oil well leak
07/29/2019	Mead Township	Gasoline tanker fire
08/18/2019	Warren City	Petroleum plant issue
09/10/2019	Mead Township	Gray substance in creek
09/30/2019	Brokenstraw Township	Gas leak
10/31/2019	Conewango Township	Fuel spill

Hazardous Material Incidents for Warren County		
DATE	**LOCATION/FACILITY**	**DESCRIPTION**
12/14/2019	Warren County	Oil on river
02/10/2020	Warren City	NRC #1270849 Clarified Oil release
02/27/2020	Sheffield Township	NRC #1272242 Crude oil discharge
04/08/2020	Warren City	Sulfur dioxide release
04/20/2020	Warren City	Air borne release
05/29/2020	Warren City	Sulfur dioxide release
2004-2008 (WCDPS, 2009) 2009-2020 (Corvena formerly Knowledge Center™)		

4.3.18.4 Future Occurrence

Fixed facility and Transportation

While many incidents involving hazardous material release have occurred in Warren County in the past, they are generally considered difficult to predict. An occurrence is largely dependent upon the accidental or intentional actions of a person or group.

Oil and Gas Wells
It is difficult to predict when and where environmental hazards will arise. Stringent monitoring through the Pennsylvania Department of Environmental Protection will reduce the likelihood of potential impacts to the community and the environment. Incidents involving oil and gas well drilling are expected to remain relatively low.

4.3.18.5 Vulnerability Assessment

Fixed facility

One or more SARA Title III facilities exist in Brokenstraw Township, Clarendon Borough, Conewango Township, Pittsfield Township, Sheffield Township, Tidioute Borough, and the City of Warren. Populations in and around these communities are more vulnerable to facility releases particularly those within ¼ miles of the facility. Appendix D lists the number of addressable structures within a ¼ mile buffer of each SARA III facility. There is a total of 279 addressable structures within the buffer of all SARA III facilities in the county.

Transportation

Quick response to transportation accidents involving hazardous materials minimizes the volume and concentration dispersed through air, water, and soil.

Oil and Gas Wells
Every municipality in Warren County is vulnerable on some level, directly or indirectly, to environmental hazards resulting from oil and gas well activity. Surface waters closest to well sites are most vulnerable to

damage (*Table 54 – Oil and Gas Wells*); and oil and gas industry workers are most likely to be affected by gas well fires.

Private water supplies such as domestic drinking water wells in the vicinity of oil and gas wells are at risk of contamination from brine and other pollutants including methane which can pose a fire and explosive hazard. Ideally vulnerability of private drinking well owners would be established by comparing distance of drinking water well to known oil and gas well locations, but this data is not available at this time. Private drinking water is largely unregulated and information on these wells is submitted to the Pennsylvania Topographic and Geologic Survey by water well drillers. Therefore, the existing data is largely incomplete and/or inaccurate (PaGWIS).

Pennsylvania Department of Environmental Protection manages oil and gas wells drilled. *Table 53 – Drilled Oil and Gas Wells* lists the number of wells drilled in Warren County per year between 2000 and August 7, 2020.

Table 53 – Drilled Oil and Gas Wells

Drilled Oil and Gas Wells		
Year	**Conventional**	**Unconventional**
2000	159	0
2001	171	0
2002	142	0
2003	201	0
2004	170	0
2005	255	0
2006	325	0
2007	466	0
2008	365	0
2009	222	0
2010	218	0
2011	252	1
2012	371	1
2013	304	1
2014	223	0
2015	107	0
2016	50	0
2017	40	0
2018	71	0
2019	100	0
2020*	11	0

*2020 is recorded from January 1, 2020 to August 7, 2020

In 2007 the most oil and gas wells were drilled in Warren County, with 466 conventional wells; and (not counting 2020) in 2017 the least amount was drilled, with a total of forty. Three unconventional wells were drilled between 2011 and 2013 with one for each year.

Table 54 – Oil and Gas Wells

MUNICIPALITY	OIL AND GAS WELLS			
	ACTIVE	ABANDONED and ORPHAN	PLUGGED or INACTIVE	PROPOSED
Bear Lake Borough	2	1	0	0
Brokenstraw Township	1,960	82	748	225
Cherry Grove Township	196	10	44	46
Clarendon Borough	31	4	26	0
Columbus Township	178	8	37	18
Conewango Township	943	8	143	37
Deerfield Township	152	12	45	14
Eldred Township	605	74	867	34
Elk Township	26	7	4	2
Farmington Township	628	2	20	27
Freehold Township	128	4	17	10
Glade Township	1,196	74	279	43
Limestone Township	179	38	33	37
Mead Township	3,437	792	1,019	184
Pine Grove Township	46	5	7	2
Pittsfield Township	68	5	13	1
Pleasant Township	2,118	55	199	170
Sheffield Township	2,030	90	351	119
Southwest Township	696	275	2,321	89
Spring Creek Township	189	19	21	65
Sugar Grove Borough	33	0	6	9
Sugar Grove Township	2,155	29	130	312
Tidioute Borough	6	3	1	0
Triumph Township	904	144	532	39
City of Warren	142	17	86	29

MUNICIPALITY	OIL AND GAS WELLS			
	ACTIVE	ABANDONED and ORPHAN	PLUGGED or INACTIVE	PROPOSED
Watson Township	848	8	39	117
Youngsville Borough	41	5	34	5
Total	**18,937**	**1,771**	**7,021**	**1,634**

4.3.19. Substance Abuse

4.3.19.1 Location and Extent

Pennsylvania and the nation at large have been experiencing an epidemic of opioid drug abuse. Opioids are a class of drugs that interact with receptors on nerve cells in the body and brain, producing euphoria and pain relief (NIH, 2017). Opioid drugs are highly addictive, and the Commonwealth and country at large have been experiencing an epidemic of opioid addiction and abuse, resulting in increasing numbers of over-dose deaths from both prescribed (e.g. fentanyl) and illicit (e.g. heroine) opioids. Overdose deaths from opioids occur when a large dose slows breathing, which can be especially likely when opioids are combined with alcohol or antianxiety drugs. While generally prescribed with good intentions, opioids can often be over-prescribed, resulting in addiction due to their highly addictive nature.

While other addictive substances such as methamphetamines and alcohol can be problematic for the health of individuals and the community in Warren County, this profile focuses on opioid drugs and the opioid epidemic.

The opioid crisis was declared to be a public health emergency on October 26, 2017. While the declaration provides validation for the scope and severity of the problem, it was not accompanied by any release of funding for mitigating actions. On January 10, 2018, Governor Wolf declared the opioid epidemic to be a statewide public health disaster emergency for Pennsylvania. The declaration is intended to enhance re-sponse and increase access to treatment.

4.3.19.2 Range of Magnitude

According to the CDC, more than 192 Americans die every day from an opioid overdose. In 2014, 2,732 overdose deaths were reported across Pennsylvania. This number increased to 3,264 reported overdose deaths in 2015, an increase of 19.5% (DEA, 2015). Reported overdose deaths increased again in 2016 to 4,627, an increase of 41.7% from 2015 (DEA & PITT, 2017), then again to a total of 5,388 deaths in 2017. From 2015 to 2017, the increase in reported drug related overdose deaths in Pennsylvania increased 65%. This increase gave rise to the need for the gubernatorial disaster declaration in Pennsylvania that was made on January 10, 2018. Heroin and Fentanyl are the two drugs most often found in overdose deaths, and they are considered highly available and nearly ubiquitous in Pennsylvania (DEA & PITT, 2018).

4.3.19.3 Past Occurrence

In 2017, there were a total of 5,456 drug-related overdose deaths in the Pennsylvania. According to a report prepared by the Drug Enforcement Administration (DEA), Warren County experienced zero overdose deaths in 2016 with a slight increase of six drug-related overdose deaths in 2017.

In 2017, the national average of drug related overdose deaths was twenty-two deaths per 100,000 people. The death rate in Pennsylvania is nearly double this national average, at almost forty-three deaths per

100,000 people. Warren County drug-related overdose statistics from 2018 to current were incomplete during the update process. From 2014 to 2019, there has been a significant increase in the abuse of Fentanyl in Pennsylvania. Fentanyl is the most prevalent opioid drug trafficked, abused and overdosed on in Pennsylvania, and is found in seventy percent of overdose victims in 2018 in Pennsylvania (see *Table 55 – Drugs Present in 2018 PA Overdose Deaths*).

Table 55 – Drugs Present in 2018 PA Overdose Deaths

Drugs Present in 2018 PA Overdose Deaths *(DEA & Pitt, 2018)*	
Drug Category	**Percent Reported Among 2018 Decedents**
Fentanyl	70%
Heroin	35%
Cocaine	33%
Benzodiazepines	28%
Prescription Opioids	23%
Ethanol	18%
FRSs & NPSO	18%
Other Illicit Drugs	14%

4.3.19.4 Future Occurrence

In the event of an opioid overdose, death can sometimes be prevented with the use of the drug naloxone. Emergency medical responders have access to the treatment, and as of 2015, naloxone is available without a prescription in Pennsylvania. Furthermore, with the January 10, 2018 disaster declaration, emergency medical technicians (EMTs) are now allowed to leave naloxone behind at a scene, further increasing distribution and accessibility of this lifesaving medication. According to a study published in September 2018, drug users reported that users often have multiple overdoses in the course of their drug use, and the availability of naloxone has saved many lives (DEA & PITT, 2018). While the introduction of naloxone has been a significant benefit to the fight against opioid abuse, efforts to prevent overdoses are still underway.

Rather than reduce pain, in some cases high doses of opioid painkillers can actually increase pain due to a phenomenon known as opioid-induced hyperalgesia (OIH). It is difficult to know how much of an influence OIH has on the opioid epidemic. Some researchers think that OIH could be increasing patients' pain and in turn, increasing their dosages and dependence on opioid drugs, suggesting that patients should work with lower dosages of opioids (Servick, 2016). However, other researchers are unsure of the importance of OIH for opioid users (Servick, 2016).

Opioid drugs have been a problematic and addictive solution for patients to deal with pain. Employing alternative approaches to pain management could prevent patients from ever being introduced to addictive opioids, especially considering the most common overdose drug in Warren County has been prescription opioids (DEA & PITT, 2018). A possible alternative pain treatment comes from hemp extracted cannabidiol, or CBD. Unlike THC (the psychoactive constituent of cannabis) CBD is non-psychoactive and does not have the same intoxicating effect as THC; however, CBD can provide relief from pain (Lynch & Campbell, 2011), inflammation (Burstein, 2015), anxiety (Scuderi et al., 2009) and even psychosis (Iseger & Bossong, 2015). CBD is legal without a prescription throughout the United States of America.

4.3.19.5 Vulnerability Assessment

Deaths from prescription opioid drugs like oxycodone, hydrocodone, and methadone have increased more than four-fold since 1999. Opioid overdoses have resulted in many tragic deaths in Pennsylvania and most people have been affected by the epidemic through the loss of either a family member, close friend, or member of their community. Opioid addiction is a direct detriment to the personal wellbeing of addicts, a burden to their families and communities, and a strain to the emergency response system that cares for overdose victims.

While opioid addiction is often viewed as a criminal problem, a more productive way to view the epidemic can be to view opioid addiction as a chronic disease. This paradigm shift moves away from faulting the abuser and incentivizing quick cures, to viewing the abuser as a patient and working towards long-term management of the disease (ASAM, 2014). In general, it is important to consider alternative approaches to pain treatment in order to avoid beginning a dependence on highly addictive prescribed opioids.

There have been several reports nationally of first responders accidentally overdosing on fentanyl or carfentanyl through brief skin contact or the drug becoming airborne. It is best for first responders to err on the side of caution to avoid any potential exposure. The American College of Medical Toxicology (ACMT) and the American Academy of Clinical Toxicology (AACT) suggest that nitrile gloves provide sufficient protection for handling of fentanyl, and for "exceptional circumstances where the drug particles or droplets suspended in the air, an N95 respirator provides sufficient protection" (Moss et al., 2017). Their official position paper suggests that "the risk of clinically significant exposure to emergency responders is extremely low" (Moss et al., 2017).

4.3.20. Terrorism

4.3.20.1 Location and Extent

Following several serious international and domestic terrorist incidents during the 1990's and early 2000's, citizens across the United States paid increased attention to the potential for deliberate, harmful actions of individuals or groups. The term "terrorism" refers to intentional, criminal, malicious acts. The functional definition of terrorism can be interpreted in many ways. Officially, terrorism is defined in the Code of Federal Regulations as "*...the unlawful use of force and violence against persons or property to intimidate or coerce a government, the civilian population, or any segment thereof, in furtherance of political or social objectives*." (28 CFR §0.85)

The Federal Bureau of Investigation (FBI) further characterizes terrorism as either domestic or international, depending on the origin, base, and objectives of the terrorist organization. Often, the origin of the terrorist or person causing the hazard is far less relevant to mitigation planning than the hazard itself and its consequences. However, it is important to consider that the prevalence of Homegrown Violent Extremists (HVEs) has increased in recent years, with individuals able to become radicalized on the internet. In a speech on August 29, 2018 addressed to the 11th annual Utah National Security and Anti-Terrorism Conference, FBI Director Christopher Wray describes HVEs as "the primary terrorist threat to the homeland here today, without question."

Critical facilities are either in the public or private sector that provide essential products and/or services to the general public. Critical facilities are often necessary to preserve the welfare and quality of life in the county, or fulfill important public safety, emergency response, and/or disaster recovery functions. Critical facilities identified in the county are shelters, gas, electric and communication utilities, hospitals and other health care facilities, water and wastewater treatment plants, hazardous waste sites, and schools.

In addition to critical facilities, the county contains at risk populations that should be factored into a vulnerability assessment. These populations include not only the residents and workforce in the county, but

also the tourists that visit the area on a daily basis, those that are traveling through the county on any of the major highways and marginalized groups such as LGBTQ persons and racial minorities. Potential targets for attack include:

- Commercial facilities
- Abortion or Family Planning Clinics and other organizations associated with controversial issues
- Education facilities
- Events attracting large amounts of people
- Places of worship
- Industrial facilities, especially those utilizing large quantities of hazardous materials
- Transportation infrastructure
- Historical sites;
- Government Facilities

4.3.20.2 Range of Magnitude

Terrorism may include use of Weapons of Mass Destruction (WMD) (including biological, chemical, explosive, nuclear, and radiological weapons) of arson, incendiary, explosive, armed attacks, industrial sabotage, intentional hazardous materials releases, and cyber-terrorism. Within these general categories, there are many variations. There is a wide variety of agents and ways for them to be disseminated, particularly in the case of biological and chemical weapons. Terrorist methods can take many forms, including:

- Active assailant
- Agri-terrorism
- Arson/incendiary attack
- Armed attack
- Assassination
- Biological agent
- Chemical agent
- Cyber-terrorism
- Conventional bomb or bomb threat
- Hijackings
- Hazardous material release (intentional)
- Kidnapping
- Nuclear bomb
- Radiological agent

The rural areas of Warren County are most susceptible to disruptive actions like active assailant threats and transportation incidents.

Active assailant incidents and threats can disrupt the learning atmosphere in schools, interfere with worship services, cause traffic to be re-routed, and uses taxpayer assets from deploying police, EMS and/or fire units. Warren County has one school district (per Public Schools K12) and three institutions of higher learning throughout the county.

The areas along major transportation routes can be susceptible to forms of public transit terrorist attacks. More populated areas of the county, including the county seat of Warren, can be susceptible to chemical, biological, radiological, nuclear or explosive (CBRNE) events due to the concentration and density of residential communities and government activity and buildings. Secondary effects from CBRNE incidents can be damaging as well. Mass evacuations could result in congestion of roadways and possibly result in

breakdown of civil order, further exacerbating the situation. Government operations may be disrupted due to the need to displace or operate under reduced capacity. Radiation fallout, hazardous chemical introduction into the groundwater, or biologic/germ agents can cause long-term environmental damage.

Cyber terrorism is becoming increasingly prevalent. Cyber terrorism can be defined as activities intended to damage or disrupt vital computer systems. These acts can range from taking control of a host website to using networked resources to directly cause destruction and harm. Protection of databases and infrastructure are the main goals for a safe cyber environment. Cyber terrorists can be difficult to identify because the internet provides a meeting place for individuals from various parts of the world. Individuals or groups planning a cyber-attack are not organized in a traditional manner, as they are able to effectively communicate over long distances without delay. The largest threat to institutions from cyber terrorism comes from any processes that are networked and controlled via computer. Any vulnerability that could allow access to sensitive data or processes should be addressed and any possible measures taken to harden those resources to attack.

4.3.20.3 Past Occurrence

An active assailant (shooter), as defined by the US Department of Homeland Security, is an individual actively engaged in killing or attempting to kill people in a confined area; in most cases, active shooters use firearms and there is not necessarily a pattern or method to their selection of victims. Throughout the year in 2019, there were a total of 417 mass shooting incidents in the United States according to the non-profit www.GunViolenceArchive.org. Often these shooters are homegrown violent extremists (HVE). Two significant events have occurred in Pennsylvania in recent history: one happened on October 27, 2018, when eleven people were killed by a gunman in the Pittsburgh neighborhood of Squirrel Hill; the gunman (an HVE) attacked the congregation at the *Tree of Life* Synagogue in a shooting that targeted the Jewish population and was fueled by the gunman's anti-Semitic, anti-immigrant, and anti-refugee sentiments; and, in January 2019, a gunman killed two people and permanently injured one inside P.J. Harrigan's bar in State College and later killed a homeowner and himself.

A few other significant active shooter events include those that occurred at Virginia Tech (April 2007), Sandy Hook elementary School (December 2012), San Bernardino, California (December 2015), an Aurora, Colorado movie theater (July 2012) and a church in Charleston, South Carolina (June 2015). A 2014 study by the FBI concluded that there has been a significant recent increase in frequency of active shooter incidents, and the vast majority (154 of 160 shooters between 2000 and 2013) were male (FBI, 2014). Of these 160 incidents, 45.6% took place in commercial environments, 24.3% took place in an educational environment, and the remaining 30.1% took place at other locations such as open spaces, military and other government properties, residential locations, houses of worship, and health care facilities (FBI, 2014). *Figure 51 - Active Shooter Incidents 2000-2018* summarizes the FBI's findings in the study.

Significant international terrorism incidents in the USA include: the World Trade Center bombing in 1993, the bombing of the Murrow Building in Oklahoma City in 1995, and the September 11, 2001 attacks on the World Trade Center and The Pentagon. One of the aircrafts hijacked in the September 11, 2001 attack crash landed in Somerset County, Pennsylvania before it reached its intended target. While fatalities and destruction at the intended target were avoided, all passengers on the flight perished.

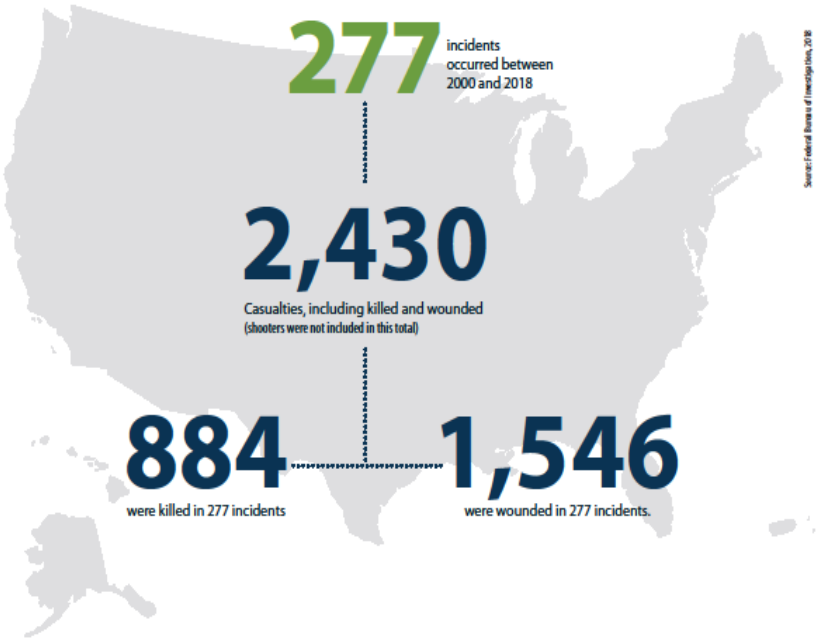
While the largest scale terrorist incidents have often had international stimuli, many other incidents are caused by home grown actors who may have become radicalized through hate groups either in real life or via the internet, and who may struggle with mental health issues. Hate groups such as the Ku Klux Klan (KKK), Aryan Nation and, more recently, the Alt-Reich have been a part of domestic terrorism in different forms.

Knowledge Center reports of terrorist activity in Warren County as of January 2020 can be found in *Table 56 - Terrorist Activity History*; however, these incidents are not all inclusive of the history of terrorism nor are they necessarily real terrorism as defined by the FBI. Entries vary due to the recorder's selection of category and description.

Table 56 - Terrorist Activity History

Terrorist Activity History ***(Knowledge Center, 2020)***		
Title	**Location**	**Date**
Earth Liberation Front Fire-bombing	Allegheny National Forest	02/11/2002
Bomb Threat on School	Youngsville Borough	03/28/2008
Riot at Warren State Hospital	Conewango Township	04/18/2008
Bomb Threat	Warren City	07/10/2009
Bomb Threat on Beatty Middle School	Warren	01/17/2012
Suspicious Device Found	Warren City	10/07/2012
Suspicious Package	Youngsville Borough	10/08/2014

Figure 51 - Active Shooter Incidents 2000-2018 (FBI, 2019)



4.3.20.4 Future Occurrence

The likelihood of Warren County being a primary target for a major international terrorist attack is somewhat small. More likely terrorist activity in Warren County includes bomb threats or other incidents at schools. Warren County has one school district consisting of nine public schools and three institutions of higher education. Despite the lack of recent events reported in *Table 56 - Terrorist Activity History,* bomb threats at schools are typically experienced at least once a year across the county.

4.3.20.5 Vulnerability Assessment

Warren County should stay prepared to terrorism type incidents. With the existence of industrial commerce, interstate highways and freight railroad activity create soft targets that could be used to interfere with the focus of day to day life that the county enjoys. It is important to note that the use and exposure to biological agents can remain unknown for several days until the infected person(s), livestock, or crops begin to experience symptoms or show damages. Often such agents are contagious, and the infected persons must be quarantined, livestock culled, and/or crops destroyed.

The probability of terrorist activity is more difficult to quantify than some other hazards. Instead of considering likelihood of occurrence, vulnerability is assessed in terms of specific assets. By identifying potentially at-risk terrorist targets in a community, planning efforts can be put in place to reduce the risk of attack. Planning should work towards identifying potentially at-risk critical facilities and systems in the community, prioritizing those assets and locations, and identifying their vulnerabilities relative to known potential threats.

All communities in Warren County are vulnerable on some level, directly or indirectly, to a terrorist attack. However, communities with schools and government infrastructure like the county seat of Warren City should be considered more likely to attract terrorist activity.

Site-specific assessments should be based on the relative importance of a particular site to the surrounding community or population, threats that are known to exist, and vulnerabilities, including:

Inherent vulnerability:

- Visibility – How aware is the public of the existence of the facility?
- Utility – How valuable might the place be in meeting the objectives of a potential terrorist?
- Accessibility – How accessible is the place to the public?
- Asset mobility – is the asset's location fixed or mobile?
- Presence of hazardous materials – Are flammable, explosive, biological, chemical, and/or radiological materials present on site? If so, are they well secured?
- Potential for collateral damage – What are the potential consequences for the surrounding area if the asset is attacked or damaged?
- Occupancy – What is the potential for mass casualties based on the maximum number of individuals on-site at a given time?

Tactical vulnerability:

Site Perimeter:

- Site planning and Landscape Design – Is the facility designed with security in mind – both site-specific and with regard to adjacent land uses?
- Parking Security – Are vehicle access and parking managed in a way that separates vehicles and structures?

Building Envelope:

- Structural Engineering – Is the building's envelope designed to be blast-resistant? Does it provide collective protection against chemical, biological, and radiological contaminants?

Facility Interior:

- Architectural and Interior Space Planning – Does security screening cover all public and private areas?

- Mechanical Engineering – Are utilities and HVAC systems protected and/or backed up with redundant systems?
- Electrical Engineering – Are emergency power and telecommunications available? Are alarm systems operational? Is lighting sufficient?
- Fire Protection Engineering – Are the building's water supply and fire suppression systems adequate, code-compliant, and protected? Are on-site personnel trained appropriately? Are local first responders aware of the nature of the operations at the facility?
- Electronic and Organized Security – Are systems and personnel in place to monitor and protect the facility?

4.3.21. Transportation Accidents

4.3.21.1 Location and Extent

For the purposes of this plan, transportation accidents are defined as incidents involving highway, air, and rail travel. With transportation routes available all over Pennsylvania, every county, including Warren, in the Commonwealth is susceptible to this hazard. There are over 530 miles of state highways, 600 miles of secondary and municipal roads, 260 state-owned bridges and fifty-nine locally owned bridges in Warren County. The major transportation networks include US Routes 6 and 62, State Routes 27, 59, 69, 127, 200, 346, 426, 666, 948, 957, and 958. *Figure 3 – Warren County Base Map* shows the location of US, State routes, and local roads.

There are no public airports in Warren County, but there are private airports and one heliport:

- Brokenstraw Airport, Pittsfield Township
- Rigrtona Airport, Tidioute Borough
- Emery Mahan Airport, Conewango Township
- Nichols Airport, Eldred Township
- Saunders Airport, Sugar Grove Township
- Scandia Airpark, Elk Township
- Warren General Hospital Heliport, City of Warren

Railroads within Warren County consist of Norfolk Southern and CSX; with a railcar repair facility in the City of Warren.

4.3.21.2 Range of Magnitude

Significant transportation accidents can result in death or serious injury or extensive property loss or damage. Road and railway accidents have the potential to result in hazardous materials release as well (see Section 4.3.18).

Potential environmental impacts from traffic accidents include:

- Accidents involving hazardous materials could pose air, water and/or soil contamination.
- Accidents involving electric lines could pose wildfires and/or structure fires.

A five-mile radius around each airport can be considered a high-risk area since most aviation incidents occur near landing or take-off sites.

4.3.21.3 Past Occurrence

The most common transportation accidents in the county involve highway incidents involving motor vehicles. The county's most serious transportation concerns involve US Routes 6 and 62, and PA Routes 27, and 59. Hazardous material spills are the most common secondary effect of transportation accidents.

Table 57 - Transportation Accidents identifies transportation accidents reported in Corvena/Knowledge Center™ for Warren County between January 2010 and May 31, 2020.

Table 57 - Transportation Accidents (Corvena/Knowledge Center™)

Date	Event	Location
01/11/2010	Motor vehicle accident- police car backed into during a traffic stop	Unknown location
01/26/2010	Motor vehicle accident	Pittsfield Township
01/26/2010	Vehicle rollover with fatality	Pine Grove Township
02/05/2010	Motor vehicle accident	Conewango Township
02/12/2010	Multi-vehicle accident with fatality	Unknown location
03/05/2010	Motor vehicle accident with road closure	Mead Township
05/09/2010	ATV accident	Southwest Township
05/13/2010	Motor vehicle accident – car and school bus	Conewango Township
05/26/2010	Motor vehicle accident – rollover with entrapment and ejection	Deerfield Township
06/23/2010	Motor vehicle accident	Brokenstraw Township
08/08/2010	Motor vehicle accident with rollover	Mead Township
08/08/2010	Motor vehicle accident – rollover and entrapment	Freehold Township
09/05/2010	Motor vehicle accident	Conewango Township
09/10/2010	Motor vehicle accident with entrapment	Mead Township
10/10/2010	ATV accident	Eldred Township
10/11/2010	Rollover of a semi	Mead Township
10/19/2010	Motorcycle accident	Conewango Township
11/09/2010	Tractor trailer accident	Eldred Township
12/22/2010	Officer involved in a motor vehicle accident	Brokenstraw Township
12/30/2010	Motor vehicle accident with entrapment	Conewango Township
01/04/2011	Motor vehicle accident with entrapment	Conewango Township
01/15/2011	Motor vehicle accident	Bear Lake Borough
02/03/2011	Motor vehicle accident	Pittsfield Township
02/05/2011	Multiple motor vehicle accident RT 62 south closed	Triumph Township
02/25/2011	Traffic accident	Pine Grove Township
03/04/2011	Motor vehicle accident with school bus involved	Warren City
03/09/2011	Motor vehicle accident Rt 426 closed	Columbus Township
03/13/2011	Motor vehicle accident with fire and entrapment	Mead Township
05/20/2011	Motor vehicle accident	Conewango Township
09/19/2011	Motor vehicle accident	Glade Township
11/12/2011	Motor vehicle accident	Brokenstraw Township
11/14/2011	Motor vehicle accident	Youngsville Borough
11/17/2011	Motor vehicle accident Rt 957	Columbus Township
11/21/2011	Motor vehicle accident with gas main leak	Columbus Township
12/03/2011	Motor vehicle accident with entrapment	Sugar Grove Borough
12/05/2011	Motor vehicle accident County Transit Bus	Pleasant Township
12/14/2011	Motor vehicle accident South Main Street, Russell	Pine Grove Township
12/20/2011	Motor vehicle accident – diesel fuel spill	Conewango Township
12/28/2011	Motor vehicle accident –rollover	Pine Grove Township
01/10/2012	Motor vehicle accident Rt 426 closed	Spring Creek Township
02/12/2012	Motor vehicle accident with water rescue	Freehold Township
03/18/2012	Motor vehicle accident Rt 27 Garland	Pittsfield Township
06/18/2012	Motor vehicle accident with rollover	Pittsfield Township

Date	Event	Location
10/11/2012	Motor vehicle accident with entrapment, multiple pts	Farmington Township
10/18/2012	Motor vehicle accident	Pittsfield Township
10/30/2012	Tractor trailer accident	Eldred Township
12/20/2012	School Bus accident	Conewango Township
12/27/2012	Tractor trailer vs. car accident	Pine Grove Township
01/09/2013	Log truck rollover	Pittsfield Township
03/25/2013	Motor vehicle accident with entrapment	Limestone Township
05/21/2013	Motor vehicle accident	Sugar Grove Township
06/24/2013	Motor-vehicle accident with entrapment. EMT injured.	Unknown location
07/09/2013	Motor-vehicle accident	Pine Grove Township
07/13/2013	Motor-vehicle accident, vehicle in the water	Tidioute
09/15/2013	Motor-vehicle accident, roll-over with entrapment	Freehold Township
11/12/2013	Motor-vehicle accident involving a school transport bus	Conewango Township
12/24/2013	Semi-tanker fire in Grand Valley	Southwest Township
12/29/2013	Three (3) care motor vehicle accident	Sheffield Township
01/10/2014	Tractor trailer accident	Pittsfield Township
04/16/2014	Motor-vehicle accident, road closure	Lottsville
04/21/2014	Asphalt tanker rollover with entrapment	Glade Township, SR 59
05/12/2014	Motor-vehicle accident involving Warren Fire Department Engine 3	Warren City
05/19/2014	MVA with county probation vehicle	Warren City
05/23/2014	Motor vehicle accident on RT 27 with road closure	Brokenstraw Township
05/25/2014	Motorcycle crash with roadway closure	Pittsfield Township
05/27/2014	Warren City Ambulance involved in an accident with another vehicle	Unknown
06/30/2014	Motor vehicle accident with entrapment	Pittsfield Township
07/22/2014	Motor vehicle accident with entrapment	Mead Township
09/09/2014	Semi-truck roll-over	Mead Township
09/14/2014	Fatal motor vehicle accident with road closed	Sugar Grove Township
10/18/2014	Motor vehicle accident with fire	Glade Township
11/13/2014	Transportation emergency with road closed	Farmington Township
11/14/2014	Motor vehicle accident with entrapment	Pleasant Township
11/30/2014	Two car motor vehicle accident	Mead Township
12/09/2014	Semi-truck rollover	Brokenstraw Township
12/18/2014	Motor vehicle accident	Conewango Township
01/04/2015	Tanker trailer rollover	Brokenstraw Township
03/04/2015	Road closure on US 6	Columbus Township
03/27/2015	Tanker Truck rollover	Southwest Township
04/02/2015	School bus accident	Pittsfield Township
04/24/2015	Semi-tanker truck rollover	Mead Township
05/27/2015	Motor vehicle accident on Rt. 6	Mead Township
06/01/2015	Tanker truck rollover with asphalt	Mead Township
06/08/2015	Motor vehicle accident with entrapment	Clarendon Borough
07/05/2015	Motor vehicle sheared off a utility pole on Rt. 69, road closed	Sugar Grove Township
08/02/2015	Motorcycle accident	Unknown location
11/11/2015	School bus accident	Conewango Township
12/01/2015	Motor vehicle accident ton a train trestle with a greater than 20’ fall	Pleasant Township
12/01/2015	Motor vehicle accident	Limestone Township
02/03/2016	Car vs. school van	Pittsfield Township
02/04/2016	Vehicle accident with a road closure	Conewango Township
02/26/2016	Vehicle accident	Unknown location
04/08/2016	Vehicle accident with Route 957 closed	Farmington Township
04/08/2016	Vehicle accident involving PennDOT	Pittsfield Township
04/08/2016	Vehicle accident	Cherry Grove Township
04/08/2016	Vehicle accident	Brokenstraw Township
04/09/2016	Vehicle accident	Farmington Township

Date	Event	Location
04/13/2016	Fatal motor vehicle accident	Unknown location
04/15/2016	Pick-up truck vs bus	Warren City
05/28/2016	Motor vehicle accident	Mead Township
06/01/2016	Tractor-trailer accident	Sheffield Township
07/12/2016	Vehicle accident with entrapment	Unknown location
07/17/2016	Single vehicle accident	Unknown location
08/17/2016	Train vs. pick-up truck	Unknown location
08/29/2016	Vehicle accident with entrapment	Unknown location
09/26/2016	Vehicle accident with entrapment	Unknown location
10/16/2016	ATV accident with multiple injuries	Unknown location
10/19/2016	Motorcycle accident with injuries	Unknown location
12/17/2016	Motor vehicle accident	Pittsfield Township
01/10/2017	Vehicle accident with injuries	Unknown location
01/10/2017	Vehicle accident with unknown injuries/entrapment	Unknown location
01/30/2017	Person struck by a vehicle	Brokenstraw Township
02/15/2017	Commercial vehicle off the roadway	Unknown location
02/19/2017	ATV crash on railroad with a fatality	Sheffield Township
03/01/2017	Multiple vehicle accident	Sugar Grove Borough
03/03/2017	Five (5) vehicles involved in an accident	Brokenstraw Township
03/31/2017	Vehicle accident involving police vehicle	Warren City
04/28/2017	Tractor-trailer roll-over	Sheffield Township
06/07/2017	Motor vehicle accident with a gas leak	Unknown location
06/10/2017	Vehicle roll-over	Pittsfield Township
06/11/2017	Fatal crash	Brokenstraw Township
06/12/2017	ATV roll-over in ANF	Cherry Grove Township
08/10/2017	Vehicle roll-over	Pittsfield Township
09/25/2017	Vehicle accident	Unknown location
10/05/2017	Two-vehicle accident	Pittsfield Township
10/10/2017	Motor-vehicle accident	Sheffield Township
12/13/2017	Vehicle accident with entrapment	Unknown location
02/02/2018	Vehicle accident involving a school van	Freehold Township
02/05/2018	Tanker rollover	Brokenstraw Township
02/07/2018	Motor vehicle roll-over with entrapment	Unknown location
02/17/2018	Vehicle accident with entrapment and ejection	Conewango Township
03/14/2018	Small school bus off the roadway	Glade Township
03/16/2018	Two-vehicle accident	Mead Township
04/17/2018	Fire truck roll-over	Unknown location
06/10/2018	ATV accident in the Allegheny National Forest	Pleasant Township
06/17/2018	Vehicle roll-over	Mead Township
07/11/2018	Vehicle into the Kinzua Reservoir	Elk Township
07/22/2018	Motorcycle vs RV accident	Freehold Township
07/28/2018	Car vs. Amish buggy	Sugar Grove Township
07/29/2018	Vehicle accident with entrapment	Warren City
08/12/2018	Car vs. tractor	Farmington Township
09/19/2018	Vehicle accident	Pleasant Township
09/16/2018	Multiple vehicle accident	Freehold Township
09/26/2018	Vehicle roll-over	Mead Township
10/24/2018	Vehicle roll-over with entrapment	Watson Township
11/29/2018	Vehicle roll-over with entrapment	Sugar Grove Township
11/29/2018	Vehicle roll-over	Deerfield Township
12/04/2018	Law enforcement officer involved vehicle accident vs. deer	Spring Creek Township
03/01/2019	Snowmobile accident	Pleasant Township
03/07/2019	Pick-up truck vs. tractor-trailer	Pine Grove Township
03/07/2019	School bus involved in an accident	Columbus Township

Date	Event	Location
05/06/2019	Car vs. Amish buggy	Freehold Township
08/09/2019	Multiple motorcycle accident	Deerfield Township
12/01/2019	Vehicle accident with entrapment	Pleasant Township
12/15/2019	Car vs. tractor-trailer accident	Mead Township
12/18/2019	Vehicle accident involving a school bus	Farmington Township
01/08/2020	Truck vs. train	Conewango Township
02/09/2020	Medevac helicopter emergency landing	Mead Township
04/09/2020	Vehicle accident roll-over with entrapment	Southwest Township
04/20/2020	Vehicle into a reservoir with entrapment	Elk Township

It should be noted that there was a decrease in transportation accidents during the months of March through May 2020. There were only two accidents reported during this time frame. This can be attributed to travel restrictions during the COVID-19 pandemic.

PennDOT's commitment in making roadways safe has generated statistics on crashes and fatalities throughout the Commonwealth. Below is data regarding the total number of crashes, fatal crashes, and fatalities each year for both Pennsylvania and Warren County.

Table 58 - Automotive Crashes

Automotive Crashes					
Year	Total crashes		Total fatal crashes		
	Warren County	Pennsylvania	Warren County	# of fatalities for Warren County	Pennsylvania
2008	449	125,327	10	10	1,468
2009	411	121,242	10	11	1,143
2010	372	121,312	7	7	1,208
2011	414	125,395	6	7	1,191
2012	405	124,092	7	7	1,211
2013	412	124,149	4	4	1,117
2014	382	121,317	3	3	1,107
2015	379	127,127	6	6	1,102
2016	411	129,395	4	4	1,088
2017	412	128,188	5	7	1,083
2018	347	128,420	5	6	1,103

Source: Pennsylvania Department of Transportation

Table 59 - Vehicle vs. Train crashes in Warren County

Vehicle vs. Train Crashes in Warren County		
Year	**# of crashes**	**# of deaths**
2008	0	0
2009	0	0
2010	1	0
2011	0	0
2012	0	0
2013	0	0
2014	0	0
2015	0	0
2016	0	0
2017	0	0
2018	0	0

Source: Pennsylvania Department of Transportation

4.3.21.4 Future Occurrence

The probability of a transportation accident is highly likely. Automobile accidents, ranging from minor to fatal, will occur more frequently than a railway or aviation accident. However, the trucking industry is expected to continue to grow increasing the number of long-haul trucks operating daily in the county.

The 2016 average rate of aviation accidents nation-wide is 3.45 accidents per 100,000 flight hours. Therefore, the likelihood of an aviation incident in the county is considered low.

4.3.21.5 Vulnerability Assessment

A transportation related accident can occur on any stretch of road or railway in Warren County. However, severe accidents are more likely along highways such as US Routes 6 and 62, and PA Routes 27 and 59, which experience heavier traffic volumes including heavy freight vehicles. The combination of high traffic volume, severe winter weather in the county, and large numbers of hazardous materials haulers increase the chances of traffic accidents occurring.

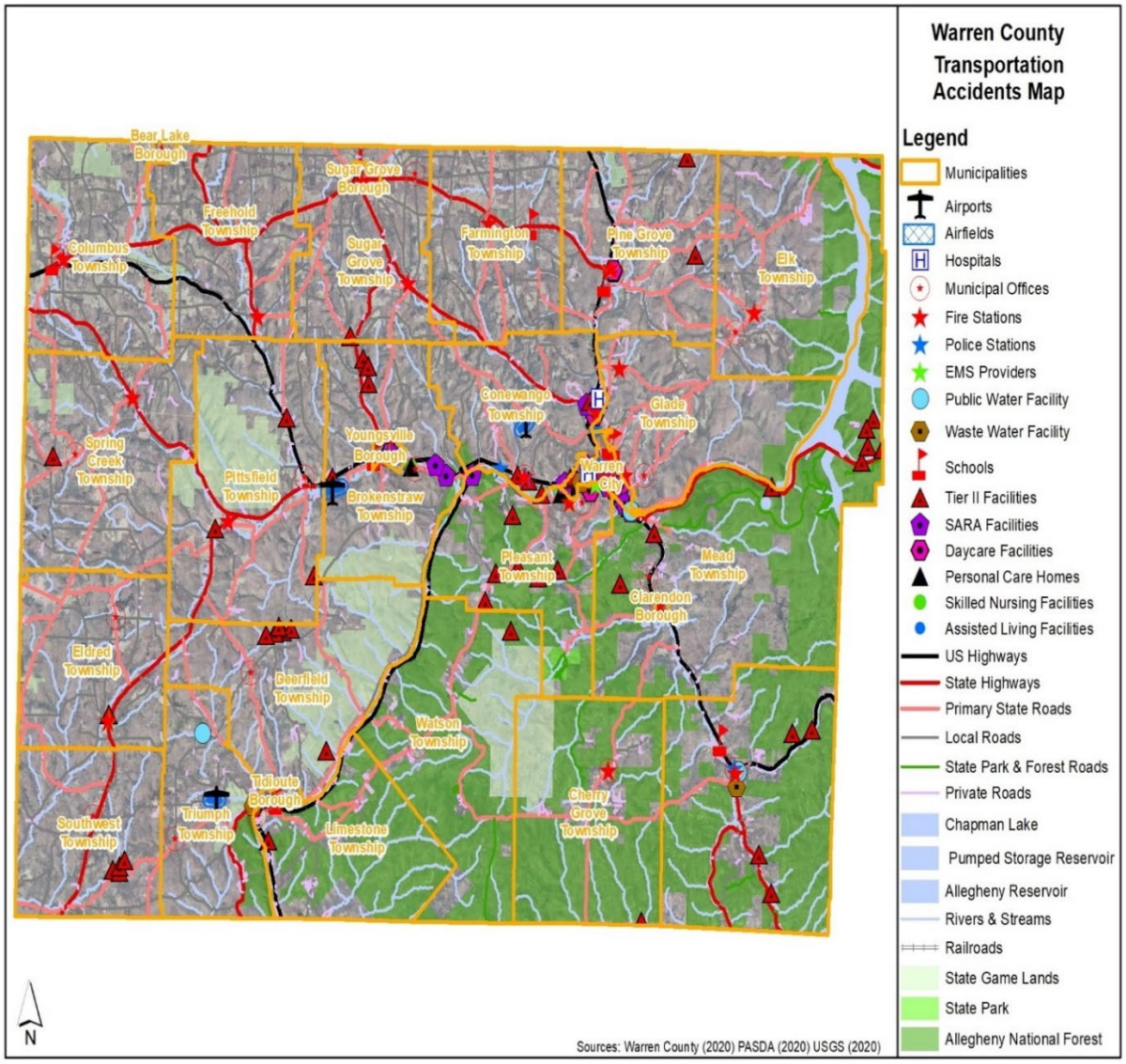
Figure 52 – Transportation Accidents Map identifies the vulnerable roadways and railways in Warren County. This map also reflects a ¼ mile vulnerable zone for each roadway and railway. Numerous critical facilities were identified within this ¼ mile zone. These critical facilities would be more vulnerable to a transportation related accident than critical facilities that are not within that ¼ mile vulnerability zone.

Table 60 - Critical Facilities within ¼ Mile of Major Transportation Routes identifies the various critical facilities that are vulnerable to the transportation hazard.

Table 60 - Critical Facilities within ¼ Mile of Major Transportation Routes

Critical Facilities within ¼ Mile of Major Transportation Routes			
Critical Facility	**Quantity**	**Critical Facility**	**Quantity**
9-1-1 Tower	6	Municipal Government	16
Cellular Tower	4	PennDOT Facility	5
Church	49	Prison	1
EMS Station	9	SARA Facility	12
Fire Station	16	Schools	8
Police Station	7		

Figure 52 – Transportation Accidents Map



4.3.22. Utility Interruption

4.3.22.1 Location and Extent

Utility interruptions in Warren County include disruptions in fuel, water, electric and telecommunications capabilities within the county, with a primary focus on electric power failures. Power failure is often a secondary impact of another hazard event. For example, severe thunderstorms or winter storms could bring down power lines and cause widespread disruptions in electricity service. Strong heat waves may result in rolling blackouts where power may not be available for an extended period of time. Local outages may be caused by traffic accidents or wind damage. *Table 61 – Utility Providers* identifies utility providers to Warren County. Utility interruptions can occur anywhere in the county, not only in residential areas, but along service lines as well.

Table 61 - Utility Providers

Utility Providers	
Name	**Utility provided**
Atlantic Broadband	Internet service
Brokenstraw Valley Area Authority	Sanitary sewer service
Clarendon Water Company	Water
Columbia Gas of Pennsylvania	Natural gas
Columbus Township General Authority	Sanitary sewer service
Farmington Twp. Municipal Authority	Sanitary sewer system to Lander
Kiantone Pipeline Corp./United Refining Company	Natural gas transmission pipeline
Kinzua Net	Internet service
Kinzua-Warren Area Sewer System	Sanitary sewer service
National Fuel Gas Supply Corporation	Natural gas
North Warren Municipal Authority	Water and sanitary sewer services
NRG Electric & Gas Supplier	Electric and gas
Penelec	Electric
Pennsylvania-American Water Company	Water
Pine Grove Water Authority	Water
Sheffield Township Municipal Authority	Water and sanitary sewer services
Southwest Warren County Authority	Water and sanitary sewer services
Spectrum Internet	Internet services
Sugar Grove Area Sewer Authority	Sanitary sewer service
Time Warner Cable	Cable and satellite television
UGI Utilities Inc.	Electric
Verizon	Communications
Warren Electric Co-Op	Electric
West PA Net	Internet service
Williams	Natural gas
Windstream	Communications
Youngsville Borough	Wastewater treatment
Sources: (1) http://www.yellowpages.com/warren-pa/utility-providers, (2) Coordinated Response Exercise for First Responders (CORE) 2019 Emergency Responder Manual, (3) Warren County Comprehensive Plan August 2005	

4.3.22.2 Range of Magnitude

Utility loss can have serious effects on the health, safety, and general welfare of Warren County's citizens. Special need populations are the most vulnerable to a loss of heat or air conditioning during extreme weather events. Those that rely on electricity to supply medical equipment are also at risk.

Severe utility interruptions could be classified as regional or widespread power and or telecommunications outages. Most often these events are short-term, however, there is the possibility of a large storm hindering the repair of power lines resulting in outages that last several days.

Efficient and effective communications and adequate water supply are critical resources for first responders and their efforts to assist the public during an emergency or disaster.

Potential impacts from utility interruptions could include:

- Downed power lines pose a wildfire or structure fire hazard.
- Water line breaks could have hazardous materials infiltrate potable water systems.
- A breakdown of communications could cause any/all emergencies that occur within the county left unmitigated properly.
- A loss of electricity can cause:
  - Loss of heat or air conditioning.
  - Basement flooding due to sump pump failure.
  - Loss of water supply due to well pump failure.

Some of these issues can be more of a nuisance than a hazard, such as food spoilage due to long term electrical outages. However, significant damage or harm can occur depending on the population affected and the severity of the outage.

4.3.22.3 Past Occurrence

Minor power outages occur annually. The continued documentation of these failures may provide opportunities for Warren County to mitigate such service failures.

A significant outage occurred on December 16, 2007. Approximately 75,000 Pennsylvania Power and Lighting customers were without power across south-central Pennsylvania due to heavy icing. Some customers were without power for up to three days.

In Warren County power outages are most often associated with winter storms and windstorms. *Table 62 – Utility Interruptions* identifies utility interruptions as identified in Corvena/Knowledge Center™ for Warren County.

Table 62 - Utility Interruptions (Knowledge Center™)

Utility Interruptions		
Date	**Event**	**Location**
02/10/2009	Power outage	Warren City
02/22/2009	Power outage	Sheffield Township
12/25/2009	Power outage	Warren City
01/16/2010	Power outage	Youngsville Borough
01/23/2010	Large scale power outage	Warren City to Brokenstraw Township
05/30/2010	Power outage	Warren City
09/09/2010	Power outage	Brokenstraw Township
11/16/2010	Power outage	Conewango Township
04/17/2011	Power outage	Warren City
06/14/2011	Power outage	Sheffield Township
09/22/2011	Power outage	Warren City
01/23/2012	Power outage	Warren City
04/23/2012	Starbrick power outage	Conewango Township
03/30/2013	Large power outage	Warren City
08/09/2013	Power outage	Mead Township
10/29/2013	Boil water advisory until 11/18/13	Eldred Township
01/07/2014	Stone Tower site failure	Stone Tower site
06/12/2014	Boil water advisory until 06/21/14	Warren City
11/05/2014	Natural gas leak	Warren City
11/13/2014	Communications outage	Western Warren County

Utility Interruptions		
Date	**Event**	**Location**
11/15/2014	Communications outage	Warren City and Youngsville area
01/03/2015	Power outage	United Refining
01/06/2015	Power outage	Warren County
01/21/2015	Starbrick Water shutoff – a car hit a fire hydrant	Conewango Township
02/08/2015	Emergency 9-1-1 VoIP outage	Countywide
09/01/2015	Boil water advisory	Tidioute Community Charter School
09/03/2015	911 center on generator power	Brokenstraw Township
01/05/2016	911 outage	Warren County
05/14/2016	Natural gas line leaking	Limestone Township
06/20/2016	Gas line ruptured on Scandia Road	Glade Township
08/01/2016	Residential gas leak	Warren City
09/28/2016	Phone issues	Warren City
12/13/2016	Boil water advisory until 12/28/16	Pleasant Township
02/14/2017	Main gas supply line ruptured	Warren County
04/16/2017	Residential gas leak	Warren City
05/30/2017	Power lines down, Rt 27 closed	Pittsfield Township
06/13/2017	Landline phone outage until 06/16/17	Pine Grove Township
07/03/2017	Internet outage until 07/05/2017	Warren County
10/04/2017	Gas line struck	Pine Grove Township
10/05/2017	Water main break until 10/12/17	Warren City
10/05/2017	Boil water advisory until 10/08/17	Warren City
02/01/2018	Boil water advisory until 02/14/18	Brokenstraw Township
04/18/2018	Gas leak	Warren City
06/14/2018	Windstream phone exchange down	Sheffield Township
06/28/2018	Ruptured gas line	Columbus Township
07/05/2018	Power outage	Mead Township
07/06/2018	Boil water advisory until 07/15/18	Sugar Grove Township
07/16/2018	Gas leak	Youngsville Borough
07/31/2018	911 center power outage	Brokenstraw Township
09/05/2018	Power outage to include the hospital	Warren City
10/07/2018	Power outage	Warren County
01/31/2019	Boil water advisory until 02/04/19	Conewango Township
04/14/2019	Gas leak with evacuation	Conewango Township
04/15/2019	Radio tower collapse, repaired 12/09/19	Warren County
07/06/2019	Power outage	Warren City
09/30/2019	Gas leak, repaired 10/01/19	Brokenstraw Township
11/01/2019	Power outage until 11/02/19	Mead Township
11/08/2019	Boil water advisory until 11/22/19	Pittsfield Township
11/19/2019	Water main break, repaired on 11/27/19	Brokenstraw Township
12/18/2019	Verizon Wireless outage	Warren County
03/29/2020	Power outage after the sound of an explosion	Mead Township

4.3.22.4 Future Occurrence

Minor power failure events (i.e. short outage) events may occur several times per year for any given area in the county, while major (i.e. widespread, long outage) events take place once every few years. Power

failures are likely occurrences during severe weather and therefore outages should be anticipated during severe weather events.

An aging infrastructure also poses a threat to potential utility interruptions. Constant wear and tear of the service deteriorates equipment. There is often a mix of new and old equipment along the line, as total replacement is not a feasible solution for any utility company.

4.3.22.5 Vulnerability Assessment

Emergency medical facilities, including retirement homes and senior centers are particularly vulnerable to power outages. While back-up power generators are often used at these facilities, loss of electricity may result in hot or cold temperatures for which elderly populations are particularly vulnerable Appendix C provides a list of where those facilities are in Warren County.

Electric

Severe weather is one of the largest causes of power loss. The electric power grid infrastructure can be damaged by snow, ice, high winds, lightning, flooding, falling tree limbs and vehicle accidents involving utility poles. Small animals can also cause minor power outages by climbing the lines and shorting out the power supply.

Causes of a regional scale power shortage or failure would be from infrastructure failure, sabotage, human error, and worker strikes.

Water

Water distribution can be affected in three ways: the amount of water available; the quality of the water; and the viability of the physical components of the distribution system. The quantity of water depends on nature. Humans are primarily responsible for the maintenance of water quality. Well contamination or water shortages due to drought would pose a high vulnerability.

Water contamination can occur naturally, by human error, or intentionally. Occasionally, releases of manure and milk into the water supply can cause contamination. Overflows from sewage systems and lagoons on farms can also cause contamination of groundwater and drinking water. There are times when accidental spills and releases of hazardous materials contaminate water supplies, thereby, water supplies along transportation routes may be affected.

Gas and liquid pipelines

Interruptions to natural gas distribution lines could be affected by:

- The deterioration of lines and facilities
- Puncturing the distribution lines by humans (either intentional or accidental),
- Coastal and winter storms
- Extreme heat or cold events
- Transportation accidents

Communications

Interruptions in communications could be caused as a secondary effect of storms or high winds, infrastructure failure, or by humans (intentional or accidental). A loss of communications by emergency services would be devastating to the population of Warren County if 9-1-1 calls could not be received, nor could emergency units be dispatched properly.

4.4. Hazard Vulnerability Summary

4.4.1. Methodology

Ranking hazards helps communities set goals and priorities for mitigation based on their vulnerabilities. A risk factor (RF) is a tool used to measure the degree of risk for identified hazards in a particular planning area. The RF can also assist local community officials in ranking and prioritizing hazards that pose the most significant threat to a planning area based on a variety of factors deemed important by the planning team and other stakeholders involved in the hazard mitigation planning process. The RF system relies mainly on historical data, local knowledge, general consensus from the planning team and information collected through development of the hazard profiles included in Section 4.3. The RF approach produces numerical values that allow identified hazards to be ranked against one another; the higher the RF value, the greater the hazard risk.

RF values were obtained by assigning varying degrees of risk to five categories for each of the hazards profiled in the HMP update. Those categories include *probability*, *impact*, *spatial extent*, *warning time and duration*. Each degree of risk was assigned a value ranging from one to four. The weighting factor agreed upon by the planning team is shown in *Table 63 - Risk Factor Approach* Summary. To calculate the RF value for a given hazard, the assigned risk value for each category was multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the following example equation:

Risk Factor Value =
[(Probability x .30) + (Impact x .30) +(Spatial Extent x .20) + (Warning Time x .10) + (Duration x .10)]

Table 63 - Risk Factor Approach Summary summarizes each of the five categories used for calculating a RF for each hazard. According to the weighting scheme applied, the highest possible RF value is 4.0.

Table 63 - Risk Factor Approach Summary

Summary of Risk Factor Approach Used to Rank Hazard Risk.					
RISK ASSESSMENT CATEGORY	**DEGREE OF RISK**				**WEIGHT VALUE**
	LEVEL	**CRITERIA**		**INDEX**	
PROBABILITY *What is the likelihood of a hazard event occurring in a given year?*	**UNLIKELY**	LESS THAN 1% ANNUAL PROBABILITY		1	30%
	POSSIBLE	BETWEEN 1 & 10% ANNUAL PROBABILITY		2	
	LIKELY	BETWEEN 10 &100% ANNUAL PROBABILITY		3	
	HIGHLY LIKELY	100% ANNUAL PROBABILTY		4	
IMPACT *In terms of injuries, damage, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?*	**MINOR**	VERY FEW INJURIES, IF ANY. ONLY MINOR PROPERTY DAMAGE & MINIMAL DISRUPTION ON QUALITY OF LIFE. TEMPORARY SHUTDOWN OF CRITICAL FACILITIES.		1	30%
	LIMITED	MINOR INJURIES ONLY. MORE THAN 10% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE DAY.		2	
	CRITICAL	MULTIPLE DEATHS/INJURIES POSSIBLE. MORE THAN 25% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE WEEK.		3	
	CATASTROPHIC	HIGH NUMBER OF DEATHS/INJURIES POSSIBLE. MORE THAN 50% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR 30 DAYS OR MORE.		4	
SPATIAL EXTENT *How large of an area could be impacted by a hazard event? Are impacts localized or regional?*	**NEGLIGIBLE**	LESS THAN 1% OF AREA AFFECTED		1	20%
	SMALL	BETWEEN 1 & 10% OF AREA AFFECTED		2	
	MODERATE	BETWEEN 10 & 50% OF AREA AFFECTED		3	
	LARGE	BETWEEN 50 & 100% OF AREA AFFECTED		4	
WARNING TIME *Is there usually some lead time associated with the hazard event? Have warning measures been implemented?*	**MORE THAN 24 HRS**	SELF-DEFINED	*(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	1	10%
	12 TO 24 HRS	SELF-DEFINED		2	
	6 TO 12 HRS	SELF-DEFINED		3	
	LESS THAN 6 HRS	SELF-DEFINED		4	
DURATION *How long does the hazard event usually last?*	**LESS THAN 6 HRS**	SELF-DEFINED	*(NOTE: Levels of warning time and criteria that define them may be adjusted based on hazard addressed.)*	1	10%
	LESS THAN 24 HRS	SELF-DEFINED		2	
	LESS THAN 1 WEEK	SELF-DEFINED		3	
	MORE THAN 1 WEEK	SELF-DEFINED		4	

4.4.2. Ranking Results

Using the methodology described in Section 4.4.1, *Table 64 – Risk Factor Assessment* lists the risk factor calculated for each of the twenty-five potential hazards identified in the 2021 HMP. *It should be noted that the tornado hazard and windstorm hazard were ranked individually instead of together. Additionally, so were flash flooding, flooding, and ice jam flooding as well as environmental hazards – transportation and fixed facility.* Hazards identified as *high* risk have risk factors greater than 2.5. Risk factors ranging from 2.0 to 2.4 were deemed *moderate* risk hazards. Hazards with risk factors 1.9 and less are considered *low* risk.

Table 64 - Risk Factor Assessment

Warren County Hazard Ranking Based on RF Methodology.							
HAZARD RISK	HAZARD NATURAL(N) OR MANMADE(M)	RISK ASSESSMENT CATEGORY					RISK FACTOR (RF)
		PROBABILITY	ECONOMIC IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
HIGH	Emergency Services (M)	4	4	4	1	4	3.7
	Flash Flooding (N)	4	4	2	4	4	3.6
	Invasive Species (N)	4	3	3	1	4	3.2
	Winter Storms (N)	4	2	4	2	3	3.1
	Windstorm (N)	4	2	2	4	4	3
	Flooding (N)	4	2	2	3	4	2.9
	Dam Failure (M)	1	4	3	4	4	2.9
	Substance Abuse (M)	4	3	1	4	2	2.9
	Pandemic & Infectious Disease (M)	2	3	4	1	4	2.8
	Extreme Temperatures (N)	2	3	4	1	3	2.7
	Environmental Hazards – Fixed Facility (M)	3	2	2	4	3	2.6
	Environmental Hazards – Transportation (M)	4	2	1	4	2	2.6
	Wildfire (N)	4	2	2	3	1	2.6
	Drowning (M)	3	3	1	4	2	2.6
	Utility Interruptions (M)	4	1	2	4	3	2.6
	Disorientation (M)	4	2	1	4	2	2.6
MODERATE	Tornado (N)	2	2	2	4	4	2.4
	Terrorism (M)	2	2	2	4	4	2.4
	Drought (N)	2	1	4	1	4	2.2
	Transportation Accidents (M)	4	1	1	4	1	2.2
	Lightning Strike (N)	2	2	1	4	2	2.0
LOW	Levee Failure (M)	1	2	2	2	4	1.9
	Hailstorm (N)	3	1	1	4	1	1.9
	Hurricane/Tropical Storm (N)	2	1	3	1	3	1.9
	Landslides (N)	2	1	1	4	4	1.9
	Earthquake (N)	1	1	1	4	1	1.3

Based on these results, there are sixteen high risk hazards, five moderate risk hazards and five low risk hazards in Warren County. Mitigation actions were developed for all high, moderate, and low risk hazards (see sections 6.4). The threat posed to life and property for moderate and high-risk hazards is considered significant enough to warrant the need for establishing hazard-specific mitigation actions. Mitigation actions related to future public outreach and emergency service activities are identified to address low risk hazard events.

A risk assessment result for the entire county does not mean that each municipality is at the same amount of risk to each hazard. *Table 65 – Countywide Risk Factor by Hazard* shows the different municipalities in Warren County and whether their risk is greater than (>), less than (<), or equal to (=) the risk factor assigned to the county as a whole. This table was developed by the consultant based on the findings in the hazard profiles located in sections 4.3.1 through 4.3.22.

Table 65 - Countywide Risk Factor by Hazard

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk										
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR										
JURISDICTION	Emergency Services (M)	Flash Flooding (N)	Invasive Species (N)	Winter Storms (N)	Windstorm (N)	Flooding (N)	Dam Failure (M)	Substance Abuse (M)	Pandemic & Infectious Disease (N)	Extreme Temperatures (N)
	3.7	*3.6*	*3.2*	*3.1*	*3*	*2.9*	*2.9*	*2.9*	*2.8*	*2.7*
Bear Lake Borough	Not completed by municipality									
Brokenstraw Township	Not completed by municipality									
Cherry Grove Township	>	<	>	>	>	<	<	>	=	=
Clarendon Borough	Not completed by municipality									
Columbus Township	=	=	=	=	=	=	<	=	=	=
Conewango Township	>	=	=	=	=	>	=	=	>	=
Deerfield Township	Not completed by municipality									
Eldred Township	=	=	=	=	=	=	=	=	=	=
Elk Township	=	<	=	=	=	<	<	=	=	=
Farmington Township	=	=	=	=	=	=	<	=	=	=
Freehold Township	=	=	>	<	<	=	>	=	=	=
Glade Township	=	=	=	=	=	=	=	=	=	=
Limestone Township	Not completed by municipality									
Mead Township	=	=	=	=	=	=	=	=	=	=
Pine Grove Township	=	=	=	>	=	=	<	=	=	=
Pittsfield Township	>	=	=	=	=	>	=	=	=	=
Pleasant Township	>	=	=	=	>	<	=	=	=	=
Sheffield Township	=	=	=	=	=	<	>	=	=	=
Southwest Township	=	=	=	>	>	=	<	=	>	=

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk										
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR										
JURISDICTION	Emergency Services (M)	Flash Flooding (N)	Invasive Species (N)	Winter Storms (N)	Windstorm (N)	Flooding (N)	Dam Failure (M)	Substance Abuse (M)	Pandemic & Infectious Disease (N)	Extreme Temperatures (N)
	3.7	*3.6*	*3.2*	*3.1*	*3*	*2.9*	*2.9*	*2.9*	*2.8*	*2.7*
Spring Creek Township	=	=	=	=	=	=	=	=	=	=
Sugar Grove Borough	Not completed by municipality									
Sugar Grove Township	=	=	=	=	=	=	=	=	=	=
Tidioute Borough	Not completed by municipality									
Triumph Township	Not completed by municipality									
Warren City	Not completed by municipality									
Watson Township	=	=	=	=	>	=	=	=	>	=
Youngsville Borough	Not completed by municipality									

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk														
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR														
JURISDICTION	Environmental Hazards – Fixed Facility (M)	Environmental Hazards - Transportation (M)	Wildfire (N)	Drowning (M)	Utility Interruptions (M)	Disorientation (M)	Tornado (N)	Terrorism (M)	Drought (N)	Transportation Accidents (M)	Lightning Strike (N)	Levee Failure (M)	Hailstorm (N)	Hurricane/Tropical Storm (N)
	2.6	*2.6*	*2.6*	*2.6*	*2.6*	*2.6*	*2.4*	*2.4*	*2.2*	*2.2*	*2*	*1.9*	*1.9*	*1.9*
Bear Lake Borough	Not completed by municipality													
Brokenstraw Township	Not completed by municipality													
Cherry Grove Township	>	>	=	<	>	>	=	<	>	=	=	>	>	>
Clarendon Borough	Not completed by municipality													

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk														
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR														
JURISDICTION	Environmental Hazards – Fixed Facility (M)	Environmental Hazards - Trans-portation (M)	Wildfire (N)	Drowning (M)	Utility Interruptions (M)	Disorientation (M)	Tornado (N)	Terrorism (M)	Drought (N)	Transportation Accidents (M)	Lightning Strike (N)	Levee Failure (M)	Hailstorm (N)	Hurricane/Tropical Storm (N)
	2.6	*2.6*	*2.6*	*2.6*	*2.6*	*2.6*	*2.4*	*2.4*	*2.2*	*2.2*	*2*	*1.9*	*1.9*	*1.9*
Columbus Township	=	=	=	=	=	=	=	=	=	=	=	<	=	=
Conewango Township	>	>	<	=	>	<	=	=	=	>	=	=	=	=
Deerfield Township	Not completed by municipality													
Eldred Township	=	=	=	=	=	=	=	=	=	=	=	=	=	=
Elk Township	<	=	=	=	>	<	=	<	=	=	=	<	<	<
Farmington Township	=	=	=	=	=	=	=	=	=	=	=	<	=	=
Freehold Township	=	=	=	=	>	=	>	>	=	=	=	>	=	>
Glade Township	=	=	=	=	=	=	=	=	=	=	=	=	=	=
Limestone Township	Not completed by municipality													
Mead Township	=	=	=	=	=	=	=	=	=	=	=	=	=	=
Pine Grove Township	<	=	=	=	>	=	=	<	>	=	=	=	=	=
Pittsfield Township	=	=	<	<	>	=	=	<	=	=	=	=	=	=
Pleasant Township	=	=	>	=	=	>	=	=	>	=	=	>	=	=
Sheffield Township	>	>	<	>	<	<	>	>	>	>	=	>	=	=
Southwest Township	=	=	=	=	>	=	=	=	=	=	=	=	=	=
Spring Creek Township	=	=	=	=	=	=	=	=	=	=	=	=	<	<
Sugar Grove Borough	Not completed by municipality													
Sugar Grove Township	=	=	=	=	=	=	=	=	=	=	=	=	=	=
Tidioute Borough	Not completed by municipality													
Triumph Township	Not completed by municipality													
Warren City	Not completed by municipality													
Watson Township	=	=	>	=	=	>	>	=	>	<	>	=	=	=
Youngsville Borough	Not completed by municipality													

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk														
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR														
JURISDICTION	Landslides (N)	Earthquake (N)												
	1.9	*1.3*												
Bear Lake Borough	Not completed by municipality													
Brokenstraw Township	Not completed by municipality													
Cherry Grove Township	>	>												
Clarendon Borough	Not completed by municipality													
Columbus Township														
Conewango Township	=	=												
Deerfield Township	Not completed by municipality													
Eldred Township	=	=												
Elk Township	<	=												
Farmington Township	=	=												
Freehold Township	>	>												
Glade Township	=	=												
Limestone Township	Not completed by municipality													
Mead Township	=	=												
Pine Grove Township	=	=												
Pittsfield Township	=	=												
Pleasant Township	=	=												
Sheffield Township	=	=												
Southwest Township	=	=												
Spring Creek Township	=	=												
Sugar Grove Borough	Not completed by municipality													
Sugar Grove Township	=	=												
Tidioute Borough	Not completed by municipality													
Triumph Township	Not completed by municipality													
Warren City	Not completed by municipality													
Watson Township	=	>												
Youngsville Borough	Not completed by municipality													

4.4.3. Potential Loss Estimates

Based on various kinds of available data, potential loss estimates were established for flooding. Estimates provided in this section are based on HAZUS-MH, version MR4, geospatial analysis, and previous events. Estimates are considered *potential* in that they generally represent losses that could occur in a countywide hazard scenario. In events that are localized, losses may be lower, while regional events could yield higher losses.

Potential loss estimates have four basic components, including:

Replacement Value: Current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials.
Content Loss: Value of building's contents, typically measured as a percentage of the building replacement value.
Functional Loss: The value of a building's use or function that would be lost if it were damaged or closed.
Displacement Cost: The dollar amount required for relocation of the function (business or service) to another structure following a hazard event.

Flooding Loss Estimation:

Flooding is a high-risk natural hazard in Warren County. The estimation of potential loss in this assessment focuses on the monetary damage that could result from flooding. The potential property loss was determined for each municipality and for the entire county. The quantity of commercial and residential structures in each Warren County municipality is outlined in section 4.3.4 of the flooding hazard profile.

MCM Consulting Group, Inc. conducted a countywide flood study using the Hazards U.S. Multi-Hazard (HAZUS-MH) software that is provided by the Federal Emergency Management Agency. This software is a standardized loss estimation software deriving economic loss, building damage, content damage and other economic impacts that can be used in local flood mitigation planning activities.

Using HAZUS-MH, total building-related losses from a 1%-annual-chance flood in Warren County are estimated to equal $130.73 million with $122 million of that coming from residential homes. Total economic loss, including replacement value, content loss, functional loss, and displacement cost, from a countywide 1%-annual-chance flood are estimated to equal $431.28 million.

4.4.4. Future Development and Vulnerability

The 2019 estimated population for Warren County is 39,191 which is 2,624 less than the 2010 census. There was an overall decrease of 6.3% in population based on the estimate. All municipalities have seen population decreases in the period between 2010 and the 2019 estimate as identified in *Table 66 – Population Change in Warren County from 2010-2019.*

Table 66 - 2010-2019 Population Change

Population Change in Warren County from 2010-2019				
Municipality	**2010 Census**	**2015 Estimates**	**2019 Estimates**	**Percent of Change 2010-2019 Estimate**
Bear Lake Borough	164	160	155	-5.5%
Brokenstraw Township	1,884	1,819	1,777	-5.7%
Cherry Grove Township	216	210	205	-5.1%
Clarendon Borough	450	435	424	-5.8%
Columbus Township	2,034	1,967	1,911	-6.0%
Conewango Township	3,594	3,439	3,339	-7.1%
Deerfield Township	339	327	316	-6.8%
Eldred Township	650	626	608	-6.5%
Elk Township	520	506	490	-5.8%
Farmington Township	1,259	1,226	1,199	-4.8%
Freehold Township	1,510	1,467	1,424	-5.7%
Glade Township	2,308	2,228	2,162	-6.3%
Limestone Township	403	384	370	-8.2%
Mead Township	1,386	1,338	1,300	-6.2%
Pine Grove Township	2,695	2,599	2,526	-6.3%
Pittsfield Township	1,405	1,364	1,344	-4.3%
Pleasant Township	2,444	2,362	2,296	-6.1%
Sheffield Township	2,121	2,044	1,980	-6.6%
Southwest Township	527	509	495	-6.1%
Spring Creek Township	852	814	788	-7.5%
Sugar Grove Borough	614	591	573	-6.7%
Sugar Grove Township	1,723	1,688	1,659	-3.7%
Tidioute Borough	688	661	641	-6.8%
Triumph Township	316	303	292	-7.6%
Warren City	9,710	9,339	9,049	-6.8%
Watson Township	274	264	256	-6.6%
Youngsville Borough	1,729	1,664	1,612	-6.8%
TOTAL	**41,815**	**40,334**	**39,191**	**-6.3%**

5. Capability Assessment

5.1. Update Process Summary

The capability assessment is an evaluation of Warren County's governmental structure, political framework, legal jurisdiction, fiscal status, policies and programs, regulations and ordinances and resource availability. Each category is evaluated for its strengths and weaknesses in responding to, preparing for, and mitigating the effects of the profiled hazards. A capability assessment is an integral part of the hazard mitigation planning process. Here, the county and municipalities identify, review, and analyze what they are currently doing to reduce losses and identify the framework necessary to implement new mitigation actions. This information will help the county and municipalities evaluate alternative mitigation actions and address shortfalls in the mitigation plan.

A capabilities assessment survey was provided to the municipalities during the planning process at meetings held with Warren County officials. These meetings were designed to seek input from key county and municipal stakeholders on legal, fiscal, technical, and administrative capabilities of all jurisdictions. As such, the capabilities assessment helps guide the implementation of mitigation projects and will help evaluate the effectiveness of existing mitigation measures, policies, plans, practices, and programs.

Throughout the planning process, the mitigation local planning team considered the county's twenty-seven municipalities. Pennsylvania municipalities have their own governing bodies, pass and enforce their own ordinances and regulations, purchase equipment and manage their own resources, including critical infrastructure. These capability assessments, therefore, consider the various characteristics and capabilities of municipalities under study.

The evaluation of the following categories – political framework, legal jurisdiction, fiscal status, policies and programs and regulations and ordinances – allows the mitigation planning team to determine the viability of certain mitigation actions. The capability assessment analyzes what Warren County and its municipalities have the capacity to do and provides an understanding of what must be changed to mitigate loss.

Warren County has a number of resources it can access to implement hazard mitigation initiatives including emergency response measures, local planning and regulatory tools, administrative assistance and technical expertise, fiscal capabilities and participation in local, regional, state and federal programs. The presence of these resources enables community resiliency through actions taken before, during and after a hazardous event. While the capability assessment serves as a good instrument for identifying local capabilities, it also provides a means for recognizing gaps and weaknesses that can be resolved through future mitigation actions. The results of this assessment lend critical information for developing an effective mitigation strategy.

5.2. Capability Assessment Findings

All twenty-seven municipalities in Warren County completed and submitted a capability assessment survey. The results of the survey were collected, aggregated, and analyzed.

5.2.1. Planning and Regulatory Capability

Municipalities have the authority to govern more restrictively than state and county minimum requirements as long as they are compliant with all criteria established in the Pennsylvania Municipalities Planning Code (MPC) and their respective municipal codes. Municipalities can develop their own policies and programs and implement their own rules and regulations to protect and serve their local residents. Local policies and programs are typically identified in a comprehensive plan, implemented through a local ordinance, and enforced by the governmental body or its appointee.

Municipalities regulate land use via the adoption and enforcement of zoning, subdivision, and land development, building codes, building permits, floodplain management and/or stormwater management ordinances. When effectively prepared and administered, these regulations can lead to an opportunity for hazard mitigation. For example, the National Flood Insurance Program (NFIP) established minimum floodplain management criteria. Adoption of the Pennsylvania Floodplain Management Act (Act 166 of 1978) established higher standards. A municipality must adopt and enforce these minimum criteria to be eligible for participation in the NFIP. Municipalities have the option of adopting a single-purpose ordinance or incorporating these provisions into their zoning, subdivision and land development, or building codes; thereby mitigating the potential impacts of local flooding. This capability assessment details the existing Warren County and municipal legal capabilities to mitigate the profiled hazards. It identifies the county's and the municipalities' existing planning documents and their hazard mitigation potential. Hazard mitigation recommendations are, in part, based on the information contained in the assessment.

Building Codes

Building codes are important in mitigation because they are developed for a region of the country in respect to the hazards existing in that area. Consequently, structures that are built according to applicable codes are inherently resistant to many hazards, such as strong winds, floods, and earthquakes; and can help mitigate regional hazards, such as wildfires. In 2003, Pennsylvania implemented the Uniform Construction Code (UCC) (Act 45), a comprehensive building code that establishes minimum regulations for most new construction, including additions and renovations to existing structures.

The code applies to almost all buildings, excluding manufactured and industrialized housing (which are covered by other laws), agricultural buildings and certain utility and miscellaneous buildings. The UCC has many advantages. It requires builders to use materials and methods that have been professionally evaluated for quality and safety, as well as inspections to ensure compliance.

The initial election period, during which all of Pennsylvania's 2,565 municipalities were allowed to decide whether the UCC would be administered and enforced locally, officially closed on August 7, 2004. The codes adopted for use under the UCC are the 2003 International Codes issued by the International Code Council (ICC). Supplements to the 2003 codes have been adopted for use over the years since.

If a municipality has "opted in", all UCC enforcement is local, except where municipal (or third party) code officials lack the certification necessary to approve plans and inspect commercial construction for compliance with UCC accessibility requirements. If a municipality has "opted out", the PA Department of Labor and Industry is responsible for all commercial code enforcement in that municipality; and all residential construction is inspected by independent third-party agencies selected by the owner. The department also has sole jurisdiction for all state-owned buildings no matter where they are located. Historical buildings may be exempt from such inspections and Act 45 provides quasi-exclusion from UCC requirements.

The municipalities in Warren County adhere to the standards of the Pennsylvania Uniform Construction Code (Act 45). Twenty-five of twenty-seven municipalities in Warren County have opted-in on building code enforcement. The two municipalities that have opted-out of building code enforcement are Bear Lake Borough and Spring Creek Township.

Zoning Ordinance

Article VI of the Municipalities Planning Code (MPC) authorizes municipalities to prepare and enact zoning to regulate land use. Its regulations can apply to the permitted use of land; the height and bulk of structures; the percentage of a lot that may be occupied by buildings and other impervious surfaces; yard setbacks; the density of development; the height and size of signs; the parking regulations. A zoning ordinance

has two parts, including the zoning map that delineates zoning districts and the text that sets forth the regulations that apply to each district. Fifteen of the twenty-seven municipalities in Warren County have zoning regulations in place. Thirteen of the fifteen municipalities that have zoning regulations utilize the county planning department for zoning enforcement and the remaining two use their own zoning enforcement. The remaining twelve municipalities do not have zoning regulations in place.

Subdivision Ordinance

Subdivision and land development ordinances include regulations to control the layout of streets, the planning of lots and the provision of utilities and other site improvements. The objectives of a subdivision and land development ordinance are to: coordinate street patterns; assure adequate utilities and other improvements are provided in a manner that will not pollute streams, wells and/or soils; reduce traffic congestion; and provide sound design standards as a guide to developers, the elected officials, planning commissions and other municipal officials. Article V of the Municipality Planning Code authorizes municipalities to prepare and enact a subdivision and land development ordinance. Subdivision and land development ordinances provide for the division and improvement of land. All municipalities in Warren County utilize some form of land use and land development regulation. The Warren County Subdivision and Land Development Ordinance provides regulatory guidance for twenty-five of the twenty-seven municipalities.

Stormwater Management Plan/Stormwater Ordinance

The proper management of storm water runoff can improve conditions and decrease the chance of flooding. Pennsylvania's Storm Water Management Act (Act 167) confers on counties the responsibility for development of watershed plans. The Act specifies that counties must complete their watershed storm water plans within two years following the promulgation of these guidelines by the DEP, which may grant an extension of time to any county for the preparation and adoption of plans. Counties must prepare the watershed plans in consultation with municipalities and residents. This is to be accomplished through the establishment of a watershed plan advisory committee. The counties must also establish a mechanism to periodically review and revise watershed plans, so they are current. Plan revisions must be done every five years or sooner, if necessary.

Municipalities have an obligation to implement the criteria and standards developed in each watershed storm water management plan by amending or adopting laws and regulation for land use and development. The implementation of storm water management criteria and standards at the local level are necessary since municipalities are responsible for local land use decisions and planning. The degree of detail in the ordinances depends on the extent of existing and projected development. The watershed storm water management plan is designed to aid the municipality in setting standards for the land uses it has proposed. Municipalities within rapidly developing watersheds will benefit from the watershed storm water management plan and will use the information for sound land use considerations. A major goal of the watershed plan and the attendant municipal regulations is to prevent future drainage problems and avoid the aggravation of existing problems. All municipalities in Warren County have adopted the county's stormwater management plan. There are five major watersheds in Warren County:

- The Allegheny River
- Conewango Creek
- Brokenstraw Creek
- Tionesta Creek
- Oil Creek

Comprehensive Plan

A comprehensive plan is a policy document that states objectives and guides the future growth and physical development of a municipality. The comprehensive plan is a blueprint for housing, transportation, community facilities, utilities, and land use. It examines how the past led to the present and charts the community's future path. The Pennsylvania Municipalities Planning Code (MPC Act 247 of 1968, as reauthorized and amended) requires counties to prepare and maintain a county comprehensive plan. In addition, the MPC requires counties to update the comprehensive plan every ten years.

With regard to hazard mitigation planning, Section 301.a(2) of the Municipality Planning Code requires comprehensive plans to include a plan for land use, which, among other provisions, suggests that the plan give consideration to floodplains and other areas of special hazards and other similar uses. The MPC also requires comprehensive plans to include a plan for community facilities and services and recommends considering storm drainage and floodplain management.

The Warren County Comprehensive Plan was last updated in 2005. The county plans to update their comprehensive plan within the next year.

Article III of the MPC enables municipalities to prepare a comprehensive plan; however, development of a comprehensive plan is voluntary. Two of the twenty-seven municipalities in Warren County have adopted their own comprehensive plan.

Capital Improvements Plan

The capital improvements plan is a multi-year policy guide that identifies needed capital projects and is used to coordinate the financing and timing of public improvements. Capital improvements relate to streets, storm water systems, water distribution, sewage treatment and other major public facilities. A capital improvements plan should be prepared by the respective county's planning department and should include a capital budget. This budget identifies the highest priority projects recommended for funding in the next annual budget. The capital improvements plan is dynamic and can be tailored to specific circumstances. Warren County does not have any capital improvement plans in place.

Participation in the National Flood Insurance Program (NFIP)

Floodplain management is the operation of programs or activities that may consist of both corrective and preventive measures for reducing flood damage, including but not limited to such things as emergency preparedness plans, flood control works and flood plain management regulations. The Pennsylvania Floodplain Management Act (Act 166) requires every municipality identified by the Federal Emergency Management Agency (FEMA) to participate in the National Flood Insurance Program (NFIP) and permits all municipalities to adopt floodplain management regulations. It is in the interest of all property owners in the floodplain to keep development and land usage within the scope of the floodplain regulations for their community. This helps keep insurance rates low and makes sure that the risk of flood damage is not increased by property development.

The Pennsylvania DCED provides communities, based on their CFR, Title 44, Section 60.3 level of regulations, with a suggested ordinance document to assist municipalities in meeting the minimum requirements of the NFIP along with the Pennsylvania Flood Plain Management Act (Act 166). These suggested or model ordinances contain provisions that are more restrictive than state and federal requirements. Suggested provisions include, but are not limited to:

1. Prohibiting manufactured homes in the floodway.

2. Prohibiting manufactured homes within the area measured fifty feet landward from the top-of bank of any watercourse within a special flood hazard area.
3. Special requirements for recreational vehicles within the special flood hazard area.
4. Special requirement for accessory structures.
5. Prohibiting new construction and development within the area measured fifty feet landward from the top-of bank of any watercourse within a special flood hazard area.
6. Providing the county conservation district an opportunity to review and comment on all applications and plans for any proposed construction or development in any identified floodplain area.

Act 166 mandates municipal participation in and compliance with the NFIP. It also establishes higher regulatory standards for new or substantially improved structures which are used for the production or storage of dangerous materials (as defined by Act 166) by prohibiting them in the floodway. Additionally, Act 166 establishes the requirement that a special permit be obtained prior to any construction or expansion of any manufactured home park, hospital, nursing home, jail and prison if said structure is located within a special flood hazard area.

The NFIP's Community Rating System (CRS) provides discounts on flood insurance premiums in those communities that establish floodplain management programs that go beyond NFIP minimum requirements. Under the CRS, communities receive credit for more restrictive regulations; acquisition, relocation, or flood-proofing of flood-prone buildings; preservation of open space; and other measures that reduce flood damages or protect the natural resources and functions of floodplains.

The CRS was implemented in 1990 to recognize and encourage community floodplain management activities that exceed the minimum NFIP standards. Section 541 of the 1994 Act amends Section 1315 of the 1968 Act to codify the Community Rating System in the NFIP. The section also expands the CRS goals to specifically include incentives to reduce the risk of flood-related erosion and to encourage measures that protect natural and beneficial floodplain functions. These goals have been incorporated into the CRS and communities now receive credit toward premium reductions for activities that contribute to them.

Under the Community Rating System, flood insurance premium rates are adjusted to reflect the reduced flood risk resulting from community activities that meet a minimum of three of the following CRS goals:

1. Reduce flood losses
2. Protect public health and safety
3. Reduce damage to property
4. Prevent increases in flood damage from new construction
5. Reduce the risk of erosion damage
6. Protect natural and beneficial floodplain functions
7. Facilitate accurate insurance rating
8. Promote the awareness of flood insurance

There are ten Community Rating System classes. Class 1 requires the most credit points and gives the largest premium reduction; Class 10 receives no premium reduction. CRS premium discounts on flood insurance range from 5% for Class 9 communities up to 45% for Class 1 communities. The CRS recognizes eighteen credible activities, organized under four categories: Public Information, Mapping and Regulations, Flood Damage Reduction and Flood Preparedness.

FEMA Region III makes available to communities, an ordinance review checklist which lists required provisions for floodplain management ordinances. This checklist helps communities develop an effective floodplain management ordinance that meets federal requirements for participation in the NFIP. The

Pennsylvania Department of Community and Economic Development (DCED) provides communities, based on their 44 CFR 60.3 level of regulations, with a suggested ordinance document to assist municipalities in meeting the minimum requirements of the NFIP and the Pennsylvania Flood Plain Management Act (Act 166). Act 166 mandates municipal participation in and compliance with the NFIP. It also establishes higher regulatory standards for hazardous materials and high-risk land uses. As new Digital Flood Insurance Rate Maps (DFIRMs) are published, the Pennsylvania State NFIP Coordinator at DCED works with communities to ensure the timely and successful adoption of an updated floodplain management ordinance by reviewing and providing feedback on existing and draft ordinances.

All twenty-seven municipalities that reside in Warren County have floodplain regulations in place that meet requirements set forth by the NFIP. Currently, no municipalities have completed or started to complete the CRS program. Additional research will be conducted on the CRS program and mitigation actions will be developed in support of the CRS.

In an effort to spread awareness as well as capture participation levels, all municipalities were instructed to complete an NFIP survey provided by the Federal Emergency Management Agency. All twenty-seven municipalities submitted an NFIP survey. These surveys can be found in Appendix C of this plan.

5.2.2. Administrative and Technical Capability

There are ten boroughs, sixteen townships, and one city within Warren County. Each of these municipalities conducts its daily operations and provides various community services according to local needs and limitations. Some of these municipalities have formed cooperative agreements and work jointly with their neighboring municipalities to provide services such as police protection, fire and emergency response, infrastructure maintenance and water supply management. Municipalities vary in staff size, resource availability, fiscal status, service provision, constituent population, overall size and vulnerability to the profiled hazards.

County Planning and Zoning Department

In Pennsylvania, planning responsibilities traditionally have been delegated to each county and local municipality through the Municipalities Planning Code (MPC). A planning agency acts as an advisor to the governing body on matters of community growth and development. A governing body may appoint individuals to serve as legal or engineering advisors to the planning agency. In addition to the duties and responsibilities authorized by Article II of the MPC, a governing body may, by ordinance, delegate approval authority to a planning agency for subdivision and land development applications. A governing body has considerable flexibility, not only as to which powers and duties are assigned to a planning agency, but also as to what form an agency will possess. A governing body can create a planning commission, a planning department, or both. The Warren County Planning and Zoning Department all municipalities in the county as needed. The county employs a county planner on an annual basis.

Municipal Engineer

A municipal engineer performs duties as directed in the areas of construction, reconstruction, maintenance and repair of streets, roads, pavements, sanitary sewers, bridges, culverts, and other engineering work. The municipal engineer prepares plans, specifications and estimates of the work undertaken by the township. All municipalities, with the exception of one, employ a municipal engineer on an as-needed basis.

Personnel Skilled in GIS or FEMA HAZUS Software

A geographic information system (GIS) is an integrated, computer-based system designed to capture, store, edit, analyze, and display geographic information. Some examples of uses for GIS technology in local government are land records management, land use planning, infrastructure management and natural resources planning. A GIS automates existing operations such as map production and maintenance, saving a great deal of time and money. The GIS also includes information about map features such as the capacity of a municipal water supply or the acres of public land. GIS data is managed, maintained and developed by the Warren County Planning and Zoning Department. There are currently no members of the Warren County GIS Department that have completed Basic HAZUS-MH.

Emergency Management Coordinator

Emergency management is a comprehensive, integrated program of mitigation, preparedness, response, and recovery for emergencies/disasters of any kind. No public or private entity is immune to disasters and no single segment of society can meet the complex needs of a major emergency or disaster on its own.

A municipal emergency management coordinator is responsible for emergency management – preparedness, response, recovery, and mitigation within his/her respective authority having jurisdiction (AHJ). The responsibilities of the emergency management coordinator are outlined in PA Title 35 §7503:

- Prepare and maintain a current disaster emergency management plan
- Establish, equip, and staff an emergency operations center
- Provide individuals and organizational training programs
- Organize and coordinate all locally available manpower, materials, supplies, equipment, and services necessary for disaster emergency readiness, response, and recovery
- Adopt and implement precautionary measures to mitigate the anticipated effects of a disaster
- Cooperate and coordinate with any public and private agency or entity
- Provide prompt information regarding local disaster emergencies to appropriate Commonwealth and local officials or agencies and the general public
- Participate in all tests, drills and exercises, including remedial drills and exercises, scheduled by the agency or by the federal government

Title 35 requires Warren County and its municipalities to have an emergency management coordinator.

The Warren County Emergency Management Agency countywide emergency management efforts. Each municipality has a designated local emergency management coordinator who possesses a unique knowledge of the impact hazard events have on their community.

The Emergency Management Services Code (PA Title 35) requires that all municipalities in the Commonwealth have a local emergency operations plan (EOP) which is updated every two years. All twenty-seven municipalities have adopted the county EOP. The notification and resource section of the plan was developed individually by each municipality.

Political Capability

One of the most difficult capabilities to evaluate involves the political will of a jurisdiction to enact meaningful policies and projects designed to mitigate hazard events. The adoption of hazard mitigation measures may be seen as an impediment to growth and economic development. In many cases, mitigation may not generate interest among local officials when compared with competing priorities. Therefore, the local

political climate must be considered when designing mitigation strategies, as it could be the most difficult hurdle to overcome in accomplishing the adoption or implementation of specific actions.

The capability assessment survey was used to capture information on each jurisdiction's political capability. Survey respondents were asked to identify examples of political capability, such as guiding development away from hazard areas, restricting public investments or capital improvements within hazard areas, or enforcing local development standards that go beyond minimum state or federal requirements (i.e. building codes, floodplain management ordinances, etc.). These examples were used to guide respondents in scoring their community on a scale of "unwilling" (0) to "very willing" (5) to adopt policies and programs that reduce hazard vulnerabilities. Of the municipalities that responded, none of the municipalities completed this section with a numerical response. *Table 67 - Warren County Community Political Capability* summarizes the results of political capability.

Table 67 - Warren County Community Political Capability

Warren County Community Political Capability						
Municipality Name	**Capability Ranking**					
	0	**1**	**2**	**3**	**4**	**5**
Bear Lake Borough		X				
Brokenstraw Township					X	
Cherry Grove Township					X	
Clarendon Borough				X		
Columbus Township				X		
Conewango Township						X
Deerfield Township		X				
Eldred Township				X		
Elk Township				X		
Farmington Township				X		
Freehold Township				X		
Glade Township						X
Limestone Township				X		
Mead Township						X
Pine Grove Township						X
Pittsfield Township				X		
Pleasant Township			X			
Sheffield Township				X		
Southwest Township			X			
Spring Creek Township	Not completed by municipality					
Sugar Grove Borough				X		
Sugar Grove Township					X	
Tidioute Borough				X		
Triumph Township	X					
Warren City						X
Watson Township						X
Youngsville Borough					X	

Self-Assessment

In addition to the inventory and analysis of specific local capabilities, the capability assessment survey required each local jurisdiction to conduct its own self-assessment of its capability to effectively implement hazard mitigation activities. As part of this process, county and municipal officials were encouraged to consider the barriers to implementing proposed mitigation strategies in addition to the mechanisms that could enhance or further such strategies. In response to the survey questionnaire, local officials classified each of the capabilities as either "L = limited" "M = moderate" or "H = high." *Table 68 – Capability Self-Assessment* Matrix summarizes the results of the self-assessment survey. Nineteen municipalities returned this section of the assessment completed.

Table 68 - Capability Self-Assessment Matrix

Warren County Capability Self-Assessment Matrix				
Municipality Name	**Capability Category**			
	Planning and Regulatory Capability	**Administrative and Technical Capability**	**Fiscal Capability**	**Community Political Capability**
Bear Lake Borough	L	L	L	L
Brokenstraw Township	L	L	L	L
Cherry Grove Township	L	L	L	L
Clarendon Borough	L	M	M	M
Columbus Township	L	M	M	M
Conewango Township	H	H	H	H
Deerfield Township	L	L	M	L
Eldred Township	L	L	L	L
Elk Township	L	L	L	L
Farmington Township	L	L	L	L
Freehold Township	L	L	L	L
Glade Township	L	M	M	M
Limestone Township	L	L	L	L
Mead Township	L	M	H	M
Pine Grove Township	L	L	L	H
Pittsfield Township	L	L	L	L
Pleasant Township	L	L	L	L
Sheffield Township	L	M	M	M
Southwest Township	L	L	L	L
Spring Creek Township	L	L	L	L
Sugar Grove Borough	L	M	H	H
Sugar Grove Township	L	M	M	M
Tidioute Borough	L	M	M	M
Triumph Township	Not completed by municipality			
Warren City	H	H	H	H
Watson Township	L	M	M	M
Youngsville Borough	L	M	H	M

Existing Limitations

Funding has been identified as the largest limitation for a municipality to complete mitigation activities. The acquisition of grants is the best way to augment this process for the municipalities. The county's and municipalities' representatives will need to rely on regional, state, and federal partnerships for future financial assistance. Development of intra-county regional partnerships and intra-municipality regional partnerships will bolster this process.

5.2.3. Financial Capability

Fiscal capability is significant to the implementation of hazard mitigation activities. Every jurisdiction must operate within the constraints of limited financial resources. The following information pertains to various financial assistance programs relevant to hazard mitigation.

State and Federal Grants

During the 1960s and 1970s, state and federal grants-in-aid were available to finance a large number of municipal programs, including streets, water and sewer facilities, airports, parks, and playgrounds. During the early 1980s, there was a significant change in federal policy, based on rising deficits and a political philosophy that encouraged states and local governments to raise their own revenues for capital programs. The result has been a growing interest in "creative financing".

Capital Improvement Financing

Because most capital investments involve the outlay of substantial funds, local governments can seldom pay for these facilities through annual appropriations in the annual operating budget. Therefore, numerous techniques have evolved to enable local government to pay for capital improvements over a time period exceeding one year. Public finance literature and state laws governing local government finance classify techniques that are used to finance capital improvements. The techniques include: revenue bonds; lease-purchase, authorities and special district; current revenue (pay-as-you-go); reserve funds; and tax increment financing. Most municipalities have very limited local tax funds for capital projects. Grants and other funding are always a priority.

Indebtedness through General Obligation Bonds

Some projects may be financed with general obligation bonds. With this method, the jurisdiction's taxing power is pledged to pay interest and principal to retire debt. General obligation bonds can be sold to finance permanent types of improvements, such as schools, municipal buildings, parks, and recreation facilities. Voter approval may be required.

Municipal Authorities

Municipal authorities are most often used when major capital investments are required. In addition to sewage treatment, municipal authorities have been formed for water supply, airports, bus transit systems, swimming pools and other purposes. Joint authorities have the power to receive grants, borrow money and operate revenue generating programs. Municipal authorities are authorized to sell bonds, acquire property, sign contracts and take similar actions. Authorities are governed by authority board members, who are appointed by the elected officials of the member municipalities.

Sewer Authorities

Sewer authorities include multi-purpose authorities with sewer projects. They sell bonds to finance acquisition of existing systems or for construction, extension, or system improvement. Sewer authority operating revenues originate from user fees. The fee frequently is based on the amount of water consumed and payment is enforced by the ability to terminate service or by the imposition of liens against real estate. In areas with no public water supply, flat rate charges are calculated on average use per dwelling unit.

Water Authorities

Water authorities are multi-purpose authorities with water projects, many of which operate both water and sewer systems. The financing of water systems for lease back to the municipality is among the principal activities of the local government facilities' financing authorities. An operating water authority issues bonds to purchase existing facilities or to construct, extend, or improve a system. The primary source of revenue is user fees based on metered usage. The cost of construction or extending water supply lines can be funded by special assessments against abutting property owners. Tapping fees also help fund water system capital costs. Water utilities are also directly operated by municipal governments and by privately owned public utilities regulated by the Pennsylvania Public Utility Commission. The Pennsylvania Department of Environmental Protection has a program to assist with consolidating small water systems to make system upgrades more cost effective.

Circuit Riding Program (Engineer)

The Circuit Riding Program is an example of intergovernmental cooperation. This program offers municipalities the ability to join together to accomplish a common goal. The circuit rider is a municipal engineer who serves several small municipalities simultaneously. These are municipalities that may be too small to hire a professional engineer for their own operations yet need the skills and expertise the engineer offers. Municipalities can jointly obtain what no one municipality could obtain on its own.

5.2.4. Education and Outreach

Warren County conducts an education and outreach program. The Warren County Emergency Management Agency conducts public outreach at public events to update the citizens and visitors of the county on natural and human-caused hazards. The county conservation district also conducts outreach on various activities and projects in the county. Many of these projects are related to or directly impact hazard mitigation projects.

Educational activities that directly impact hazard mitigation in Warren County predominantly revolve around the first responders. Providing fire, medical and search and rescue training and education enhances the response and recovery capabilities of response agencies in the county. Additional training is always a goal within Warren County.

Education and outreach on the NFIP are necessary. With new regulations in flood-plain management, updated digital flood insurance rate maps and new rates for insurance policies, education, and outreach on the NFIP would assist the program. The Warren County Local Planning Team will identify actions necessary to complete this.

5.2.5. Plan Integration

The Warren County Comprehensive Plan was utilized for various sections of the 2021 Warren County HMP Update. The Preface and Statement of Objectives sections provided useful information on the economy, land use, housing, transportation, community facilities and utilities, natural resources and historical

resources. Additionally, the Land Use section of the plan was utilized when developing section 2.4 of the community profile which provided valuable information on land use trends in Warren County. The Community Facilities and Utilities Plan section of the comprehensive plan was used in section 2.2 community facts which provided information on healthcare facilities and school districts.

The Warren County Comprehensive Plan identifies a list of priorities and goals related to the economy, land use, housing, transportation, community facilities and utilities, natural resources, and historical resources. Each guiding principle from this plan provided numerous actions and projects that were integrated into the 2021 HMP mitigation strategy. The following are some of the goals and actions from the 2005 comprehensive plan, followed by the 2021 HMP mitigation actions that were developed or supported by the goals and actions from the 2005 comprehensive plan:

- An identified goal in the county comprehensive plan mentions promoting the wise use of natural resources. The 2021 HMP local planning team developed mitigation goal five which identifies the need for conserving natural resources.
- On page 100 of the 2005 comprehensive plan is a section titled Inclusion by Reference. In this section, it states that the Warren County Hazard Mitigation Plan and the Warren County Solid Waste Plan were both utilized during the development of the comprehensive plan.

Although specific portions of the comprehensive plan outlined projects, actions or specific planning items that would support hazard mitigation, the information will be more comprehensive with the integration of new hazard mitigation principals and data from the 2021 Warren County HMP Update. During discussions with county planning personnel as part of this hazard mitigation plan update, discussions about the importance of hazard mitigation integration during the next comprehensive plan update was expressed. Specifically, the risk assessment section and mitigation strategy section hold vital information that requires integration into the next plan update. Identification of hazard areas, vulnerable structures and developments and future risk is critical in the determination of and management of economic growth and development areas in the county. Additionally, mitigation opportunity forms that have been received during the planning period would provide beneficial information for the next comprehensive plan update as well. The local planning team determined that an action to integrate 2021 hazard mitigation principals and data into the next updated county comprehensive plan was needed in the 2021 Warren County Hazard Mitigation Plan. Action 1.1.4 and 1.1.6 identify this.

In addition to the comprehensive plan, the Warren County Greenways Plan was also utilized in the development of goals and objectives found in the mitigation strategy section of this HMP update. An identified goal in the greenways plan is to conserve existing natural areas and to promote natural resources throughout Warren County. The 2021 HMP local planning team developed goal five which identifies the importance of promoting natural resources.

Warren County Emergency Operations Plan

The Pennsylvania Emergency Management Services Code, 35 PA C.S. Sections 7701-7707, as amended, requires each county and municipality to prepare, maintain and keep current an Emergency Operations Plan (EOP). Warren County Department of Emergency Services is responsible for preparing and maintaining the county's EOP, which applies to both the county and municipal emergency management operations and procedures.

The EOP is reviewed at least annually. Whenever portions of the plan are implemented in an emergency event or training exercise, a review is performed, and changes are made where necessary. These changes are then distributed to the county's municipalities.

The complete risk assessment section, mitigation actions and mitigation project opportunities identified in the Warren County Hazard Mitigation Plan will assist with decreasing hazard specific risk and vulnerability. Understanding the risks and vulnerability in the county and municipalities will allow for emergency management and other response agencies to better direct planning, response, and recovery aspects.

Warren County Emergency Management Agency will consider the Warren County Hazard Mitigation Plan during its annual review of the county EOP. Recommended changes to the HMP will then be coordinated with the hazard mitigation local planning team.

Plan Interrelationships

Ensuring consistency between these planning mechanisms is critical. In fact, Section 301 (4.1) of the Pennsylvania Municipalities Planning Code requires that comprehensive plans include a discussion of the interrelationships among their various plan components, "which may include an estimate of the environmental, energy conservation, fiscal, economic development and social consequences on the environment."

To that end, Warren County and its municipalities must ensure that the components of the hazard mitigation plan are integrated into existing community planning mechanisms and are generally consistent with goals, policies, and recommended actions. Warren County and the hazard mitigation planning team will utilize the existing maintenance schedule of each plan to incorporate the goals, policies and recommended actions as each plan is updated.

6. Mitigation Strategy

6.1. Update Process Summary

Mitigation goals are general guidelines that explain what the county wants to achieve. Goals are usually expressed as broad policy statements representing desired long-term results. Mitigation objectives describe strategies or implementation steps to attain the identified goals. Objectives are more specific statements than goals; the described steps are usually measurable and can have a defined completion date. There were six goals and fourteen objectives identified in the 2016 hazard mitigation plan. The 2021 Warren County Hazard Mitigation Plan Update has four six goals and sixteen objectives. Objectives have been added and arranged in order to associate them with the most appropriate goal. These changes are noted in *Table 69 – 2016 Mitigation Goals and Objectives Review*. These reviews are based on the five-year hazard mitigation plan review worksheet, which includes a survey on existing goals and objectives completed by the local planning team. Municipal officials then provided feedback on the changes to the goals and objectives via a mitigation strategy update meeting. Copies of these meetings and all documentation associated with the meetings are located in Appendix C.

Actions provide more detailed descriptions of specific work tasks to help the county and its municipalities achieve prescribed goals and objectives. There were thirty actions identified in the 2016 mitigation strategy. A review of the 2016 mitigation actions was completed by the local planning team. The results of this review are identified in *Table 70 – 2016 Mitigation Actions Review.* Actions were evaluated by the local planning team with the intent of carrying over any actions that were not started or continuous for the next five years.

Table 69 - 2016 Mitigation Goals and Objectives Review

2016 Mitigation Goals and Objectives Review		
GOAL Objective	**Description**	**Review Comments**
GOAL 1	**Warren County will provide guidance to municipalities on various programs that will support hazard mitigation efforts.**	Leave as-is.
Objective 1.1	Administer the following locally or at the county level: land use, zoning, building codes, storm water management and floodplain.	12 municipalities continue to remain un-zoned. All other land use controls remain in effect in all 27 municipalities. Change to: "Continue to enhance, review, update, and maintain municipal regulations."
Objective 1.2	Implement Community Wildfire Protection Plan (CWPP) recommendations and actions from this plan.	County Planning will re-engage municipalities and Volunteer Fire Departments.
GOAL 2	**Encourage municipalities to implement property protection measures intended to permanently get people, property, and businesses out of hazard prone areas.**	Change to: "Encourage municipalities to implement property protection measures that will discourage development in hazard prone areas.

GOAL Objective	Description	Review Comments
Objective 2.1	Pursue funding and resources available for purchase and removal of homes and businesses from hazard-prone areas and the relocation of at-risk structures.	The County has not yet pursued funding for this type of program. Leave as-is.
Objective 2.2	Obtain 100% NFIP participation when flood maps are updated	Change to "Maintain flood maps."
Objective 2.3	Encourage participation in the National Flood Insurance Program, Community Rating System	Update to the following and make it an action instead: "Educate and review as needed the CRS program."
GOAL 3	**Encourage municipalities to take measures aimed at minimizing the impact of hazards and disasters.**	Leave as-is.
Objective 3.1	Implement emergency response planning, alert/warning systems, monitoring systems, evacuation, and critical facility protection measures.	Take out "implement" and change to "maintain".
Objective 3.2	Conduct various training sessions for local officials and the public.	Warren County LPT decided this was an on-going objective.
GOAL 4	**Reduce or redirect the impact of natural disaster (especially flood), away from at–risk populations.**	New: "Reduce or redirect the impact of all-hazards away from at-risk populations."
Objective 4.1	Ensure proper maintenance of existing infrastructure (i.e. storm sewer systems, reservoirs, levees, floodwalls, etc.)	On-going municipal, or Army Corp of Engineers projects.
Objective 4.2	Implement various project opportunities to decrease the impact of flooding.	County and municipalities continue to investigate resource opportunities.
GOAL 5	**Protect natural resources.**	Change to: "*Conserve* natural resources."
Objective 5.1	Preserve and restore natural areas and natural functions.	On-going with conservation organizations such as Western Penna. Conservancy and like organizations. Change to: "Conserve and manage natural resources and natural functions."
Objective 5.2	Implement best management practices through cooperation between municipalities and park, recreation, conservation, and wildlife organizations.	On-going through PennSoil RC&D, Conservation District, etc. Change to: "Encourage cooperation and leveraging of resources among municipalities, state and federal agencies, and park & recreation conservation organizations through implementations of Best Management Practices (BMP's).

GOAL Objective	Description	Review Comments
Objective 5.3	Encourage stream bank restoration projects.	Warren County LPT decided this was an on-going objective.
GOAL 6	**Increase public awareness and education.**	Change to: "Increase public awareness of existing hazards and educate residents on how to best be prepared for natural and human-caused hazards."
Objective 6.1	Advise the public on personal safety and property protection.	On-going through a variety of county agencies.
Objective 6.2	Promote existing and future education and awareness programs	County EMA, Planning & Zoning, LEPC, etc.

Table 70 - 2016 Mitigation Actions Review

2016 Warren County Mitigation Actions Review Worksheet						
Existing Mitigation Actions (2016 HMP)	***Status***					***Review Comments***
	No Progress / Unknown	**In Progress / Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Action 1.1.1 – Municipal officials to review existing floodplain management ordinance and using the updated HMP, determine the necessity of implementing more restrictive provisions.				**X**		CRS Program was determined to be too burdensome. Move this to under goal 6.
Action 1.1.2 - Develop Watershed Management Plan for targeted flood prone sub-watersheds	**X**					The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 1.1.3 - Incorporate DFIRM into building permit applications.				**X**		The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 1.1.4 - Require structures to be built with the usable floor, 1.5 feet minimum, above base flood elevation.				**X**		The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.

2016 Warren County Mitigation Actions Review Worksheet						
Existing Mitigation Actions (2016 HMP)	***Status***					***Review Comments***
	No Progress / Unknown	**In Progress / Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Action 1.1.5 - Integrate the 2016 Warren County Hazard Mitigation Plan Data and principals into local municipal planning efforts.			**X**			Change to 2021.
Action 1.2.1 – Improve and publicize "burning bans".			**X**			Reword to: "Increase public awareness and more effectively publicize wildfire danger times and threats."
Action 1.2.2 - Develop incentives to encourage property owners to maintain defensible space around structures.			**X**			Reword to: "Develop awareness and educate the public on wildland/urban interface" ?
Action 1.2.3 - Encourage the use of non-combustible materials and technologies when upgrading or building structures in wildfire hazard areas.			**X**			Add: "Working with local construction businesses, encourage the use of non-combustible materials."
Action 1.2.4 - Identify and install signage to identify dry hydrant locations throughout the county.				**X**		Roll forward. "Identify, construct, and maintain dry hydrants throughout Warren County."
Action 1.2.5 - Research federal grant opportunities that will benefit local fire departments for wildfire protection, training and response services.			**X**			Done annually by EMA and Planning & Zoning.

2016 Warren County Mitigation Actions Review Worksheet						
Existing Mitigation Actions (2016 HMP)	*Status*					*Review Comments*
	No Progress / Unknown	In Progress / Not Yet Complete	Continuous	Completed	Discontinued	
Action 2.1.1 - Seek public input on using property acquisition as a technique for willing sellers to sell flood prone property.	**X**					The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 2.2.1 – Inform public about new Digital Flood Insurance Rate Maps (DFIRM).				**X**		"Continue to inform local elected officials and the public about new Digital Flood Insurance Rate Maps."
Action 2.2.2 - Continue to provide property owners information on how to obtain flood insurance from the NFIP.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 2.3.1 – Increase awareness of and participation in FEMA's Community Rating System (CRS) Program.				**X**		Moved to under goal 6.
Action 3.1.1 – Improve signage on trails and increase availability/improve maps in Allegheny National Forest.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 3.1.2 - Increase awareness about Chapman Dam Emergency Action Plan.		**X**				Reword to: "Reevaluate or review the action plan based on the recent improvements made to Chapman Dam."
Action 3.1.3 - Inventory areas vulnerable to winter storms in the municipalities.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.

2016 Warren County Mitigation Actions Review Worksheet						
Existing Mitigation Actions (2016 HMP)	*Status*					*Review Comments*
	No Progress / Unknown	In Progress / Not Yet Complete	Continuous	Completed	Discontinued	
Action 3.1.4 - Work with local wireless telecommunications carriers to improve cellular telephone coverage.		**X**				The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 3.1.5 - Identify mass clinic sites where medical supplies (e.g. vaccinations) can be distributed.				**X**		Completed
Action 3.1.6 - Determine if information on structure type including mobile homes is available for the county and attempt to compile information into a database.				**X**		Completed
Action 3.1.7 – Implement an emergency notification system for public notification of emergencies and warnings.			**X**			Reword to: "Maintain and enhance…"
Action 3.2.1 - Educate Emergency Management Coordinators and first responders about severe weather through SKYWARN.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 3.2.2 - Assist with coordination between county residents and utility companies on critical outage events.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.

2016 Warren County Mitigation Actions Review Worksheet						
Existing Mitigation Actions (2016 HMP)	*Status*					*Review Comments*
	No Progress / Unknown	In Progress / Not Yet Complete	Continuous	Completed	Discontinued	
Action 4.1.1 - Complete municipal project opportunities for elevation, relocation, and buyouts with removal of properties from the floodplain to decrease the impact of flooding.			**X**			Change to: Complete actions and projects to acquire, elevate, demolish or demolish/reconstruct repetitive loss properties
Action 5.1.1 - Continue to monitor the slide area along Route 59 and remove debris when necessary.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 5.1.2 - Encourage Programmatic agreements between state and local governments to mitigate debris when necessary to prevent the potential for flooding.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 5.2.1 - Educate the municipalities and the public in reference to the riparian buffers and their benefit.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 5.3.1 - Help manage projects to stabilize susceptible streambanks.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update.
Action 6.1.1 - Hold public meeting on deep gas well drilling, economics, and water quality.					**X**	Remove. No longer relevant.

2016 Warren County Mitigation Actions Review Worksheet						
Existing Mitigation Actions (2016 HMP)	*Status*					*Review Comments*
	No Progress / Unknown	In Progress / Not Yet Complete	Continuous	Completed	Discontinued	
Action 6.2.1 - Provide training to municipal officials on floodplain ordinance and storm water ordinance administration.			**X**			The Warren County LPT reviewed this action and determined the action should remain in the 2021 update

6.2. Mitigation Goals and Objectives

Based on results of the goals and objectives evaluation exercise and input from the local planning team, a list of six goals and fifteen corresponding objectives was developed. *Table 71 – 2021 Goals and Objectives* details the mitigation goals and objectives established for the 2021 Warren County Hazard Mitigation Plan.

Table 71 - 2021 Goals and Objectives

2021 Warren County Goals and Objectives	
GOAL Objective	***Description***
GOAL 1	**Warren County will provide guidance to municipalities on various programs that will support hazard mitigation efforts.**
Objective 1.1	Continue to enhance, review, update, and maintain municipal regulations.
Objective 1.2	Implement Community Wildfire Protection Plan (CWPP) recommendations and actions from this plan.
GOAL 2	**Encourage municipalities to implement property protection measures that will discourage development in hazard prone areas.**
Objective 2.1	Pursue funding and resources available for purchase and removal of homes and businesses from hazard-prone areas and the relocation of at-risk structures.
Objective 2.2	Maintain flood maps.
GOAL 3	**Encourage municipalities to take measures aimed at minimizing the impact of hazards and disasters.**
Objective 3.1	Maintain emergency response planning, alert/warning systems, monitoring systems, evacuations, and critical facility protection measures.
Objective 3.2	Conduct various training sessions for local officials and the public.
GOAL 4	**Reduce or redirect the impact of all-hazards away from at-risk populations.**

GOAL Objective	*Description*
Objective 4.1	Ensure proper maintenance of existing infrastructure (i.e. storm sewer systems, reservoirs, levees, floodwalls, etc.)
Objective 4.2	Implement various project opportunities to decrease the impact of flooding.
Objective 4.3	Reduce long-term vulnerabilities from eligible high hazard potential dams that pose an unacceptable risk to the public
GOAL 5	**Conserve natural resources.**
Objective 5.1	Conserve and manage natural resources and natural functions.
Objective 5.2	Encourage cooperation and leveraging of resources among municipalities, state and federal agencies, and park & recreation conservations organizations through implementation of Best Management Practices (BMP's).
Objective 5.3	Encourage stream bank restoration projects.
GOAL 6	**Increase public awareness of existing hazards and educate residents on how to best be prepared for natural and human-caused hazards.**
Objective 6.1	Advise the public on personal safety and property protection.
Objective 6.2	Promote existing and future education and awareness programs.
Objective 6.3	Investigate and pursue potential educational awareness activities in the schools and other youth organizations.
Objective 6.4	Develop a strategy to utilize social media in prevention, response, and mitigation efforts.

6.3. Identification and Analysis of Mitigation Techniques

This section includes an overview of alternative mitigation actions based on the goals and objectives identified in Section 6.2. There are four general mitigation strategy techniques to reducing hazard risks:

- Planning and regulations
- Structure and infrastructure
- Natural systems protection
- Education and awareness

Planning and Regulations: These actions include government authorities, policies or codes that influence the way land and buildings are developed and built. The following are some examples:

- Comprehensive plans
- Land use ordinances
- Subdivision regulations
- Development review
- Building codes and enforcement
- National Flood Insurance Program and Community Rating System
- Capital improvement programs
- Open space preservation
- Stormwater management regulations and master plans

The planning and regulations technique will protect and reduce the impact of specific hazards on new and existing buildings by improving building code standards and regulating new and renovation construction.

The improved building codes will decrease the impact of risk hazards. Subdivision and land development enhancements will also augment this process. Ensuring that municipalities participate in the National Flood Insurance Program and encourage participation in the Community Rating System will decrease the impact as well.

Structure and infrastructure implementation: These actions involve modifying existing structures and infrastructure or constructing new structures to reduce hazard vulnerability. The following are examples:

- Acquisitions and elevations of structures in flood prone areas
- Utility undergrounding
- Structural retrofits
- Floodwalls and retaining walls
- Detention and retention structures
- Culverts
- Safe rooms

Structure and infrastructure implementation is a technique that removes or diverts the hazard from structures or protects the structure from a specific hazard. The new or renovated structures are therefore protected or have a reduced impact of hazards.

Natural Resource Protection: These are actions that minimize damage and losses and also preserve or restore the functions of natural systems. They include the following:

- Erosion and sediment control
- Stream corridor restoration
- Forest management
- Conservation easements
- Wetland restoration and preservation

Natural resource protection techniques allow for the natural resource to be used to protect or lessen the impact on new or renovated structures through the management of these resources. Utilization and implementation of the examples above will protect new and existing buildings and infrastructure.

Education and Awareness: These are actions to inform and educate citizens, elected officials and property owners about hazards and potential ways to mitigate them and may also include participation in national programs. Examples of these techniques include the following:

- Radio and television spots
- Websites with maps and information
- Real estate disclosure
- Provide information and training
- NFIP outreach
- StormReady
- Firewise Communities

The education and awareness technique will protect and reduce the impact of specific hazards on new and existing buildings through education of citizens and property owners on the impacts that specific hazards could have on new or renovated structures. This information will allow the owner to make appropriate changes or enhancements that will lessen or eliminate the impact of hazards.

Table 72 – Mitigation Strategy Technique Matrix provides a matrix identifying the mitigation techniques used for all low, moderate, and high-risk hazards in the county. The specific actions associated with these techniques are included in *Table 73 – 2021 Mitigation Plan.*

Table 72 - Mitigation Strategy Technique Matrix

Warren County Mitigation Strategy Technique Matrix				
HAZARD	MITIGATION TECHNIQUE			
	Local Plans and Regula-tions	Structural and Infrastructure	Natural Systems Protection	Education and Awareness
Drought	X		X	X
Earthquake	X			X
Landslides	X	X		X
Flooding and Flash Flooding	X	X	X	X
Invasive Species	X		X	X
Pandemic, Epidemic, Infectious Dis-ease	X		X	X
Disorientation	X	X		X
Extreme Temperatures	X	X		X
Tornado/Windstorm	X	X		X
Wildfires	X	X	X	X
Winter Storms	X	X		X
Drowning	X			X
Hurricane/Tropical Storm	X	X		X
Hailstorm	X	X		X
Lightning Strike	X	X		X
Dam/Levee Failure	X		X	X
Emergency Services	X			X
Environmental Hazard: Hazardous Materials/Transportation	X	X		X
Substance Abuse	X			X
Terrorism	X			X
Transportation Accidents	X	X		X
Utility Interruptions	X	X		X

6.4. Mitigation Action Plan

The Warren County Hazard Mitigation Local Planning Team (LPT) immediately began work on the mitigation strategy section of the 2021 hazard mitigation plan (HMP) update after the risk assessment section was completed. The LPT started this section by reviewing the 2016 HMP mitigation strategy section. A review of the previous goals, objectives, actions and project opportunities documented in the 2016 HMP was conducted. The next step the LPT completed was the brainstorming of possible new actions based on new identified risks. The LPT compiled all this information for presentations to the municipalities.

MCM Consulting Group, Inc. completed municipality meetings at various time periods via conference calls due to COVID-19. During all these meetings, an overview of mitigation strategy was presented, and the municipalities were informed that they needed to have at least one hazard-related mitigation action for their municipality. All municipalities were invited to attend these meetings. Municipalities that were not able to join conference calls were contacted individually.

The municipalities were notified of draft mitigation actions and encouraged to provide new mitigation actions that could be incorporated into the plan. Municipalities were provided copies of their previously

submitted mitigation opportunity forms and asked to determine if the projects were still valid. Municipalities were solicited for new project opportunities as well. All agendas, sign in sheets and other support information from these meetings is included in Appendix C. Mitigation measures for the 2021 Warren County HMP are listed in *Table 73 – Mitigation Action Plan*. This plan outlines mitigation actions and projects that comprise a strategy for Warren County. The action plan includes actions, a benefit and cost prioritization, a schedule for implementation, any funding sources to complete the action, a responsible agency or department and an estimated cost. All benefit and cost analysis were completed using the Pennsylvania Emergency Management Agency recommended analysis tool. The completed analysis is located in Appendix H. *Table 74 – Municipal Hazard Mitigation Actions Checklis* is a matrix that identifies the county and/or municipalities responsible for mitigation actions in the new mitigation action plan.

Table 73 - 2021 Mitigation Action Plan

Warren County 2021 Mitigation Action Plan									
Action Number	Mitigation Actions			Prioritization			Implementation		
	Category	Description/ Action Items	Hazard Vulnerability	High	Medium	Low	Schedule	Funding	Local Champion
1.1.1	Planning and Regulations	Develop Watershed Management Plan for targeted flood prone sub-watersheds.	Flooding		**X**		2021 - 2024	Local	Warren County Planning and Zoning Department
1.1.2	Planning and Regulations	Incorporate DFIRM into building permit applications	Flooding		**X**		2021 - 2024	Local	Warren County Planning and Zoning Department
1.1.3	Structure and Infrastructure	Require structures to be built with the usable floor, 1.5 feet minimum, above base flood Elevation.	Flooding		**X**		2021 - 2024	Local	Warren County Planning and Zoning Department
1.1.4	Planning and Regulations	Integrate the 2021 Warren County Hazard Mitigation Plan Data and principals into local municipal planning efforts.	All-Hazards		**X**		2021 - 2024	FMA, BRIC Local	Warren County EMA/ Warren County Planning and Zoning Department
1.1.5	Planning and Regulations	Conduct a Commodity Flow Study (CFS).	Transportation Accidents		**X**		2021 - 2024	HMEP and LEPC	Warren County LEPC
1.1.6	Planning and Regulations	Integrate the current Warren County Hazard Mitigation Plan into the current county comprehensive plan and the current county and municipal emergency operations plan.	All-Hazards		**X**		2021 - 2024	Local	Warren County Planning and Zoning Department

Warren County 2021 Mitigation Action Plan									
Action Number	Mitigation Actions			Prioritization			Implementation		
	Category	Description/ Action Items	Hazard Vulnerability	High	Medium	Low	Schedule	Funding	Local Champion
1.2.1	Planning and Regulations	Increase public awareness and more effectively publicize wildfire danger times and threats.	Wildfire		**X**		2021 - 2024	Local	Warren County EMA
1.2.2	Planning and Regulations	Develop awareness and educate the public on wildland/urban interface.	Wildfire		**X**		2021 - 2024	Local	Warren County EMA
1.2.3	Structure and Infrastructure	Work with local construction businesses and encourage the use of non-combustible materials and technologies when upgrading or building structures in wildfire hazard areas.	Wildfire		**X**		2021 - 2024	Local	Warren County Municipalities/ Warren County Planning and Zoning Department
1.2.4	Planning and Regulations	Identify, construct, and maintain dry hydrants throughout Warren County.	Wildfire/Emergency Services/Environmental Hazards		**X**		2021 - 2024	AFG, PA Fire Grant, DCNR,Local	Warren County Municipalities
1.2.5	Planning and Regulations	Research federal grant opportunities that will benefit local fire departments for wildfire protection, training and response services.	Emergency Services/Wildfire		**X**		2021 - 2024	AFG, PA Fire Grant, DCNR,Local	Warren County EMA
2.1.1	Planning and Regulations	Seek public input on using property acquisition as a technique for willing sellers to sell flood prone property	Flooding		**X**		2021 - 2024	Local	Warren County EMA
2.2.1	Planning and Regulations	Continue to inform local elected officials and the public about new Digital Flood Insurance Rate Maps.	Flooding		**X**		2021 - 2024	FMA, BRIC Local	Warren County Planning and Zoning Department
2.2.2	Structure and Infrastructure	Continue to provide property owners information on how to obtain flood insurance from the NFIP	Flooding		**X**		2021 - 2024	FMA, BRIC Local	Warren County EMA
3.1.1	Planning and Regulations	Improve signage on trails and increase availability/improve maps in Allegheny National Forest.	Disorientation		**X**		2021 - 2024	DCNRLocal	Warren County EMA
3.1.2	Planning and Regulations	Reevaluate or review the action plan based on the recent improvements made to Chapman Dam.	Dam/Levee Failure	**X**			2021 - 2024	Local	Warren County EMA

Warren County 2021 Mitigation Action Plan									
Action Number	Mitigation Actions			Prioritization			Implementation		
	Category	Description/ Action Items	Hazard Vulnerability	High	Medium	Low	Schedule	Funding	Local Champion
3.1.3	Planning and Regulations	Inventory areas vulnerable to winter storms in the municipalities.	Winter Storms	**X**			2021 - 2024	Local	Warren County EMA/Warren County Municipalities
3.1.4	Planning and Regulations	Work with local wireless telecommunications carriers to improve cellular telephone coverage.	Emergency Services/Disorientation		**X**		2021 - 2024	Local	Warren County EMA
3.1.5	Planning and Regulations	Maintain and enhance an emergency notification system for public notification of emergencies and warnings.	All-Hazards/Emergency Services	**X**			2021 - 2024	Local	Warren County EMA
3.1.6	Education and Outreach	Communicate to the public of limited cell phone coverage to minimize disorientation and exhausting emergency response resources.	All-Hazards/Disorientation		**X**		2021 - 2024	Local	Warren County EMA
3.2.1	Structure and Infrastructure	Educate Emergency Management Coordinators and first responders about severe weather through SKYWARN.	All-Hazards			**X**	2021 - 2024	Local	Warren County EMA
3.2.2	Structure and Infrastructure	Assist with coordination between County residents and utility companies on critical outage events	Utility Interruption			**X**	2021 - 2024	Local	Warren County EMA
4.1.1	Structure and Infrastructure	Complete actions and projects to acquire, elevate, demolish, or demolish/reconstruct repetitive loss properties.	Flooding		**X**		2021 - 2024	Local	Warren County Municipalities
4.2.1	Structure and Infrastructure	Seek funding and participate in FEMA's High Hazard Potential Dams (HHPD) grant program and rehabilitate eligible dams in Warren County.	Dam/Levee Failure		**X**		2021 - 2024	Local	Warren County Planning and Zoning Department
4.2.2	Structure and Infrastructure	Continue to work with municipalities to identify and incorporate hazard mitigation Project Opportunity Forms to include in the 5-year update to the HMP.	All-Hazards		**X**		2021 - 2024	Local	Warren County EMA
4.3.1	Planning and Regulations	Enhance planning and mitigation strategy development for high hazard dams and levees.	Dam and Levee Failure	**X**				Local/EMPG/HHPD	High-Hazard Dam Owner
5.1.1	Structure and Infrastructure	Continue to monitor the slide area along Route 59 and remove debris when necessary.	Landslides		**X**		2021 - 2024	Local	Warren County Municipalities
5.1.2	Structure and Infrastructure	Encourage programmatic agreements between state and local governments to mitigate debris when necessary to prevent the potential for flooding.	Flooding		**X**		2021 - 2024	Local	Warren County Municipalities

Warren County 2021 Mitigation Action Plan									
Action Number	Mitigation Actions			Prioritization			Implementation		
	Category	Description/ Action Items	Hazard Vulnerability	High	Medium	Low	Schedule	Funding	Local Champion
5.1.3	Planning and Regulations	Collaborate with partnering agencies to promote awareness of invasive species (i.e. spotted lantern fly).	Invasive Species		X		2021 - 2024	Local	Warren County EMA
5.2.1	Planning and Regulations	Educate the municipalities and the public in reference to the riparian buffers and their benefit.	All-Hazards		X		2021 - 2024	FMA, BRIC Local	Warren County Planning and Zoning Department
5.3.1	Planning and Regulations	Help manage projects to stabilize susceptible streambanks	Flooding		X		2021 - 2024	FMA, BRIC Local	Warren County EMA
6.1.1	Structure and Infrastructure	Hold public meeting on deep gas well drilling, economics, and water quality.	Flooding		X		2021 - 2024	Local	Warren County Planning and Zoning Department
6.1.2	Planning and Regulations	Encourage municipal officials to review existing floodplain management ordinance and using the updated HMP.	Flooding		X		2021 - 2024	FMA, BRIC	Warren County EMA/ Warren County Planning and Zoning Department
6.1.3	Planning and Regulations	Increase awareness of and participation in FEMA's Community Rating System (CRS) Program.	Flooding		X		2021 - 2024	FMA	Warren County EMA
6.1.4	Education and Outreach	Continue to collaborate with public health agencies and law enforcement to identify and promote public awareness of opioids/substance abuse.	Substance Abuse		X		2021 - 2024	Local	Warren County EMA
6.2.1	Structure and Infrastructure	Provide training to municipal officials on floodplain ordinance and storm water ordinance administration.	Flooding		X		2021 - 2024	Local	Warren County Municipalities
6.3.1	Structure and Infrastructure	Incorporate emergency preparedness into school curriculum. Increase exposure of middle/high school students to first responder opportunities and careers.	Emergency Services		X		2021 - 2024	Local	Warren County EMA

Funding acronym definitions:

BRIC: Building Resilient Infrastructure and Communities, administered by the Federal Emergency Management Agency

DCNR: Department of Conservation and Natural Resources, administered by the State of Pennsylvania

FMA: Flood Mitigation Assistance Grant Program, administered by the Federal Emergency Management Agency

HMGP: Hazard Mitigation Grant Program, administered by the Federal Emergency Management Agency
PDM: Pre-Disaster Mitigation Grant, administered by the Federal Emergency Management Agency
EMPG: Emergency Management Performance Grant, administered by the Federal Emergency Management Agency
HSGP: Homeland Security Grant Program, administered by the Federal Emergency Management Agency
HMEP: Hazardous Material Emergency Planning Grant, administered by the Pennsylvania Emergency Management Agency
HMRF: Hazardous Material Response Fund, administered by the Pennsylvania Emergency Management Agency
HMERP: Hazard Mitigation Emergency Response Program by the Pennsylvania Emergency Management Agency
HHPD: High-hazard potential dam by the Federal Emergency Management Agency

Table 74 - Municipal Hazard Mitigation Actions Checklist

Municipal Hazard Mitigation Actions Checklist										
Municipality	**1.1.1**	**1.1.2**	**1.1.3**	**1.1.4**	**1.1.5**	**1.1.6**	**1.2.1**	**1.2.2**	**1.2.3**	**1.2.4**
Bear Lake Borough	X	X	X	X			X	X	X	X
Brokenstraw Township	X	X	X	X			X	X	X	X
Cherry Grove Township	X	X	X	X			X	X	X	X
Clarendon Borough	X	X	X	X			X	X	X	X
Columbus Township	X	X	X	X			X	X	X	X
Conewango Township	X	X	X	X			X	X	X	X
Deerfield Township	X	X	X	X			X	X	X	X
Eldred Township	X	X	X	X			X	X	X	X
Elk Township	X	X	X	X			X	X	X	X
Farmington Township	X	X	X	X			X	X	X	X
Freehold Township	X	X	X	X			X	X	X	X
Glade Township	X	X	X	X			X	X	X	X
Limestone Township	X	X	X	X			X	X	X	X
Mead Township	X	X	X	X			X	X	X	X
Pine Grove Township	X	X	X	X			X	X	X	X
Pittsfield Township	X	X	X	X			X	X	X	X
Pleasant Township	X	X	X	X			X	X	X	X
Sheffield Township	X	X	X	X			X	X	X	X
Southwest Township	X	X	X	X			X	X	X	X
Spring Creek Township	X	X	X	X			X	X	X	X
Sugar Grove Borough	X	X	X	X			X	X	X	X
Sugar Grove Township	X	X	X	X			X	X	X	X
Tidioute Borough	X	X	X	X			X	X	X	X
Triumph Township	X	X	X	X			X	X	X	X

Municipal Hazard Mitigation Actions Checklist										
Municipality	**1.1.1**	**1.1.2**	**1.1.3**	**1.1.4**	**1.1.5**	**1.1.6**	**1.2.1**	**1.2.2**	**1.2.3**	**1.2.4**
Warren City	X	X	X	X			X	X	X	X
Watson Township	X	X	X	X			X	X	X	X
Youngsville Borough	X	X	X	X			X	X	X	X
Warren County	X	X	X	X	X	X	X	X	X	X

Municipal Hazard Mitigation Actions Checklist										
Municipality	**1.2.5**	**2.1.1**	**2.2.1**	**2.2.2**	**3.1.1**	**3.1.2**	**3.1.3**	**3.1.4**	**3.1.5**	**3.1.6**
Bear Lake Borough	X	X	X	X						X
Brokenstraw Township	X	X	X	X						X
Cherry Grove Township	X	X	X	X						X
Clarendon Borough	X	X	X	X						X
Columbus Township	X	X	X	X						X
Conewango Township	X	X	X	X						X
Deerfield Township	X	X	X	X						X
Eldred Township	X	X	X	X						X
Elk Township	X	X	X	X						X
Farmington Township	X	X	X	X						X
Freehold Township	X	X	X	X						X
Glade Township	X	X	X	X						X
Limestone Township	X	X	X	X						X
Mead Township	X	X	X	X						X
Pine Grove Township	X	X	X	X						X
Pittsfield Township	X	X	X	X						X
Pleasant Township	X	X	X	X						X
Sheffield Township	X	X	X	X						X
Southwest Township	X	X	X	X						X
Spring Creek Township	X	X	X	X						X
Sugar Grove Borough	X	X	X	X						X
Sugar Grove Township	X	X	X	X						X
Tidioute Borough	X	X	X	X						X
Triumph Township	X	X	X	X						X
Warren City	X	X	X	X						X
Watson Township	X	X	X	X						X
Youngsville Borough	X	X	X	X						X
Warren County	X	X	X	X	X	X	X	X	X	X

Municipal Hazard Mitigation Actions Checklist										
Municipality	**3.2.1**	**3.2.2**	**4.1.1**	**4.2.1**	**4.2.2**	**5.1.1**	**5.1.2**	**5.1.3**	**5.2.1**	**5.3.1**
Bear Lake Borough	X	X	X	X	X		X		X	X
Brokenstraw Township	X	X	X	X	X		X		X	X
Cherry Grove Township	X	X	X	X	X		X		X	X
Clarendon Borough	X	X	X	X	X		X		X	X
Columbus Township	X	X	X	X	X		X		X	X
Conewango Township	X	X	X	X	X		X		X	X
Deerfield Township	X	X	X	X	X		X		X	X
Eldred Township	X	X	X	X	X		X		X	X
Elk Township	X	X	X	X	X		X		X	X
Farmington Township	X	X	X	X	X		X		X	X
Freehold Township	X	X	X	X	X		X		X	X
Glade Township	X	X	X	X	X		X		X	X
Limestone Township	X	X	X	X	X		X		X	X
Mead Township	X	X	X	X	X		X		X	X
Pine Grove Township	X	X	X	X	X		X		X	X
Pittsfield Township	X	X	X	X	X		X		X	X
Pleasant Township	X	X	X	X	X		X		X	X
Sheffield Township	X	X	X	X	X		X		X	X
Southwest Township	X	X	X	X	X		X		X	X
Spring Creek Township	X	X	X	X	X		X		X	X
Sugar Grove Borough	X	X	X	X	X		X		X	X
Sugar Grove Township	X	X	X	X	X		X		X	X
Tidioute Borough	X	X	X	X	X		X		X	X
Triumph Township	X	X	X	X	X		X		X	X
Warren City	X	X	X	X	X		X		X	X
Watson Township	X	X	X	X	X		X		X	X
Youngsville Borough	X	X	X	X	X		X		X	X
Warren County	X	X	X	X	X	X	X	X	X	X

Municipal Hazard Mitigation Actions Checklist										
Municipality	**6.1.1**	**6.1.2**	**6.1.3**	**6.1.4**	**6.2.1**	**6.3.1**				
Bear Lake Borough	X	X	X	X	X	X				
Brokenstraw Township	X	X	X	X	X	X				
Cherry Grove Township	X	X	X	X	X	X				
Clarendon Borough	X	X	X	X	X	X				
Columbus Township	X	X	X	X	X	X				

Municipal Hazard Mitigation Actions Checklist										
Municipality	**6.1.1**	**6.1.2**	**6.1.3**	**6.1.4**	**6.2.1**	**6.3.1**				
Conewango Township	X	X	X	X	X	X				
Deerfield Township	X	X	X	X	X	X				
Eldred Township	X	X	X	X	X	X				
Elk Township	X	X	X	X	X	X				
Farmington Township	X	X	X	X	X	X				
Freehold Township	X	X	X	X	X	X				
Glade Township	X	X	X	X	X	X				
Limestone Township	X	X	X	X	X	X				
Mead Township	X	X	X	X	X	X				
Pine Grove Township	X	X	X	X	X	X				
Pittsfield Township	X	X	X	X	X	X				
Pleasant Township	X	X	X	X	X	X				
Sheffield Township	X	X	X	X	X	X				
Southwest Township	X	X	X	X	X	X				
Spring Creek Township	X	X	X	X	X	X				
Sugar Grove Borough	X	X	X	X	X	X				
Sugar Grove Township	X	X	X	X	X	X				
Tidioute Borough	X	X	X	X	X	X				
Triumph Township	X	X	X	X	X	X				
Warren City	X	X	X	X	X	X				
Watson Township	X	X	X	X	X	X				
Youngsville Borough	X	X	X	X	X	X				
Warren County	X	X	X	X	X	X				

7. Plan Maintenance

7.1. Update Process Summary

Monitoring, evaluating, and updating this plan, is critical to maintaining its value and success in Warren County's hazard mitigation efforts. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continued basis. The Warren County HMP Local Planning Team decided to alter the current maintenance procedures. The 2021 HMP update establishes a review of the plan within thirty days of a disaster event in addition to continuing with an annual plan evaluation. This HMP update also defines the municipalities' role in updating and evaluating the plan. Finally, the 2021 HMP update encourages continued public involvement and how this plan may be integrated into other planning mechanisms in the county.

7.2. Monitoring, Evaluating and Updating the Plan

Hazard mitigation planning in Warren County is a responsibility of all levels of government (i.e., county and local), as well as the citizens of the county. The Warren County Local Planning Team will be responsible for maintaining this multi-jurisdictional HMP. The local planning team will meet annually and following each emergency declaration to review the plan. Every municipality that has adopted this plan will also be afforded the opportunity to provide updated information or information specific to hazards encountered during an emergency or disaster. Each review process will ensure that the hazard vulnerability data and risk analysis reflect current conditions of the county, that the capabilities assessment accurately reflects local circumstances and that the hazard mitigation strategies are updated based on the county's damage assessment reports and local mitigation project priorities. The HMP must be updated on a five-year cycle. An updated HMP must be completed and approved by the end of the five-year period. The monitoring, evaluating, and updating of the plan every five years will rely heavily on the outcomes of the annual HMP planning team meetings.

The Warren County Local Planning Team will complete a hazard mitigation progress report to evaluate the status and accuracy of the multi-jurisdictional HMP and record the local planning team's review process. The following items will be completed during the annual review and reporting process:

- Review the risk assessment section and identify occurrences of hazards within the last year. Identify date, time, damage, fatalities and other specific information of the events. Also identify any new hazards that have occurred or increased risk within the county.
- Complete a review and update of capability assessment section. Identify any capability weaknesses.
- Complete a review of the mitigation strategy section. Review the goals and objectives identified in the 2021 HMP and determine if any updates are needed. Provide all mitigation actions and opportunities to the county and municipalities that are applicable. Have all entities complete an action review matrix and document all results in the report. Also, add any new actions that are identified. Complete a review of each mitigation opportunity and identify the status of each opportunity on the opportunity review spreadsheet. All information will be included in the annual review report.

The Warren County Emergency Management Agency will maintain a copy of these records and place them in Appendix I of this plan. Warren County will continue to work with all municipalities regarding hazard mitigation projects, especially those municipalities that did not submit projects for inclusion in this plan.

7.3. Continued Public Involvement

The Warren County Emergency Management Agency will ensure that the 2021 Warren County Hazard Mitigation Plan is posted and maintained on the Warren County website and will continue to encourage public review and comment on the plan. The Warren County website that the plan will be located at is as follows: https://warrencopa.com/planning-zoning/

The public will have access to the 2021 HMP through their local municipal office, the Warren County Planning and Zoning Department, or the Warren County Emergency Management Agency. Information on upcoming events related to the HMP or solicitation for comments will be announced via newsletters, newspapers, mailings, and the county website.

The citizens of Warren County are encouraged to submit their comments to elected officials and/or members of the Warren County HMP Local Planning Team. To promote public participation, the Warren County Local Planning Team will post a public comment form as well as the Hazard Mitigation Project Opportunity Form on the county's website. These forms will offer the public various opportunities to supply their comments and observations. All comments received will be maintained and considered by the Warren County Hazard Mitigation Planning Team.

8. Plan Adoption

8.1. Resolutions

In accordance with federal and state requirements, the governing bodies of each participating jurisdiction must review and adopt by resolution, the 2021 Warren County Hazard Mitigation Plan. Copies of the adopting resolutions are included in this plan in Appendix J. FEMA Region III in Philadelphia is the final approval authority for the Hazard Mitigation Plan. PEMA also reviews the plan before submission to FEMA.

9. Appendices

APPENDIX A: References
APPENDIX B: FEMA Local Mitigation Review Tool
APPENDIX C: Meetings and Support Documents
APPENDIX D: Municipal Flood Maps
APPENDIX E: Critical and Special Needs Facilities
APPENDIX F: 2021 HAZUS Reports
APPENDIX G: 2021 Mitigation Project Opportunities
APPENDIX H: 2021 Mitigation Action Evaluation & Prioritization
APPENDIX I: Annual Review Documentation
APPENDIX J: Warren County & Municipal Adoption Resolutions