

Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan

Approved:
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List of Acronyms

Act 147	Pennsylvania Radiation Protection Act, 1984-147
Act 165	Pennsylvania Hazardous Material Emergency Planning and Response Act of 1990
Act 166	Pennsylvania Flood Plain Management Act of 1978
Act 167	Pennsylvania Stormwater Management Act of 1978
Act 227	Counterterrorism Planning, Preparedness and Response Act of 2002
Act 247	Pennsylvania Municipalities Planning Code Act of 1968
Act 78	Public Safety Emergency Telephone Act of 1990
ATV	All-Terrain Vehicle
BOF	Bureau of Forestry
BORM	Bureau of Recovery and Mitigation
CAC	Community Assistance Contacts
CAP	Community Assistance Program
CAV	Community Assistance Visits
CDBG-DR	Community Development Block Grant-Disaster Recovery
CDC	Centers for Disease Control and Prevention
CDMS	Comprehensive Data Management System
CEUS	Central and Eastern United States
CFR	Code of Federal Regulation
COOP	Continuity of Operations Plan
CRS	Community Rating System
DCED	Pennsylvania Department of Community and Economic Development
DCNR	Pennsylvania Department of Conservation and Natural Resources
DEP	Pennsylvania Department of Environmental Protection
DLI	Pennsylvania Department of Labor and Industry
DMA	Disaster Mitigation Act of 2000
DOH	Pennsylvania Department of Health
DRBC	Delaware River Basin Commission
DVMT	Daily vehicle miles traveled
EALs	Emergency Action Levels
EAP	Emergency Action Plan
EF-Scale	Enhanced Fujita Scale
EMAP	Emergency Management Accreditation Program
EMPG	Emergency Management Performance Grant
EOC	Emergency Operations Center
EPA	United States Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act of 1986
EPZ	Emergency Planning Zone
ESF	Emergency Support Function
FAC	Flood Advisory Committee

FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
FMA	Flood Mitigation Assistance
F-Scale	Fujita Scale
GIS	Geographic Information System
GSTF	Greatest Savings to the Fund
Hazus	Hazards United States Multi-Hazard (FEMA risk assessment software)
HIRA	Hazard Identification Risk Assessment
HM Toolkit	Commonwealth of Pennsylvania's All-Hazard Mitigation Planning and Project Identification Toolkit
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMP	Hazard Mitigation Plan
HMPO	Hazard Mitigation Project Opportunity
HUD	United States Department of Housing and Urban Development
HVAC	Heating, Ventilating and Air Conditioning
ICC	Increase Cost of Compliance
LEPC	Local Emergency Planning Committee
LiDAR	Light Detection and Ranging
LMRDP	Local Municipal Resources and Development Program
LUPTAP	Land Use Planning and Technical Assistance Program
MPO	Model Plan Outline
NCEI	National Centers for Environmental Information
NEMIS	National Emergency Management Information System
NFIA	National Flood Insurance Act of 1968
NFIF	National Flood Insurance Fund
NFIP	National Flood Insurance Program
NFPA	National Fire Protection Association
NIMS	National Incident Management System
NOAA	National Oceanic and Atmospheric Administration
NORMS	Normally occurring radioactive materials
NPL	National Priorities List
NRCS	Natural Resources Conservation Service
NWS	NOAA-National Weather Service
PACD	Pennsylvania Association of Conservation Districts
PAGs	Protective Action Guides
PHMC	Pennsylvania Historical and Museum Commission
PASDA	Pennsylvania Spatial Data Access
PASSHE	Pennsylvania State System of Higher Education
pCi/L	pico Curies per Liter
PDM	Pre-Disaster Mitigation
PDMS	Post-Defueling Monitored Storage
PDSI	Palmer Drought Severity Index

PEMA	Pennsylvania Emergency Management Agency
PEMA-KC	PEMA-Knowledge Center (incident management software)
PennDOT	Pennsylvania Department of Transportation
PennFIRS	Pennsylvania Fire Information Reporting System
PHGA	Peak Horizontal Ground Acceleration
PHMSA	United States Department of Transportation – Pipeline and Hazardous materials Safety Administration
PISC	Governor's Invasive Species Council of Pennsylvania
PNP	Private Non-profit
PRA	Probabilistic Risk Assessment
PSATS	Pennsylvania State Association of Township Supervisors
PUC	Pennsylvania Public Utilities Commission
REC	Record of Environmental Consideration
RF	Risk Factor
RFC	Repetitive Flood Claims
RL	Repetitive Loss
SARA	Superfund Amendments and Reauthorization Act of 1986
SBA	United States Small Business Administration
SCC	State Conservation Commission
SEOP	Commonwealth's State Emergency Operation Plan
SHSS	State Homeland Security Strategy
SHMO	State Hazard Mitigation Officer
SOG	Commonwealth of Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide
SPT	State Planning Team
SRL	Severe Repetitive Loss
SHMP	State Hazard Mitigation Plan
SSAHMP	State Standard All-Hazard Mitigation Plan
Stafford Act	Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988
TDS	Total Dissolved Solids
THIRA	Threat and Hazard Identification and Risk Assessment
TRI	Toxic Release Inventory
UCC	Uniform Construction Code
UDP	Urban Development Program
USACE	United States Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey

1 Introduction

1. Introduction

1.1. Background

Hazard mitigation describes sustained actions taken to reduce or eliminate long-term risks to life and property from hazards and create successive benefits over time. Mitigation is effective both before and after disaster events. It is preferred to mitigate in advance of a disaster and thus avoid impact, but often mitigation finds its greatest political and community will for implementation after a disaster. 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. Post-disaster mitigation happened during the process of recovery when re-building elevates and otherwise protects people and property from future risk. With careful selection, successful mitigation actions are cost-effective means of reducing risk of loss over the long-term. Mitigation will play a critical role both before and after disaster events as the Commonwealth aims to protect communities from current and future risk from climate change.

Since Pennsylvania's founding by William Penn, hazard mitigation has been an inherent value of the Commonwealth. In Pennsylvania, natural, technological and human-made hazards are managed through a system that is based on rights and responsibilities of individuals as well as local and state government. Through this system, the Commonwealth has created efforts to make communities safer and sustainable for future generations. The Pennsylvania Emergency Management Agency (PEMA) has been legislatively charged with coordinating Commonwealth government to prepare the State Hazard Mitigation Plan (SHMP).

Across the United States, natural and human-made disasters have led to increasing levels of deaths, injuries, property damage, and interruption of business and government services. This trend is projected to increase due to the impacts of climate change, therefore adding data, analysis, and action related to climate change was an important component of this plan update. The time, money and effort needed to recover from these disasters exhausts resources, diverting attention from important public programs and private agendas. Since 1954, there have been fifty-nine Presidential Disaster Declarations and ten Presidential Emergency Declarations in Pennsylvania.

Accordingly, the Pennsylvania Hazard Mitigation State Planning Team (SPT), composed of government agency leaders, academia and other organizations, has prepared this SHMP update. This all-hazard mitigation plan will guide the Commonwealth towards greater disaster resilience, while also respecting the character and needs of its local communities.

1 Introduction

Note that Pennsylvania is one of four states in the U.S that is officially designated as a *Commonwealth*. Therefore, with exception of certain terms such as the *State Planning Team*, *State Critical Facilities*, and others where applicable, Pennsylvania is referred to as a Commonwealth within the body of this SHMP.

1.2. Purpose

This Hazard Mitigation Plan was developed for the purpose of:

- Identifying hazards present in the Commonwealth.
- Determining the areas impacted by identified hazards that affect the lives and property of Pennsylvania citizens.
- Assessing what has been and should be done to reduce or eliminate the impact of identified hazards on Pennsylvania citizens.
- Developing and implementing a hazard mitigation action plan to make Pennsylvania citizens safer in the future.
- Qualifying for pre-disaster and post-disaster grant funding.
- Complying with state and federal legislative requirements related to state hazard mitigation planning.
- Demonstrating a firm commitment to hazard mitigation principles and building capacity to improve and complete more mitigation projects.
- Fostering collaboration and cooperation through a robust and ongoing planning process.
- Improving community resiliency following a disaster event.

1.3. Scope

Emergency Management Services Code, 35 Pa. C.S. Section 7503, as amended, gives specific authority to each political entity to prepare and implement plans that benefit the health and well-being of Pennsylvania citizens. While these plans represent “good common sense”, they also meet the federal statutory requirement for mitigation plans that enable communities to receive the full range of post-disaster assistance or mitigation grants.

This SHMP has been prepared using federal guidance as well as best mitigation practices employed successfully in areas of the Commonwealth and throughout the nation. It is consistent with the goal of fostering the protection of health and well-being of Pennsylvania citizens. Additionally, should a disaster occur that requires a presidential disaster declaration, this plan provides compliance with federal regulations that will enable expeditious availability of eligible mitigation funds.

1.4. Authority and References

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 79.4, 201 and 206.
- Disaster Mitigation Act (DMA) of 2000, Public Law 106-390, as amended.

1 Introduction

Authority for this plan originates from the following Commonwealth of Pennsylvania sources:

- Pennsylvania Emergency Management Services Code, Title 35, Chapter 73.
- Pennsylvania Municipalities Planning Code Act of 1968, P.L. 805, No. 247 as reenacted and amended.
- Pennsylvania Stormwater Management Act of 1978, P.L. 864, No. 167.

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

- *State Mitigation Plan Review Guide*, March 2015.
- *State Mitigation Planning Key Topics Bulletins: Planning Process*, July 2016.
- *State Mitigation Planning Key Topics Bulletins: Risk Assessment*, June 2016.
- *State Mitigation Planning Key Topics Bulletins: Mitigation Capabilities*, September 2016.
- *State Mitigation Planning Key Topics Bulletins: Mitigation Strategy*, October 2016.
- *Climate Change Adaptation Policy,* January 2012.
- *Hazard Mitigation Assistance Guidance*, February 2015.
- *Integrating Disaster Data into Hazard Mitigation Planning: A State and Local Mitigation Planning How-to-Guide*, February 2015
- *Integrating Hazard Mitigation Into Local Planning: Case Studies and Tools for Community Officials*, March 2013.
- *Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning: State and Local Mitigation Planning How-To Guide*, May 2005.
- *Local Mitigation Plan Review Guide,* October 1, 2011.
- *Local Mitigation Planning Handbook,* March 2013.
- *Mitigation Ideas. A Resource for Reducing Risk to Natural Hazards*, January 2013.
- *Plan Integration: Linking Local Planning Efforts*, July 2015.
- *Pre-Disaster Recovery Planning Guide for State Governments*, November 2016.

The following Pennsylvania guides and reference documents were used prepare this document:

- *Commonwealth of Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide (SOG),* October 2013 (being updated Summer 2018).
- *Hazard Mitigation Project Officer Handbook,* January 2014.
- Pennsylvania Pre-Disaster Mitigation Program Project and Planning Funding Assistance, October 2010.
- *Pennsylvania Silver Jackets Interagency Flood Mitigation Program Guide*, October 2015.
- *Pennsylvania Threat and Hazard Identification and Risk Assessment*, December 2017.

The following additional guidance document produced by the National Fire Protection Association (NFPA) was used to inform the Risk Assessment Hazard Descriptions in the SOG and this plan:

- NFPA 1600: *Standard on Disaster/Emergency Management and Business Continuity Programs*, 2007.

The *State Mitigation Plan Review Guide* notes several documents with principals that guide state hazard mitigation planning. These documents guide Pennsylvania SHMP, PEMA's overall work and mission, and the guidance followed for the SHMP update:

- *Presidential Policy Directive (PPD) 8 National Preparedness*, March 2011.
- *PPD 21 Critical Infrastructure Security and Resilience,* February 2013.
- *National Preparedness Goal,* September 2011.
- *National Mitigation Framework,* May 2013*.*
- *Executive Order 13653: Preparing the United States for the Impacts of Climate Change,* November 2013.

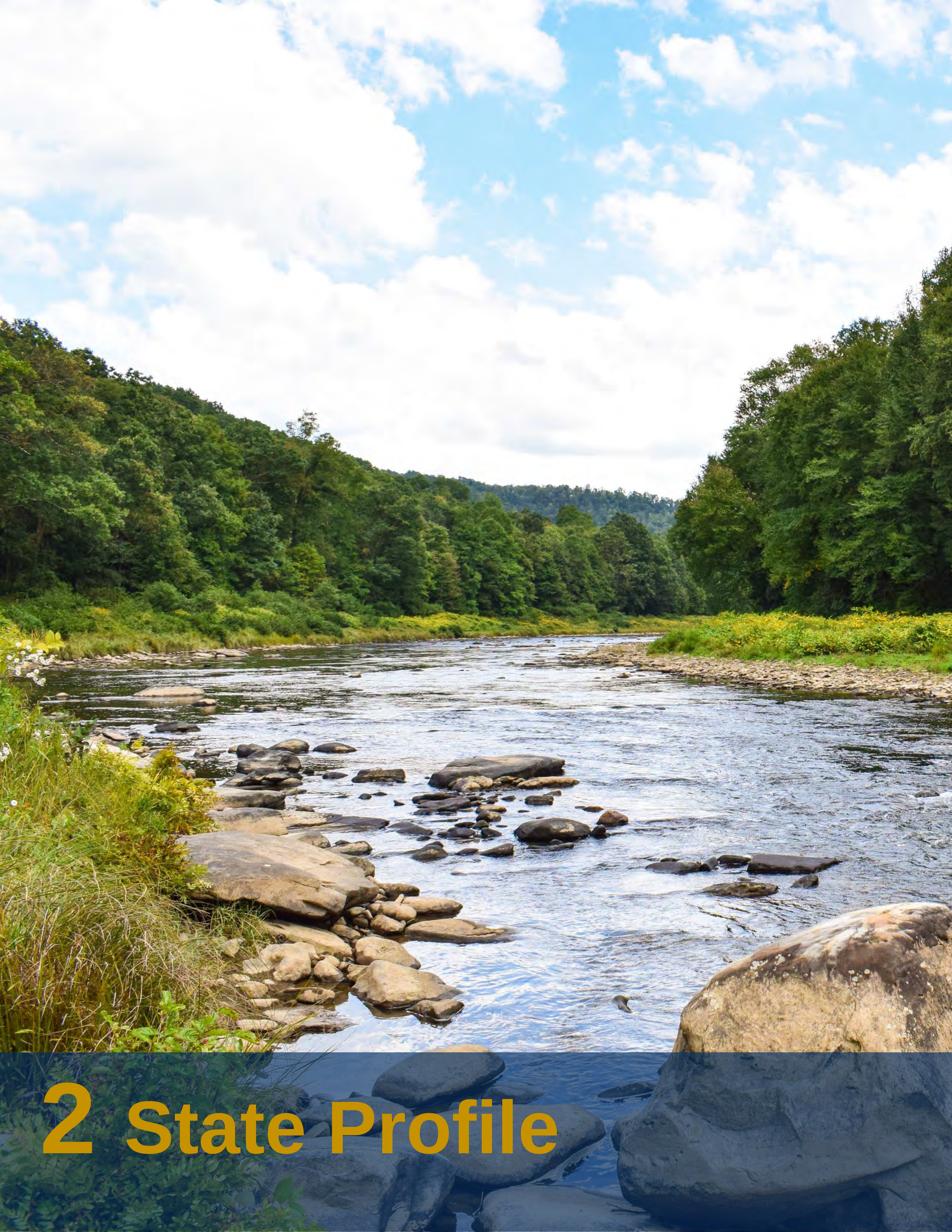
1.5. Statute Compliance Assurances

The Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), 42 U.S.C., Section 322, as amended, provides an approach to hazard mitigation planning. Section 322 continues the requirement for a state mitigation plan as a condition of disaster assistance. It also creates incentives for increased coordination and integration of mitigation activities at the state level through the establishment of criteria for two different levels of state mitigation plans, "standard" and "enhanced". The Stafford Act and associated implementing regulations emphasize the need for state, local, and tribal entities to closely coordinate mitigation planning and implementation efforts. States that demonstrate an increased commitment to comprehensive mitigation planning and implementation through the development of an approved enhanced mitigation plan can increase the amount of funding available through the Hazard Mitigation Grant Program (HMGP). Section 322 also establishes the requirement for local mitigation plans.

As part of the process of implementing the mitigation planning provisions of the Stafford Act, FEMA prepares Interim Final Rules and Final Rules regarding hazard mitigation planning and hazard mitigation assistance. Interim rules followed on February 26, 2002; October 1, 2002; October 28, 2003; September 13, 2004; October 31, 2007; and December 19, 2014. The Final Rules published October 31, 2007; September 16, 2009; April 25, 2014; and October 2, 2015. The April 25, 2014 Final Rule change the update period for state hazard mitigation plan from three to five years.

An additional summary of federal, state, and local disaster mitigation and emergency management laws is provided is Section 5.2.

The Commonwealth of Pennsylvania has created a SHMP that satisfactorily meets the requirements of the Stafford Act and has provided plan updates as required. This document follows the precedent for regulatory compliance and is consistent with the format and content prescribed under the implementing regulations of the amended Stafford Act legislation and subsequent regulations and guidance provided by FEMA. The Commonwealth of Pennsylvania will continue to comply with the Stafford Act and other applicable federal and state statutes when administering grant funding associated with this plan and will amend this plan as necessary under federal and state law. This document has been designed to be electronically available on the internet such that it can be widely distributed.



2 State Profile

2. State Profile

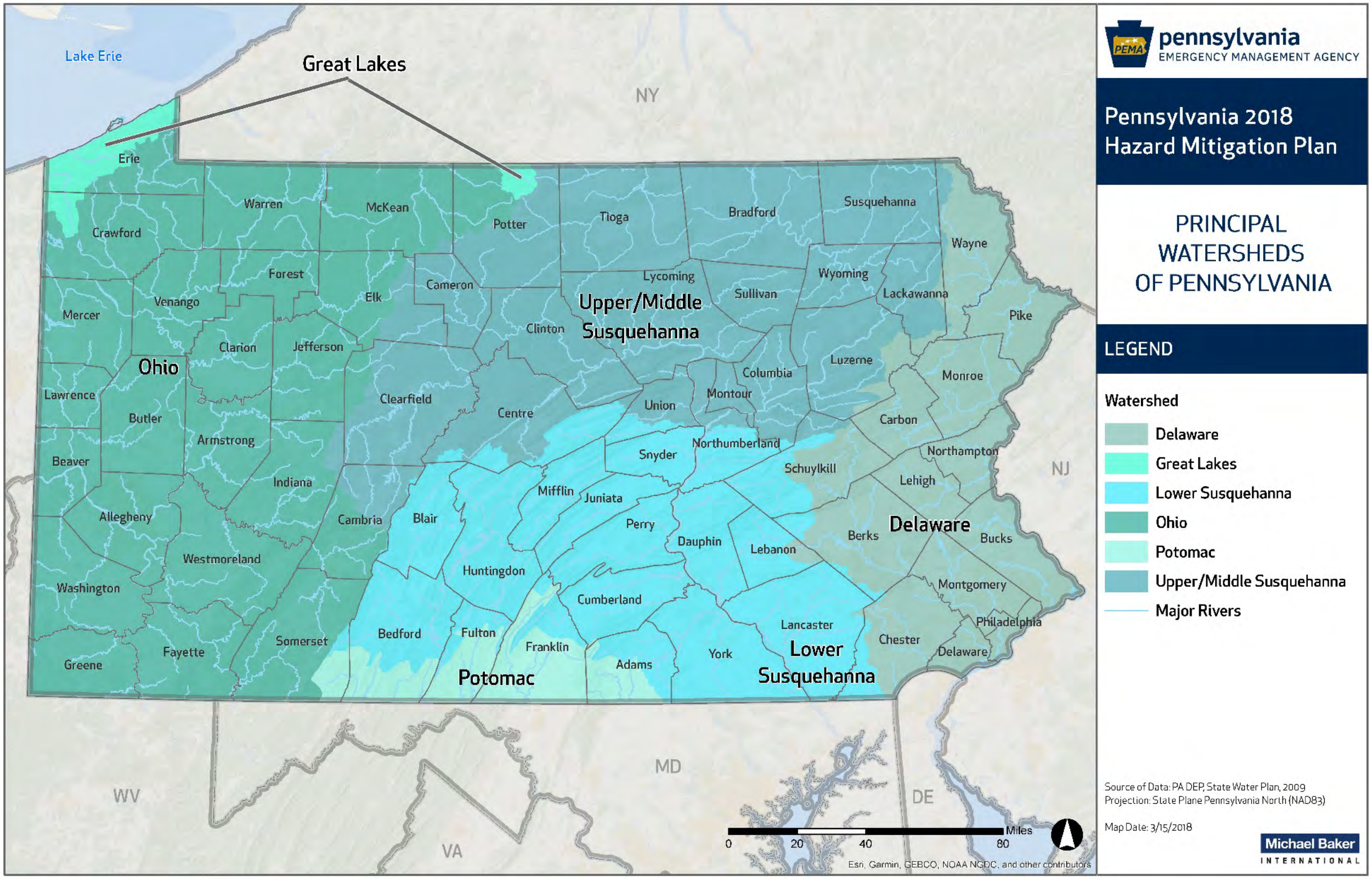
2.1. Geography and Environment

The Commonwealth of Pennsylvania consists of approximately 46,058 square miles, 44,820 square miles of which are land area. It is the 33rd largest of the 50 states. Pennsylvania covers an area defined approximately within 39.7 degrees to 42.3 degrees North Latitude and 74.4 degrees to 80.5 West Longitude.

Pennsylvania is bordered to the north by New York and Lake Erie. In the south, the Commonwealth shares a border with Maryland, New Jersey, Delaware, and West Virginia. It is bordered to the east by New Jersey and part of New York. The western border of the state is shared with West Virginia and Ohio.

The Commonwealth's eastern border is located approximately 60 miles inland from the Atlantic Ocean and the Northwestern corner of the Commonwealth borders Lake Erie. Pennsylvania has two tidal coasts: 112 miles of coastline along the Delaware Estuary and 77 miles of coastline along Lake Erie (PA DEP, 2018). Major rivers in the Commonwealth are the Allegheny River, Susquehanna River, Delaware River, and the Ohio River. Topographically, the Commonwealth is drained by the headwaters and main stems of four principal drainages: the Delaware River, Susquehanna River, the Ohio and Potomac. The Genesee and Erie watersheds drain to the Great Lakes. These principle watersheds are shown in Figure 2.1-1.

Figure 2.1-1 Major Watersheds in Pennsylvania



Pennsylvania topography varies from mountains to valleys to coastal plains as the Commonwealth contains topographic sections of the Coastal Plain, Piedmont, Ridge and Valley and Appalachian Plateau and Central Lowlands Physiographic provinces (Figure 2.1-2). The Allegheny Mountains are the primary mountain range in the state, stretching diagonally from the southwest to the northeast.

The geology of the Commonwealth is determined by these physiographic provinces. The provinces have distinct geology which can include sandstone, siltstone, clay, quartzite, etc. Karst geology is also present in the Commonwealth and can cause land subsidence and sinkholes. Karst geology is discussed in more detail is Section 4.3.13.

The various physiographic provinces of Pennsylvania also exhibit distinctive climatic characteristics based on region and elevation. In addition, Pennsylvania's climate is affected by Lake Erie and the Atlantic Ocean. The effect of the provinces on climate is described below.

Atlantic Coastal Plain and Piedmont Provinces

The Appalachian Mountains to the west and the Atlantic Ocean to the east moderate the climate of the Atlantic Coastal Plain and Piedmont provinces. Warm summers and mild winters are characteristic of this climatic zone. Daily temperatures reach 90°F or above on an average of 20 or more days during the summer season, and the area occasionally experiences uncomfortable warm periods of light winds and high relative humidity.

During the winter months, there are on average 100 or more days that have minimum temperatures at or below the freezing point. Minimum temperatures of 0°F or lower generally occur one or two times per year. The freeze-free season averages 170 to 200 days.

Precipitation is fairly evenly distributed throughout the year; maximum amounts occur during the late summer months. Annual precipitation averages 43 inches, and mean seasonal snowfall is 28 inches, the lowest for the state. Fields are normally snow covered about one third of the time during the winter season.

Ridge and Valley Province

The Ridge and Valley province has many of the characteristics of a mountain-type climate. Mountain and valley influences cause greater temperature extremes and an increase in daily ranges. The freeze-free season is generally between 140 and 180 days.

Maximum temperatures in most years are not excessively high; temperatures equal to or above 90°F occur on an average of only 18 days during the summer season. Temperatures above 100°F are seldom recorded. Minimum temperatures during January, February, and March are commonly below freezing, but are seldom below 0°F.

The average annual precipitation is 44 inches, similar to that of the Atlantic Coastal Plain and Piedmont provinces. A larger percentage of this precipitation falls in the form of snow, which averages 42 inches during the winter season.

Appalachian Plateaus Province

The Appalachian Plateaus province is fairly typical of a continental-type climate having changeable temperatures and more frequent precipitation than other parts of Pennsylvania. Latitude and elevation make the northern part of the province the coldest area of the state. Daily temperature ranges exceed those of other areas, averaging between 20°F and 30°F.

Because of the rugged topography, the freeze-free season is variable, ranging from 130 days in the north to 180 days in the south. Daily high temperatures reach 90°F or above on an average of 10 days during the summer season, but temperatures rarely exceed 100°F. During the winter months, there are normally about 145 days when temperatures dip to or below the freezing point. Low temperatures equal to or below 0°F generally occur eight days per season. In northern sections, subzero temperatures occur twice as often.

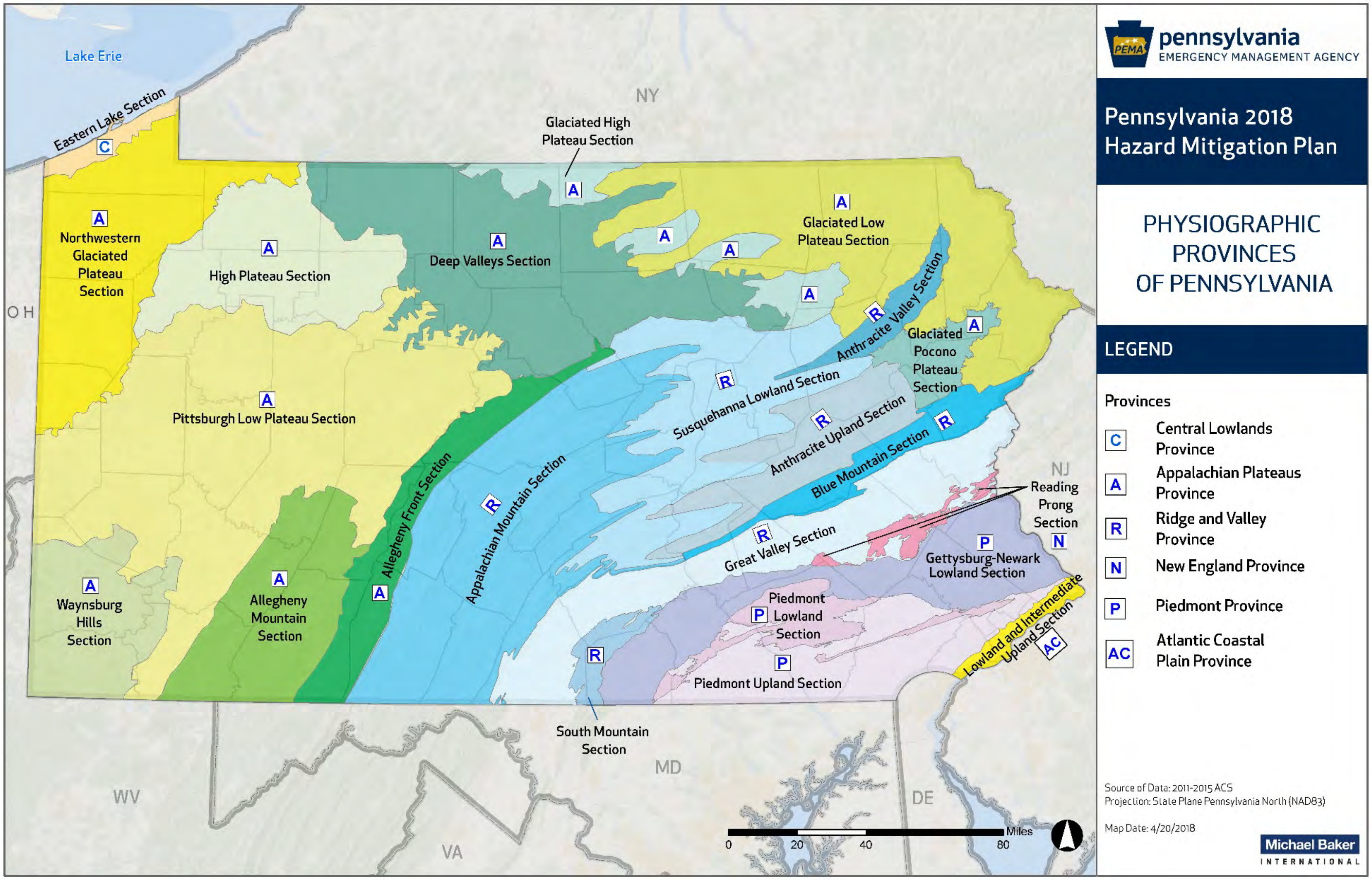
Mean annual precipitation is 40 inches, and seasonal snowfall is normally about 50 inches. The greatest amounts occur in the northern regions, where some areas average more than 80 inches annually. Fields are usually snow covered three fourths of the time during the winter season.

Central Lowland Province

The influence of Lake Erie is profoundly evident in the climate of the Central Lowland province. The lake has a moderating effect on temperatures, and the freeze-free season is normally extended to about 200 days. Temperatures above 90°F or below 0°F are extremely rare. The lake also reduces daily temperature ranges to less than 20°F in most months.

Temperature differences between the air and water produce cloudiness and frequent snowfalls during the winter months. The lake also acts as an important moisture source for the region. In Erie, mean annual snowfall averages about 60 inches, and annual precipitation averages close to 40 inches. Just inland of the lake, snowfall averages about 80 inches per year due to the added effect of Orographic influences.

Figure 2.1-2 Physiographic Provinces of Pennsylvania (DCNR, 2000).



2.2. State Facts

Before the area which is now present-day Pennsylvania was settled by the Europeans, it was first inhabited by groups of Native Americans. The largest tribes inhabiting the area were the Delaware, the Susquehannock, the Shawnee, and the Iroquois Confederacy. By the 1600's, early settlers in the area were the Dutch and the Swedes who held trading posts in the region. In 1664, the English claimed some of the land area of present-day Pennsylvania which led to conflicts with the Dutch who also held claims to some of the land. It was in 1681 that the Commonwealth of Pennsylvania was formally founded by William Penn (Pennsylvania General Assembly, 2010).

Throughout history, agriculture has been a leading industry in Pennsylvania. Primary crops were wheat, corn, rye, hemp, and flax. Although the number of farms and total farm acreage in the Commonwealth has declined since 1900, farm production has increased dramatically to meet consumer needs thanks to improved farming technologies. Today, Pennsylvania ranks 20th overall in agricultural production (USDA, 2012).

Industries such as iron and steel production were once prominent in Pennsylvania. Furthermore, textiles, leathermaking, lumbering, oil and coal production, shipbuilding, publishing, and tobacco and paper manufacturing also prospered in the 1800s and early 1900s in Pennsylvania. With the decline of some of those industries, new sectors arose which now contribute to the state's employment including wholesale and retail trade, food processing, health care and social administration, and educational, professional, scientific, and technical services.

Tourism is also a growing industry in Pennsylvania. The Commonwealth contains abundant natural resources and scenic landscapes which provide outdoor recreation opportunities such as fishing, camping, boating, bird-watching, hunting, hiking, swimming, and skiing. Additionally, Pennsylvania contains 117 state parks and several of the best museums in the country including the Philadelphia Museum of Art and the Carnegie Museums in Pittsburgh.

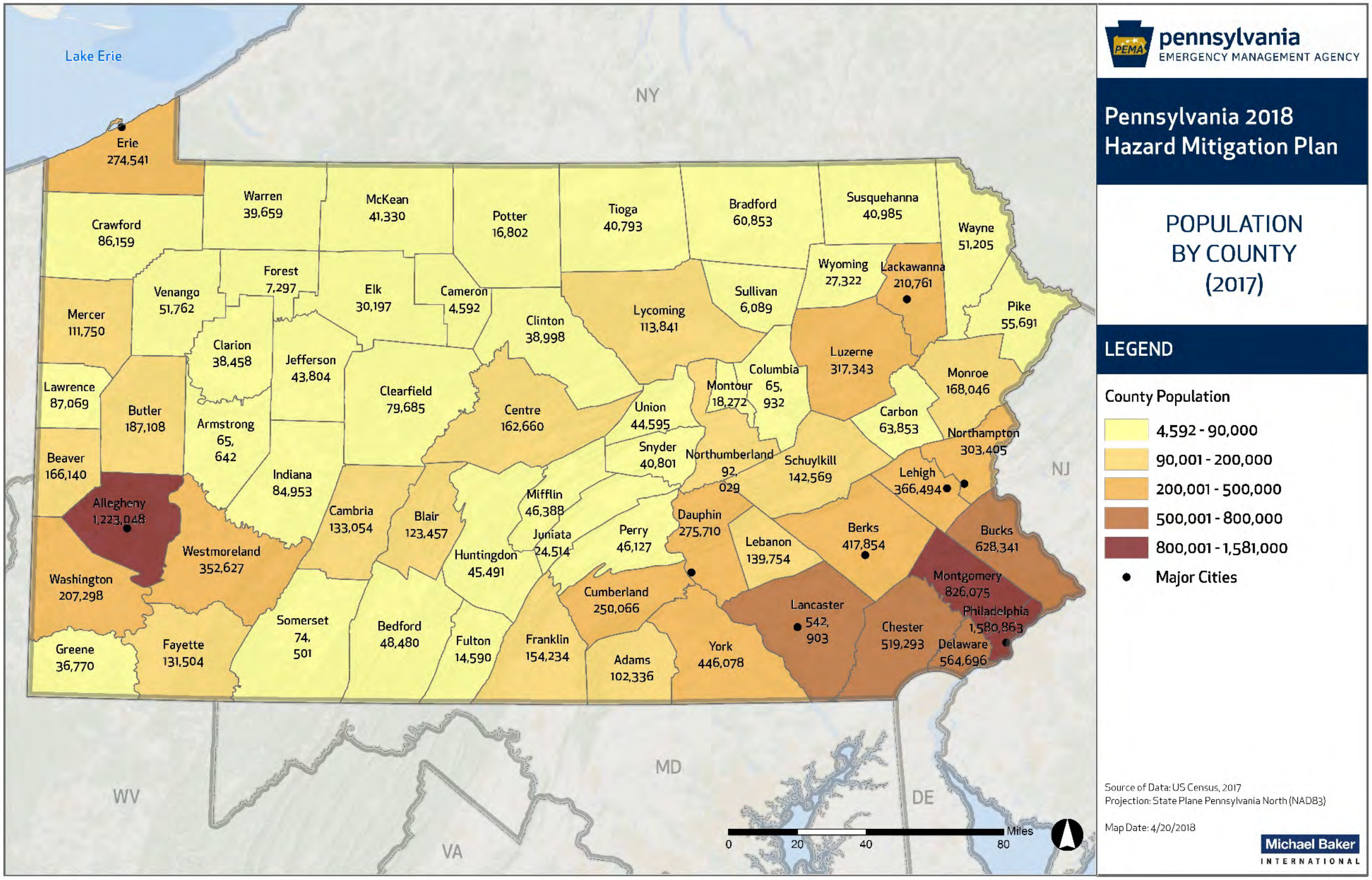
2.3. Population and Demographics

Pennsylvania contains 67 counties and 2,561 municipalities. The state's capital is Harrisburg. According to the 2010 U.S. Census, the population of Pennsylvania is 12,702,379 which ranked 6th among states in terms of total population. In 2017, the Commonwealth's estimated population grew to 12,805,537 and still ranks 6th in terms of total population. Table 2.3-1 depicts the 2010 Census county populations while Figure 2.3-1 shows population estimates for 2017. Population trends are described in Section 4.4.

Table 2.3-1 Summary of 2010 census populations for each county in Pennsylvania.			
COUNTY	**2010 CENSUS POPULATION**	**COUNTY**	**2010 CENSUS POPULATION**
Adams	101,407	Lackawanna	214,437
Allegheny	1,223,348	Lancaster	519,445
Armstrong	68,941	Lawrence	91,108
Beaver	170,539	Lebanon	133,568
Bedford	49,762	Lehigh	349,497
Berks	411,442	Luzerne	320,918
Blair	127,089	Lycoming	116,111
Bradford	62,622	McKean	43,450
Bucks	625,249	Mercer	116,638
Butler	183,862	Mifflin	46,682
Cambria	143,679	Monroe	169,842
Cameron	5,085	Montgomery	799,874
Carbon	65,249	Montour	18,267
Centre	153,990	Northampton	297,735
Chester	498,886	Northumberland	94,528
Clarion	39,988	Perry	45,969
Clearfield	81,642	Philadelphia	1,526,006
Clinton	39,238	Pike	57,369
Columbia	67,295	Potter	17,457
Crawford	88,765	Schuylkill	148,289
Cumberland	235,406	Snyder	39,702
Dauphin	268,100	Somerset	77,742
Delaware	558,979	Sullivan	6,428
Elk	31,946	Susquehanna	43,356
Erie	280,566	Tioga	41,981
Fayette	136,606	Union	44,947
Forest	7,716	Venango	54,984
Franklin	149,618	Warren	41,815
Fulton	14,845	Washington	207,820
Greene	38,686	Wayne	52,822
Huntingdon	45,913	Westmoreland	365,169
Indiana	88,880	Wyoming	28,276
Jefferson	45,200	York	434,972
Juniata	24,636	***PA TOTAL***	***12,702,379***

Table 2.3-2 Summary of 2017 census population estimates for each county in Pennsylvania.			
COUNTY	2017 ESTIMATED POPULATION	COUNTY	2017 ESTIMATED POPULATION
Adams	102,336	Lackawanna	210,761
Allegheny	1,223,048	Lancaster	542,903
Armstrong	65,642	Lawrence	87,069
Beaver	166,140	Lebanon	139,754
Bedford	48,480	Lehigh	366,494
Berks	417,854	Luzerne	317,343
Blair	123,457	Lycoming	113,841
Bradford	60,853	McKean	41,330
Bucks	628,341	Mercer	111,750
Butler	187,108	Mifflin	46,388
Cambria	133,054	Monroe	168,046
Cameron	4,592	Montgomery	826,075
Carbon	63,853	Montour	18,272
Centre	162,660	Northampton	303,405
Chester	519,293	Northumberland	92,029
Clarion	38,458	Perry	46,127
Clearfield	79,685	Philadelphia	1,580,863
Clinton	38,998	Pike	55,691
Columbia	65,932	Potter	16,802
Crawford	86,159	Schuylkill	142,569
Cumberland	250,066	Snyder	40,801
Dauphin	275,710	Somerset	74,501
Delaware	564,696	Sullivan	6,089
Elk	30,197	Susquehanna	40,985
Erie	274,541	Tioga	40,793
Fayette	131,504	Union	44,595
Forest	7,297	Venango	51,762
Franklin	154,234	Warren	39,659
Fulton	14,590	Washington	207,298
Greene	36,770	Wayne	51,205
Huntingdon	45,491	Westmoreland	352,627
Indiana	84,953	Wyoming	27,322
Jefferson	43,804	York	446,078
Juniata	24,514	***PA TOTAL***	**12,805,537**

Figure 2.3-2 Map displaying distribution by county of 2017 census populations estimates throughout Pennsylvania (U.S. Census, 2017).



The most populous county in the Commonwealth is Philadelphia County, which is conterminous with the City of Philadelphia, with a 2017 Census population of 1,580,863. Cameron County, with a population of 4,592, is the least populated county according to the 2017 Census population estimates. Populations are most dense in and around cities. Philadelphia, whose county and city jurisdictional boundaries are the same, is the largest city in the Commonwealth. The second most populous city is Pittsburgh, with a 2017 population of 305,704. Figure 2.2-3 shows population density throughout the Commonwealth based on the Census 2013-2017 five year estimates.

Population density has a strong correlation with hazard vulnerability and loss. For example, urban areas like Philadelphia and Pittsburgh naturally have larger populations and number of structures; therefore they naturally will experience greater loss during hazard events.

The age of populations can also correlate with vulnerability to hazards. Elderly populations and children may be more susceptible to hazards such as extreme temperature and pandemics. Table 2.3-2 depicts age distribution and median age of the population of each Pennsylvania County. The median age of residents of the Commonwealth of Pennsylvania is 40.6 with 21.2 percent of the population under 18 years of age and 16.7 percent 65 years or older. The Commonwealth ranks fourth in the nation in percentage of population age 65 and older. According to the Pennsylvania Department of Community and Economic Development (DCED) 2015 State Land Use and Growth Management Report, the age 65 and older population will make up nearly 23% of the state's population by the year 2030.

Table 2.3-3 Age Distribution and Median Age of County Populations, 5-Year Estimates 2011-2016 (Census, 2016).

COUNTY	Age Under 5	Age 5 – 19	Age 65+	Median Age
Adams	5,190	19,131	18,622	43.1
Allegheny	65,209	204,240	214,083	40.8
Armstrong	3,443	11,072	13,637	46
Beaver	8,799	28,257	33,333	44.8
Bedford	2,443	8,598	10,015	45.4
Berks	24,432	83,233	65,427	39.8
Blair	6,800	22,413	24,302	43.1
Bradford	3,647	11,311	11,929	44.3
Bucks	31,311	117,729	104,579	43.3
Butler	9,485	35,149	31,616	43
Cambria	6,750	23,971	28,103	44.7
Cameron	221	716	1,144	50.4
Carbon	3,024	10,936	12,544	45.5
Centre	6,526	29,925	19,738	30.8
Chester	29,186	106,502	74,756	40.3
Clarion	1,947	7,009	6,931	40.8
Clearfield	3,734	13,231	15,341	43.9

Table 2.3-3 Age Distribution and Median Age of County Populations, 5-Year Estimates 2011-2016 (Census, 2016).

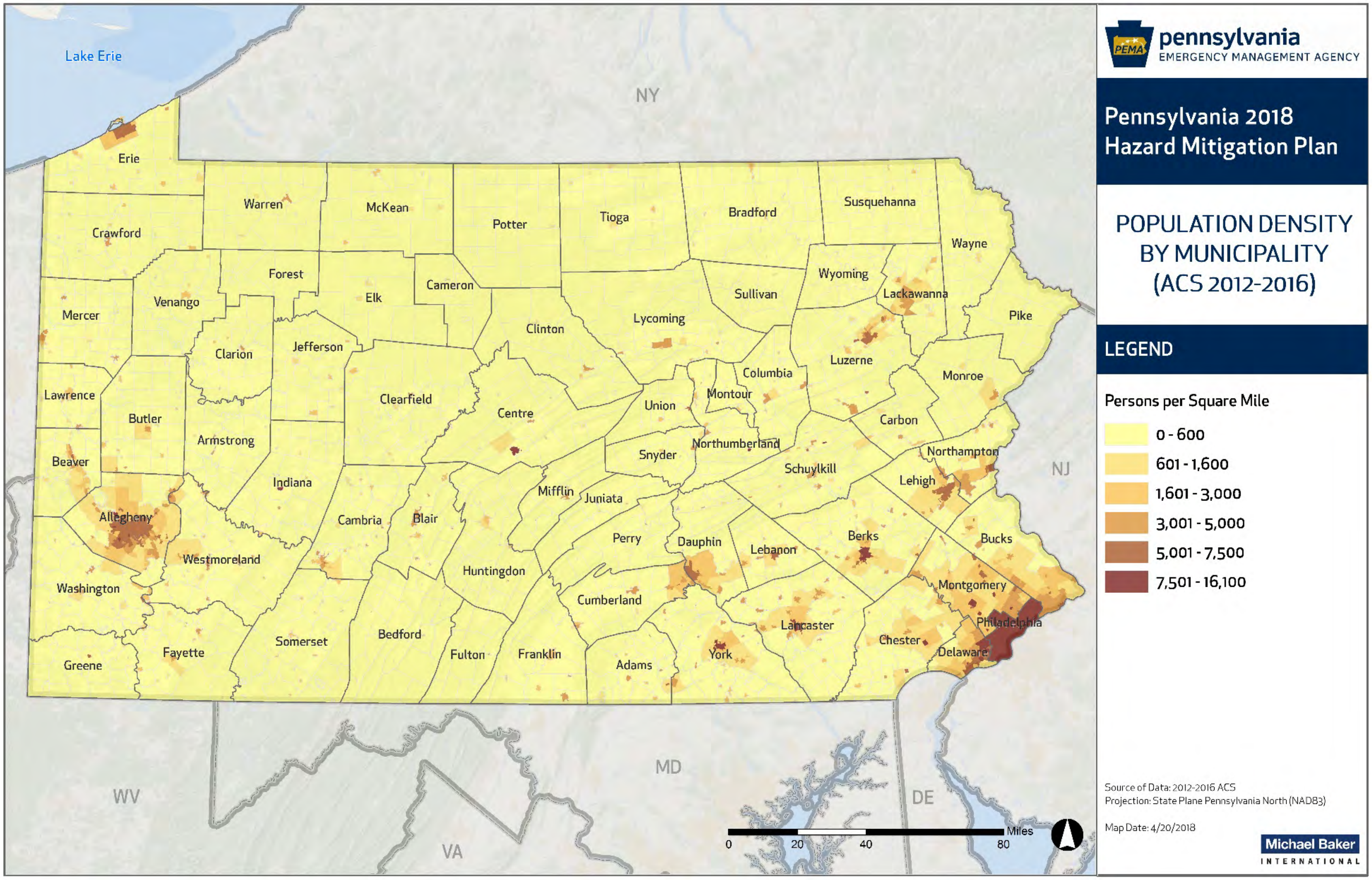
COUNTY	Age Under 5	Age 5 – 19	Age 65+	Median Age
Clinton	2,095	7,986	6,800	37.9
Columbia	3,072	12,486	11,552	40.1
Crawford	4,786	16,796	15,926	42.6
Cumberland	13,167	44,866	41,696	40.7
Dauphin	17,134	50,041	41,610	39.6
Delaware	33,739	110,776	84,910	39
Elk	1,524	5,258	6,378	46.6
Erie	15,911	54,710	43,824	38.9
Fayette	6,711	22,148	26,040	44.4
Forest	37	330	1,611	42.8
Franklin	9,162	29,625	27,793	40.9
Fulton	791	2,681	2,843	44
Greene	1,883	6,404	6,441	42
Huntingdon	2,246	7,885	8,527	42.7
Indiana	4,200	16,798	14,961	39
Jefferson	2,496	7,934	8,692	43.8
Juniata	1,389	4,739	4,913	43.2
Lackawanna	11,289	37,915	40,045	42.2
Lancaster	35,718	108,221	87,430	38.5
Lawrence	4,603	15,581	17,706	44.6
Lebanon	8,491	26,431	24,925	41.2
Lehigh	21,169	70,323	57,048	39.5
Luzerne	15,946	54,854	60,275	43
Lycoming	6,514	20,820	20,471	41.2
McKean	2,130	7,712	7,712	42.5
Mercer	5,615	21,086	22,690	44.1
Mifflin	2,842	8,618	9,410	43.5
Monroe	7,521	33,759	24,902	42
Montgomery	45,689	152,569	133,804	41.2
Montour	1,049	3,110	3,681	43.2
Northampton	15,327	56,197	51,990	41.9
Northumberland	4,960	15,349	18,437	44.2
Perry	2,648	8,353	7,258	42.5
Philadelphia	107,636	285,469	194,992	33.9
Pike	2,080	10,455	11,523	46.7
Potter	914	3,086	3,758	46.3
Schuylkill	6,984	24,299	27,937	44.1
Snyder	2,254	8,291	6,761	39.5

Table 2.3-3 Age Distribution and Median Age of County Populations, 5-Year Estimates 2011-2016 (Census, 2016).				
COUNTY	**Age Under 5**	**Age 5 – 19**	**Age 65+**	**Median Age**
Somerset	3,505	11,964	15,621	45.5
Sullivan	202	800	1,695	52.4
Susquehanna	1,924	7,153	8,408	46.9
Tioga	2,270	7,566	8,238	43.2
Union	2,033	8,629	7,274	39.1
Venango	2,833	9,142	10,639	45.8
Warren	1,992	6,870	8,414	46.4
Washington	10,413	36,655	39,363	44.3
Wayne	2,104	7,901	10,621	47
Westmoreland	16,531	58,938	74,391	46.3
Wyoming	1,399	5,119	5,147	43.7
York	25,114	84,155	69,615	40.8
PA TOTAL	**714,189**	**2,352,280**	**2,132,799**	***40.6***

There are an estimated 5,592,175 housing units in the state, eighty-nine percent of which are occupied with the remaining eleven percent being vacant. The median value of an owner-occupied home in the state is 167,700 (U.S. Census, 2012-2016).

The median income for households in Pennsylvania is $51,651. This is almost equal to the national median household income of $54,895. However, 13.3% of the Commonwealth’s residents live in poverty compared to the national average of 15.1% for the United States (U.S. Census, 2012-2016). While lower than the national average, the impact of disasters tends to be worse in low-income populations. Those living in poverty have fewer resources for evacuation during an event and less available funds for mitigation or other protective measures. Eighty-one percent of the Pennsylvania population is White, 11 percent is Black or African American, and just over three percent is American Indian, Alaska Native, Asian, Native Hawaiian, Pacific Islander or some other race (U.S. Census, 2012-2016).

Figure 2.3-3 Pennsylvania 2012-2016 Population Density (U.S. Census, 2016).



2.4. Land Use and Development

The Commonwealth of Pennsylvania has a variety of land uses ranging from agriculture to industrial. Residential land uses are concentrated in high densities in urban areas and are generally low-density and more spread out throughout the rest of the Commonwealth. Agriculture is also a prominent land use; there are over 7.7 million acres of farmland and over 59,000 farms throughout the Commonwealth. Over 489,000 acres of this farmland (~6.3%) is permanently preserved, thus protecting it from development and helping to maintain the rural character of the Commonwealth (Center for Rural Pennsylvania, 2017).

When Pennsylvania was first settled, land was predominantly forest-covered. In fact, the name *Pennsylvania* translates to “Penn’s woods.” Although much of the state’s original forest is gone, forest is still a primary land cover in the Commonwealth (Figure 2.4-1). The Allegheny National Forest is located in northwestern Pennsylvania and covers more than 500,000 acres.

Land cover significantly affects hazard vulnerability. For example, counties with a large percentage of forest cover, such as those that contain the Allegheny National Forest are more susceptible to wildfire hazards and also some invasive species. Additionally, human encroachment on wooded areas can leave more people vulnerable to wildfires if they do not appropriately plan for fire defensible space around their homes. Figure 2.4-1 displays areas the overall land cover in the Commonwealth. As urbanization occurs, areas that were once covered with trees and grass are being replaced by impervious surfaces of roads, roofs, and parking lots. This urbanization reduces infiltration of rainwater thus increasing the amount of stormwater runoff and the potential for flash flooding (USGS, 2005). This increase in stormwater runoff has a particular impact on communities built in karst areas, as more stormwater accelerates the natural percolation process that causes subsidence and sinkholes. Changes in ground cover can also exacerbate natural hazards like landslides since removing natural vegetation can cause unstable slopes. Development trends, including urbanization, are discussed in more detail in Section 4.4.

Pennsylvania land use and development are often defined by the Commonwealth’s transportation system. Roads, rail lines, airports, and ports are important for the transportation of people, goods, and services and development typically occurs around transportation hubs. Pennsylvania has a widespread highway network of over 120,000 miles which includes major interstate highways such as Interstate 80, the Pennsylvania Turnpike, Interstate 90, Interstate 79 and Interstate 81 (Figure 2.4-1). The Commonwealth has over 22,000 state-owned bridges and approximately 6,400 bridges on locally-owned roads. Pennsylvania contains over 5,000 miles of railway and 130 public-use airports, six of which are international airports (AirNav, 2010). Furthermore, there are three major ports in Pennsylvania: Philadelphia, Pittsburgh, and Erie.

The Department of Community and Economic Development completes growth management and land use reports in order to promote proactive land use planning in the Commonwealth. This report is completed every five years and evaluates contemporary land use issues, historic and projected trends, and development patterns at the state and regional level. According to their 2015 State Land Use and Growth Management Report, the pace of development was at a low between 2006 and 2011, when the amount of developed land increased by only 1.6%. This stands in stark contact to the preceding years; between 1992 and 2005, the amount of developed land in the Commonwealth increased by 131%. Additionally, between 2008 and 2014, the number of building permits issued were at historic lows. The Commonwealth's economy is back on its pre-recession track, although the state continues to deal with issues such as fiscal distress, poverty, and blight in many communities.

As a percentage of total land area, Pennsylvania's developed land area (urban or built-up land use/land cover classification) increased by 131.4% between the 1992–2005 inventory period. The Commonwealth's land use from 2006 to 2011 changed very little. Growth in developed land was only 1.7 percent, while losses in forest and agricultural lands were each less than 1 percent.

Pennsylvania has over 83,000 miles of streams and rivers within its borders, as seen in Figure 2.4-3. Every county in the Commonwealth has at least 100 miles of streams, and each county averages 1,239 linear miles of waterways. In general, counties within the Delaware River watershed have fewer miles of streams. It is important to note that fewer stream miles does not always mean reduced risk to flooding and flooding related hazards. In urban areas, streams were often historically filled in or piped into sewer systems. Hindering the natural flow of a stream can interrupt the ability of the natural environment to accommodate flood water and poor fill can lead to building collapses. Regardless of the mileage, Pennsylvania has an overall high volume of streams statewide, contributing to Pennsylvania's long and expensive flooding history.

Figure 2.4-1 Map of land cover throughout Pennsylvania (NLCD, 2011).

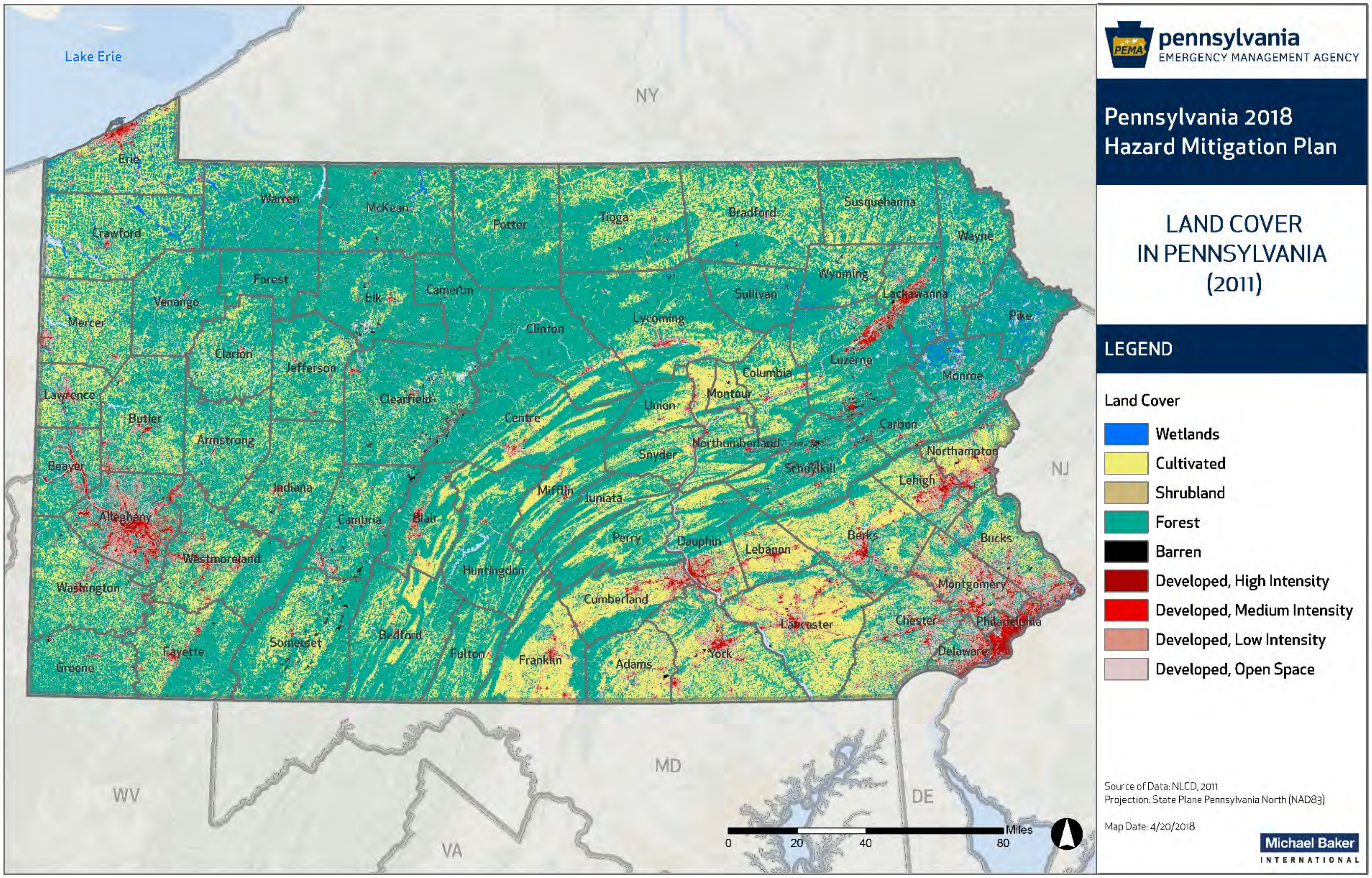
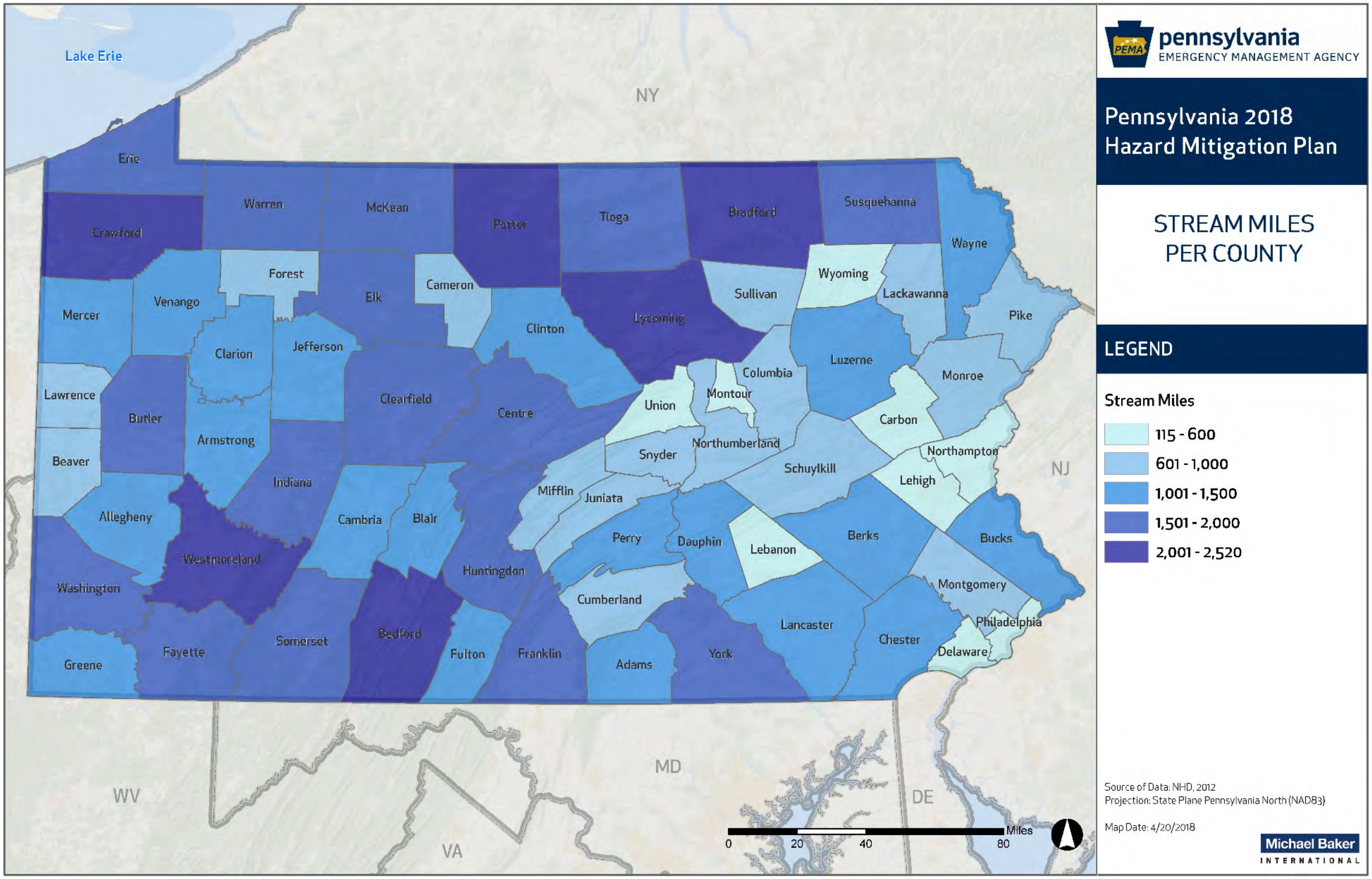


Figure 2.4-2 Major Highways in Pennsylvania (PennDOT, 2013).

Figure 2.4-3 Stream miles per county (National Hydrography Dataset, 2012).



2.5. Data Sources

To complete the Commonwealth's risk assessment, data was collected from a variety of sources. Overall, analysis was based on collecting the best data currently available. Information from the 2007 and 2010 plans was reviewed and incorporated as appropriate. Statewide data sets were used to perform spatial analyses that could more robustly address probabilistic risk.

The assessment began with a review of all the local hazard mitigation plans available in the Commonwealth. Hazards covered in county hazard mitigation plans are summarized in Section 4.1. The risk analyses in these local plans informed each of the hazard profiles throughout Section 4.3. Since the local plans use different data sources with various levels of detail, the SPT was consulted and research was conducted to identify consistent, statewide data sources. The data sources assembled through this research include national and Commonwealth databases as well as published reports. To estimate potential losses at the county and state levels, the best available data were identified for each hazard. For the vast majority of profiled hazards, more current and/or more robust datasets were available to estimate potential losses. For a few hazards, however, the measure of vulnerability did not change from the 2013 SHMP.

Data sources used for this update are covered in the Standard Operating Guide. This will allow local plans to use the same data sources as the state plan and will help standardize risk assessments throughout the Commonwealth (see Appendix D for full list). Distinct datasets and methodologies were used for natural hazards and human-made hazards. For both hazard types, however, probabilistic data on the past occurrences of hazard events was gathered, and a consistent methodology was applied to the extent possible.

The risk assessment for natural hazards was based largely on FEMA's National Risk Index, (NRI). FEMA collaborated with dozens of partners in academia, government, and private industry to develop the NRI. By combining natural hazard likelihood with social and physical factors, the NRI aims to provide state and local decision makers with a holistic understanding of place-based risk. National Risk Index scores can be viewed through the NRI's interactive, map-based platform (http://riskindex.atkinsatg.com/Home/Index), or downloaded through the National Risk Geodatabase (http://riskindex.atkinsatg.com/Home/Support). For this SHMP, the National Risk Geodatabase was downloaded and the datasets characterizing natural hazard likelihood were extracted. These natural hazard datasets were developed from data collected from authoritative government agencies and research institutes specializing in each hazard. FEMA used nationwide, probabilistic, and continuous data where possible, and processed the data to calculate hazard values at the census tract scale. For a summary of the detailed geoprocessing steps used to transform the source data into the hazard values for each hazard, please see the National Risk Index Data and Methods summary at http://riskindex.atkinsatg.com/Home/Support.

FEMA's NRI hazard values, in turn, are based largely on the NOAA National Centers for Environmental Information (NCEI) Storm Events Database. The NCEI Storm Events Database provides a comprehensive record of significant meteorological events that caused loss of life, injuries, or property damage, or that were otherwise rare or unusual. The database is based on reports from National Weather Service field offices across the US. Since 1950, these field offices have submitted reports on significant storm events to NWS headquarters, and headquarters staff have then checked the reported location and impacts before entering them into the Storm Events Database.

Note that the NRI documentation tends to refer to the calculated hazard values as “the maximum number of [hazard events] recorded in a given census tract” over the period of record. While this NRI wording was retained in the plan update, it is somewhat misleading. The geoprocessing steps applied to the source data generally involved a step to transform point data to grid data, and this step tended to result in overcounting. The hazard values therefore *correspond* to the number of occurrences of a hazard event, but should not be interpreted to *equal* the number of occurrences.

For this plan update FEMA’s NRI was used to inform nine hazard profiles: Drought; Extreme Temperature; Hailstorm; Hurricane, Tropical Storm, Nor’easter; Landslide; Lightning Strike; Tornado, Windstorm; Wildfire; and Winter Storm.

While the risk assessment for natural hazards was based largely on data from FEMA’s National Risk Index, the risk assessment for human-made hazards was based largely on data from PEMA’s incident management systems. An incident management system provides a centralized communication platform for state and local agencies engaged in incident response, allowing for more effective cross-agency and cross-jurisdictional collaboration. Since 2001, PEMA has used three different software systems to support its emergency management operations: the Pennsylvania Emergency Incident Reporting System or PEIRS (January 2001 – June 2009), WebEOC (June 2009 – Fall 2012), and PEMA-KC (Fall 2012 – present). The current incident management system, PEMA-KC, is an internet-based system that allows registered users to collaborate on emergency management by sharing incident information, planning documents, standard operating guidelines, contact information, and geospatial information. For the purposes of this plan update, PEMA provided the SPT with a database of closed incident events exported from PEMA-KC in April 2018. The database includes 73,514 events occurring between 1/1/2012 and 4/26/2018, each of which is classified into one of sixteen categories. The PEMA-KC database was used to inform five hazard profiles: Civil Disturbance, Environmental Hazard – Gas and Liquid Pipelines, Terrorism, Urban Fire and Explosion, and Utility Interruption.

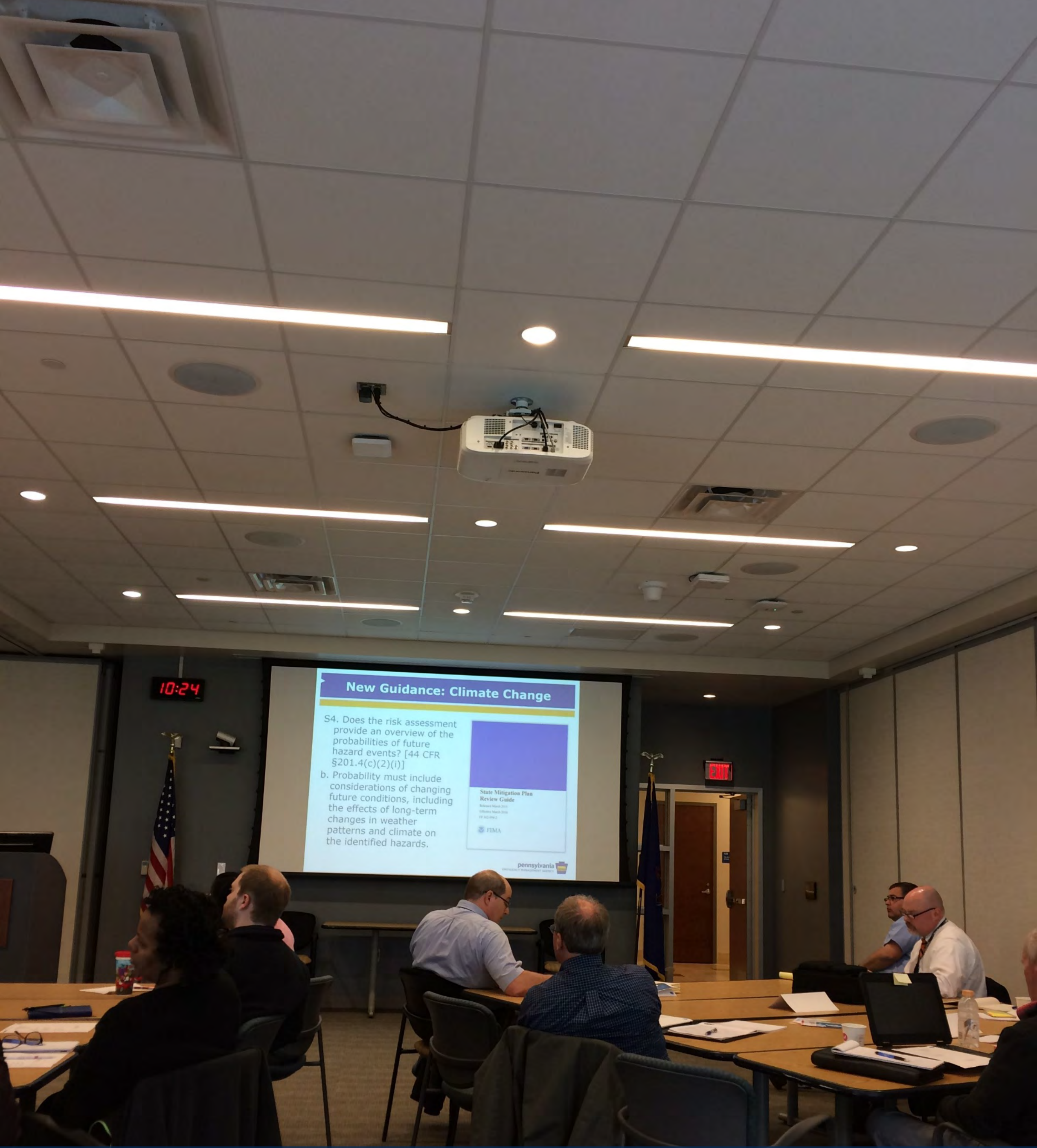
As previously stated, an attempt was made to provide consistency in reporting information. Population data used throughout this plan was drawn from the 2010 US Census and the 2016 American Community Survey. These two different Census products were used concurrently because the 2010 (and future Decennial) Census data no longer includes the “long form” – the detailed report of economics, housing, travel, and work patterns. This data is now only released in the American Community Survey. Additionally, the American Community Survey data is only released to the Census block group level rather than the block; this has implications in the Level 2 Hazus analysis completed for this plan update (See Section 4.1). Where specified in this SHMP, projected population estimates for the years 2010 - 2040 were obtained from the Pennsylvania Department of Environmental Protection (DEP).

Additionally, with so many hazards having an impact on agricultural yields, this SHMP uses the USDA Census of Agriculture to estimate losses and identify vulnerable counties. The USDA conducts this Census every 5 years. While the USDA is done collecting the data for its 2017 reporting year, this data is not yet available for use. As a result, this SHMP uses the 2012 Census.

As expected with the number and diversity of hazards being profiled, the sources of data used within this SHMP vary from hazard to hazard. Natural hazards tended to have more available information than human-made hazards. However, when available, GIS data was used for the hazards to identify hazard vulnerability and estimate potential losses. This information is presented in map and table format. GIS data was obtained from all levels of government; from the local government by obtaining building points along the Lake Erie shoreline for coastal erosion analysis; from the Commonwealth by obtaining critical facility locations and dams; and from the federal government by obtaining the most current flood and levee data, just to name a few. A complete list of data sources used primarily for mapping and analysis is listed in *Appendix D – Data Sources Lis*t. All other sources referenced in the body of the plan are listed in *Appendix A – Bibliography*. It should be noted that several GIS datasets were obtained from the Pennsylvania Spatial Data Access (PASDA) website (http://www.pasda.psu.edu/). PASDA is the official public access geospatial information clearinghouse for the Commonwealth of Pennsylvania. PASDA was developed by the Pennsylvania State University as a service to the citizens, governments, and businesses of the Commonwealth. PASDA is a cooperative project of the Governor's Office of Administration, Office for Information Technology, Geospatial Technologies Office and the Penn State Institutes of Energy and the Environment of the Pennsylvania State University.

Despite rapid strides in the quality and availability of GIS data in recent years, data limitations remain. Perhaps most conspicuously, dam inundation areas have yet to be compiled in GIS format, precluding the identification of critical facilities within those areas. Similarly, up-to-date Levee Protection Areas are net yet available in a centralized geodatabase, requiring the development of alternative methodologies to estimate vulnerability. Every effort was made to use the best available, most up-to-date information to conduct the risk assessment and vulnerability analysis for this plan update. As more accurate hazard data becomes available, the risk assessments presented in this SHMP will be further refined.

The data sources for completing the state and jurisdictional vulnerability assessments and loss estimations are presented in Section 4.1, followed by a summary of the methodologies applied.



3 Planning Process

3. Planning Process

3.1. Update Process and Participation Summary

The Planning Process was the leading force in building the SHMP. The input required to guide the update process was collected through meetings and communication with stakeholders from all levels of government, numerous agencies and organizations within the Commonwealth, the public, and PEMA staff. Three key groups that led the plan update include the SPT, County staff, and PEMA staff. These groups provided input on how to complete the update and reviewed outlines and draft text for sections of the plan as they were developed. Additionally, stakeholder outreach sessions were conducted to both educate and gather input for the plan update.

The 2018 update to the SHMP focused on value added improvements. Outreach was expanded and increased to new stakeholders. Climate change and historic preservation were two topics touched on lightly in the 2013 plan that were significantly expanded in 2018. The mitigation strategy was updated in greater detail as the focus of the plan. It was addressed in two large SPT meetings and then through additional follow-up via agency-specific meetings, conference calls, and targeted emails. The format of the plan remained consistent with the fully implemented Standard Operating Guide (SOG) for Pennsylvania allowing the focus on the update to be on clearly informing readers on risks and mitigation action in Pennsylvania.

The update process is described in the first sub-section of Sections 3 through 7. Table 3.1-1 summarizes plan updates from the 2010, 2013, and 2018 SHMP updates.

Table 3.1-1 Summary of updates of the SHMP

PLAN SECTION	SUMMARY OF UPDATE
SUMMARY OF THE 2010 UPDATE OF THE 2007 SSAHMP	
1. Introduction	Information that was contained in the Preface of the 2007 SSAHMP was re-summarized and expanded to address Background, Purpose, Scope, Authority and References, and Statue Compliance Assurances.
2. State Profile	Information that was spread throughout the 2007 SSAHMP was consolidated into one section and re-summarized to address Geography and Environment, State Facts, Population and Demographics, Land Use and Development, and Data Sources. Not all information related to these topics from 2007 was used in the 2010 SSAHMP in order to re-focus the plan on mitigation and follow FEMA hazard mitigation planning guidance more closely. In the 2010 SSAHMP, this base information serves as a summary of the Commonwealth prior to describing how hazards impact the Commonwealth.
3. Planning Process	Previous hazard mitigation planning efforts described in the 2007 SSAHMP were summarized. Information was added to describe the 2010 planning process in the sections Update Process and Participation Summary, State Planning Team, Meeting and Documentation, Public and Stakeholder Participation, and existing Planning Mechanisms.

Table 3.1-1 Summary of updates of the SHMP	
PLAN SECTION	**SUMMARY OF UPDATE**
4. Risk Assessment	All hazards identified in the 2007 SSAHMP were profiled in the 2010 SSAHMP. Two new natural hazards and one human-made hazard were profiled. Each hazard profile was re-arranged, re-summarized and new research was conducted to address the following sub-sections: 4.3.X.1 Location and Extent 4.3.X.2 Range of Magnitude 4.3.X.3 Past Occurrence 4.3.X.4 Future Occurrence 4.3.X.5 Environmental Impacts 4.3.X.6 Jurisdictional Vulnerability Assessment 4.3.X.7 State Facility Vulnerability Assessment 4.3.X.8 Jurisdictional Loss Estimation 4.3.X.9 State Facility Loss Estimation Please note that to complete spatial analysis to address all the above topics state-wide data sets were sought. Using the best data available for the 2010 plan, allowed for more robust risk analysis than just researching disasters in the 3-year period between plans.
5. Capability Assessment	Information that was in section 1.4.1 and 1.4.1.a of the 2007 SSAHMP was re-summarized and expanded to address Update Process Summary, State Capability Assessment, and Local Capability Assessment. Sub-sections within the 2010 SSAHMP more closely follow FEMA guidance for hazard mitigation planning.
6. Mitigation Strategy	Information that was in section 1.4 and 1.5 of the 2007 SSAHMP was re-summarized and expanded to address Update Process Summary, State Mitigation Strategy, and Local Mitigation Strategy. Sub-sections within the 2010 SSAHMP more closely follow FEMA guidance for hazard mitigation planning.
7. Plan Maintenance	Information that was in section 1.6 and 1.7 of the 2007 SSAHMP was re-summarized and expanded to address Update Process Summary; Monitoring, Evaluation and Updating the Plan; Incorporation into Other Planning Mechanisms; Continued Public Involvement; and Monitoring Progress of Mitigation Actions.
8. Plan Adoption	Information in 1.1.1 of the 2007 SSAHMP was re-summarized and addressed in Section 8 of the 2010 SSAHMP.
SUMMARY OF THE 2013 UPDATE OF THE 2010 SSAHMP	
1. Introduction	Information that was contained in the Preface of the 2010 SSAHMP was reviewed for correctness and for updates to the legislative and policy framework of hazard mitigation planning in the US and specific to Pennsylvania.

Table 3.1-1 Summary of updates of the SHMP	
PLAN SECTION	**SUMMARY OF UPDATE**
2. State Profile	Information from the 2010 plan was updated and to address Geography and Environment, State Facts, Population and Demographics, Land Use and Development, and Data Sources. Major inclusions include new, 2010 Census data and an update of the major data sources and limitations faced during the planning process. In the 2013 SSAHMP, this base information serves as summary of the Commonwealth and provides overall context for the risk assessment and mitigation strategy portions of the plan.
3. Planning Process	Previous hazard mitigation planning efforts described in the 2007 and 2010 SSAHMP were summarized. Information was added to describe the 2013 planning process in the sections Update Process and Participation Summary, State Planning Team, Meeting and Documentation, Public and Stakeholder Participation, and existing Planning Mechanisms.
4. Risk Assessment	All hazards identified in the 2010 SSAHMP were profiled in the 2013 SSAHMP. The SPT decided to incorporate climate change into all profiles of hazards that may be exacerbated by climate change. One new human-made hazard profile was added to the plan for Mass Food/Animal Food Contamination. Additionally, lock failure was added to the existing Dam Failure profile, Cyber Attack was added to the existing Terrorism profile, and internet interruption was added to the existing Utility Interruption profile. The SPT also decided to expand the existing Invasive Species profile. Each hazard profile was reviewed, and new research and data was added within the existing profile framework of: 4.3.X.1 Location and Extent 4.3.X.2 Range of Magnitude 4.3.X.3 Past Occurrence 4.3.X.4 Future Occurrence 4.3.X.5 Environmental Impacts 4.3.X.6 Jurisdictional Vulnerability Assessment 4.3.X.7 State Facility Vulnerability Assessment 4.3.X.8 Jurisdictional Loss Estimation 4.3.X.9 State Facility Loss Estimation Using the best data available for the 2013 plan allowed for more robust risk analysis than just researching disasters in the 3-year period between plans.

Table 3.1-1 Summary of updates of the SHMP	
PLAN SECTION	**SUMMARY OF UPDATE**
5. Capability Assessment	The 2013 SSAHMP expands upon the 2010 Capability Assessment with a summary of the tools available to the Commonwealth for pre- and post-disaster hazard mitigation efforts as well as development management. Federal, state, local and private funding sources are provided in this section. Additionally, major updates and additions include: addition of “Legal Context” section; addition of “Federal Programs Supporting Hazard Mitigation in Pennsylvania” section; updates to the BORM staff text such as job descriptions, trainings, conferences, exercises, etc.; updates to the organizational charts for PEMA and BORM; addition of “Other State and Multi-Agency Programs in Pennsylvania” section; addition of “Hazard Mitigation Land Use Measures in Pennsylvania” section; additions to the PA Emergency Operations Center section; updates to the Status of Local Hazard Mitigation Plans section text and mapping; updates to the Summary & Evaluation of Local Mitigation Capability section text and mapping; addition of a CRS participation map, Firewise and StormReady information. The 2013 Capability Assessment provides a more robust discussion of plan integration.
6. Mitigation Strategy	An evaluation of the existing strategy was conducted including a comparison of high-ranking hazards and number of associated mitigation actions. The results of this evaluation are illustrated and described in Section 6. All goals, objectives and actions were evaluated, and the Mitigation Action Plan was updated accordingly. Mitigation project information from 2010 to 2013 was incorporated in the plan. Portions of Section 6.5 that pertained to funding and assistance were moved to Sections 5.3, Capability Assessment. Commonwealth. A new “Mitigation Successes” section was added.
7. Plan Maintenance	Information that was in the 2010 SSAHMP was reviewed and updated as needed to reflect new plan maintenance procedures and schedules. Special emphasis was given to the integration of the SSAHMP into future planning efforts in the Commonwealth.
8. Plan Adoption	Information in Section 8 of the 2010 SSAHMP was reviewed and revised as necessary in the 2013 SSAHMP.
SUMMARY OF THE 2018 UPDATE OF THE 2013 SSAHMP	
1. Introduction	Information was reviewed and updated to reflect current authorities and references for State hazard mitigation planning. The new *State Mitigation Plan Review Guide* for March 2015 is noted along with broad level improvements to address climate change and historic preservation.
2. State Profile	Information from the 2013 plan was updated to address Geography and Environment, State Facts, Population and Demographics, Land Use and Development, and Data Sources.
3. Planning Process	Previous hazard mitigation planning efforts from 2007, 2010, and 2013 were summarized. Information was added to describe the 2018 planning process in the sections Update Process and Participation Summary, State Planning Team, Meeting and Documentation, Public and Stakeholder Participation, and existing Planning Mechanisms.

Table 3.1-1 Summary of updates of the SHMP	
PLAN SECTION	**SUMMARY OF UPDATE**
4. Risk Assessment	All hazards identified in the 2013 SSAHMP were profiled in the 2018 SHMP. Climate change was more robustly incorporated into all profiles of hazards that may be exacerbated by climate change based on new 2015 FEMA guidance and the input of the SPT. Four new human-made hazard profiles were added to the plan for Building and Structure Collapse, Cyber-terrorism, Environmental Hazard - Gas and Liquid Pipeline, and Opioid Addiction. Environmental Hazards was divided into multiple profiles for 2018. This was an update to the state plan and SOG.; the new profiles are: • Environmental Hazard - Coal Mining • Environmental Hazard - Conventional Oil and Gas Wells • Environmental Hazard - Gas and Liquid Pipeline • Environmental Hazard - Hazardous Materials Releases • Environmental Hazard - Unconventional Wells Each hazard profile was reviewed, and new research and data was added. The framework changed slightly to combine Vulnerability Assessment and Loss Estimation for Jurisdictions in 4.3.X.6 and State Facilities in 4.3.X.7. This change was made because each sub-section was short, and it made sense to slightly streamline the plan for these topics. The profile framework is now: 4.3.X.1 Location and Extent 4.3.X.2 Range of Magnitude 4.3.X.3 Past Occurrence 4.3.X.4 Future Occurrence 4.3.X.5 Environmental Impacts 4.3.X.6 Jurisdictional Vulnerability Assessment and Loss Estimation 4.3.X.7 State Facility Vulnerability Assessment and Loss Estimation ~~4.3.X.8 Jurisdictional Loss Estimation~~ ~~4.3.X.9 State Facility Loss Estimation~~
5. Capability Assessment	The 2018 update focused on updating existing information, improvement graphics and explanations in plan integration, adding information on the Commonwealth developing historic preservation mitigation capabilities, and recognizing that some of the Repetitive Loss and Severe Repetitive Loss actions from 2010 and 2013 were truly capabilities and moving from Section 6 to 5.
6. Mitigation Strategy	All goals, objectives and actions were evaluated in group meetings and by individual follow-up, then the Mitigation Action Plan was updated accordingly. Mitigation project information from 2013 to 2018 was incorporated in the plan to document success and progress.
7. Plan Maintenance	Information that was in the 2013 SSAHMP was reviewed and updated as needed to reflect new plan maintenance procedures and schedules. The documentation of annual meetings was noted to show that Pennsylvania had met in 2014, 2015, 2016, 2017 to update the SHMP.
8. Plan Adoption	Information in Section 8 of the 2013 SSAHMP was reviewed and revised as necessary in the 2018 SHMP.

3 Planning Process

Documentation of the Planning Process Prior to 2007

PEMA was designated as the lead agency for the Commonwealth of Pennsylvania's Hazard Mitigation Plan preparation effort. It began the process of hazard mitigation planning as an outgrowth of the State's obligation under requirements of the federal Robert T. Stafford Disaster Relief and Emergency Assistance Act, PL 100-707, signed into law November 23, 1998. The latest version of that regulatory compliant plan (2001) was used as the starting point for the construction of the Emergency Management Accreditation Program (EMAP) compliant and FEMA-approved Stafford Act compliant SSAHMP.

Each plan deemed regulatory compliant by FEMA for the period 1993 to 2007 enabled the Commonwealth to receive post-disaster assistance. Evaluation under the EMAP standards that include the National Fire Protection Association 1600: Standard on Disaster/Emergency Management and Business Continuity Programs determined that the June 2001 version of the SSAHMP was non-compliant. As a result, a comprehensive revision was undertaken to meet the EMAP Standards of an All-Hazard Mitigation Plan. The events of September 11, 2001 and the subsequent leadership of the Department of Homeland Security re-affirmed that all-hazards planning and mitigation activities in Pennsylvania needed to embrace EMAP standards. The first final draft version of the Commonwealth SSAHMP, designed to specifically meet both EMAP and Section 322 standards, was developed in 2003 and adopted by Pennsylvania in early 2004. Throughout 2004, the document continued to evolve and be modified to meet the standards of Section 322 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Pub. Law 93-288). The SSAHMP was formally promulgated September 30, 2004, garnering FEMA approval as a "Standard" State Plan on October 13, 2004.

Upon receiving approval in 2004 for a Standard State Plan, PEMA worked to modify the SSAHMP from 2004 to 2006 (known as the "Triennial Update") in order to obtain "Enhanced Status." Enhanced Plan Status was officially granted by FEMA on August 23, 2006.

Updates between 2004 and 2006 included:

- Integrating the Commonwealth's SEOP with the SSAHMP.
- Compiling, analyzing, and implementing approved local hazard mitigation plans, published research documents, and other agency initiatives into the Risk Assessment and Capability Assessment portions of the Plan.
- PEMA began a review that evaluated the performances of the intended system of integration of local plans into the State Plan and coordination of post disaster mitigation funding.
- PEMA, prior to and following disasters that occurred in 2004, 2005, and 2006, began looking at information management systems to track and record Hazard Mitigation Project Opportunities (HMPOs). They looked at National Emergency Management Information System (NEMIS) and the National Tool.
- PEMA realized it would be best to integrate local plans through the alignment of new NIMS compliant Local Emergency Operations Plans that incorporate HMPs and local projects. This was believed to allow all-hazard mitigation to be more thoroughly addressed and integrated into other planning efforts.

- PEMA reviewed mitigation actions identified in the SEOP to see if other state agencies and departments had funding vehicles for the action/project or knew of a potential external source of funding.
- Reorganization of the text of the Hazard Mitigation Plan took place in 2006. This was undertaken by the State Hazard Mitigation Officer (SHMO).
- PEMA performed review and coordination of local plans from 2004-2007 by:
- Meeting with Hazard Mitigation officers from each county as a requisite activity of the Emergency Management Planning Grant.
- Presenting hazard mitigation topics at PEMA quarterly training.
- Meeting with planners and team members individually and collectively to foster collaboration with the communities during preparation of the Hazard Mitigation Plans.
- Meeting with citizen groups to explain the nature of hazard mitigation and the process being undertaken in communities to develop Hazard Mitigation Plans.
- Meeting with Hazard Mitigation Teams to provide compliance reviews and suggestions and strategies to be considered for inclusion into the plan to assure regulatory compliance. During the Triennial Period, PEMA met with 41 County Hazard Mitigation Planning Teams.
- Providing preliminary informal reviews of Hazard Mitigation documents.
- Providing coordination with FEMA personnel to assist in the development of a local plan compliance strategy. PEMA utilized post-disaster assistance from FEMA to secure planners that visited with each county, with the exception of Philadelphia during the Triennial Period.
- Providing review and coordination of plans prior to adoption.
- Providing draft plan reviews and coordination assistance to 66 of 67 counties.

Documentation of the Triennial Planning Process in 2007

The 2007 triennial plan update was conducted as follows:

- The Federal Requirements present in Section 322 were reviewed and analyzed.
- The Requirements of the 2007 NFPA 1600 Standards were reviewed and analyzed.
- FEMA regulatory guidance was collected and analyzed for implications for plan revision.
- On May 15, 2007, meetings with FEMA Region III were held to determine Federal priorities of actions identified in the Draft Guidance and obtained clarification of certain perceived broad and ambiguous guidance requirements presented in the Draft Update Guidance. The Commonwealth proposed and received concurrence on submitting a revised Hazard Mitigation Plan based on the August 2006 format that included before each section a change sheet that identified the process used to review, evaluate and update each section and that included an evaluation rationale for each changed and unchanged section. In addition, a compendium of changes was submitted to FEMA.
- Tasks the Commonwealth indicated would be elements of the SSAHMP update were extracted from the 2006 Plan.
- A scope of tasks based on regulatory requirements, the indicated plan obligated tasks and update requirements from the FEMA guidance and tasks to maintain compliance

with EMAP standards were developed. Critical path elements were identified, and decision point elements were prioritized and presented to PEMA management on June 1, 2007. This meeting was coordinated through email and telephone conversations. During this meeting PEMA was again delegated as the Lead for updating the Plan. It was decided that existing organizational structures would be utilized to update the Plan.

- Tasks were internally assigned to PEMA employees. PEMA Bureau of Plans was tasked to coordinate the update of the Hazard Vulnerability Analysis (HVA) components and the discussion of the Recovery Plan implementation. The PEMA Bureau of Recovery and Mitigation (BORM) coordinated the update of the non-HVA tasks. PEMA BORM was identified as the final document compiler for the submission to FEMA.
- The strategy of plan development, review, and update was presented to the Flood Budget Task Force. This task force included the Office of the Governor, PEMA, DEP, Department of Conservation and Natural Resources (DCNR) and Office of Administration (OA). This task force created a comment and suggested revision form that was circulated with copies of the 2006 plan to Commonwealth agencies and the public through the Homeland Security and Emergency Preparedness Executive Cabinet Advisory Council. Members of this Council included:
    - Greater Philadelphia Chamber of Commerce (non-profit)
    - Pennsylvania Chiefs of Police Association (non-profit)
    - Pennsylvania Association of Colleges and Universities (non-profit)
    - PECO Exelon Corporation (private sector)
    - Sanofi Pasteur, Inc. (private sector)
    - Philadelphia Eagles (private sector)
    - H.J. Heinz, North America (private sector)
    - Norfolk Southern Corporation (private sector)
    - American Red Cross-Southeastern PA (non-profit)
    - Kravco Simon (private sector)
    - County Commissioners Association of PA (non-profit)
    - Sysco Food Services of Central PA, LLC (private sector)
    - Philadelphia International Airport
    - Southeast Pennsylvania Transportation Authority
    - Pennsylvania Emergency Health Services Council (non-profit)
    - PJM Interconnector (private sector)
    - ASIS International / The Hershey Company (private sector)
    - WITF, Inc. (private sector)
    - AMTRAK Police Department
    - Philadelphia Regional Port Authority
    - ARAMARK food services (private sector)
    - Hospital & Healthsystem Association of Pennsylvania (non-profit)
    - Pennsylvania Motor Truck Association (non-profit)
    - American Water Works Association, Pennsylvania Section (non-profit)
    - Pennsylvania Chemical Industry Council (non-profit)
    - Delaware River Port Authority
    - Alternates:

- o Chester County Department of Emergency Services
- o Bucks County Emergency Management Agency
- o Allegheny County Emergency Management Department
- o Pennsylvania Association of Colleges and Universities (non-profit)
- o Membership of the Executive Cabinet consists of:
- o Pennsylvania Emergency Management Agency
- o Office of Homeland Security
- o Pennsylvania State Police
- o Governor’s Office
- o Office of General Council
- o Department of Corrections
- o Department of General Services
- o Pennsylvania Department of Transportation
- o Department of Environmental Protection
- o Department of Health
- o Department of Military and Veteran Affairs
- o Office of Administration

Annual progress update forms were developed from FEMA guidance documents and suggested templates. These forms were sent to department agency directors. Responses are summarized in Table 3.1-2.

Table 3.1-2 Commonwealth agency SSAHMP progress update as of August 8, 2007.

AGENCY	NO RESPONSE	PROGRESS INDICATED	PROGRESS NOT INDICATED
Office of Administration		X	
Department of Aging		X	
Department of Agriculture		X	
Auditor General			X
Department of Banking		X	
Department of Community and Economic Development		X	
Department of Conservation and Natural Resources		X	
Department of Corrections		X	
Department of Education		X	
Department of Environmental Protection		X	
Department of General Services		X	
Fish and Boat Commission		X	
General Counsel		X	
Department of Health		X	
Higher Education Facilities Authority		X	
Human Relations Commission		X	
Pennsylvania Historical and Museum Commission	X		
Department of Insurance		X	

Table 3.1-2 Commonwealth agency SSAHMP progress update as of August 8, 2007.

AGENCY	NO RESPONSE	PROGRESS INDICATED	PROGRESS NOT INDICATED
Department of Labor and Industry		X	
Liquor Control Board		X	
Department of Military and Veterans Affairs		X	
PENNVEST	X		
Probation and Parole			X
Public School Building Authority		X	
Public Television Network Commission		X	
Public Utilities Commission		X	
Department of Public Works		X	
Department of State		X	
Pennsylvania State Police		X	
PennDOT	X		
Office of Victims Advocate			X
Department of Revenue			X

Upon receiving the progress forms, a causative factor analysis was performed to determine the broad classes of successful vs. unsuccessful tasks. Upon review, discussion elements were prepared for inclusion into the SSAHMP update change document. An update change summary document entitled “Element of Change” was prepared and the document was disseminated for comment. Comments received were incorporated where appropriate, and PEMA revised the document upon FEMA review. The final document underwent EMAP review.

The following organizations, departments and agencies directly and indirectly participated in development of the 2007 SSAHMP:

- Office of the State Fire Commissioner
- Office of Administration
- Governor’s Policy Office
- Office of Lieutenant Governor
- Governor’s Office of General Counsel
- Pennsylvania Game Commission
- Pennsylvania Department of Education
- Pennsylvania Historical and Museum Commission
- Pennsylvania Rural Development Council
- Pennsylvania Department of Environmental Protection
- Pennsylvania Department of Transportation
- Pennsylvania Department of Health
- Pennsylvania Department of Revenue

- Pennsylvania Public Utility Commission
- Governor's Green Government Council
- Pennsylvania Department of Conservation and Natural Resources
- Pennsylvania Department of Community and Economic Development
- Pennsylvania Department of Agriculture
- Governor's Office of Budget
- Pennsylvania Department of General Services
- Pennsylvania Legislature Local Government Commission
- Pennsylvania Housing Finance Agency
- PA Infrastructure Investment Authority
- Governor's Action Team
- Pennsylvania Fish and Boat Commission
- Federal Emergency Management Agency
- United States Army Corps of Engineers
- United States Department of Commerce
- Institute of Business and Safety (non-profit)
- National Weather Service of the National Oceanic and Atmospheric Administration
- Delaware River Basin Commission (non-profit)
- Susquehanna River Basin Commission (non-profit)
- United States Department of Agriculture
- United States Geologic Survey
- Hamel Geotechnical Consultants (private sector)
- Harry F. Ferguson and Associates, Ltd. (private sector)
- State University of New York
- Pennsylvania State University
- The multitude of citizens and their representative organizations

Documentation of the Triennial Planning Process in 2010

The 2010 SSAHMP represented a significant revision to the 2007 plan. PEMA, with the approval of the SPT and County staff, decided that the outline of the Commonwealth Plan should closely match the Standard Operating Guide (SOG) developed for county plan updates in Pennsylvania. The benefit of having the Commonwealth and local hazard mitigation plans have information in similar sections is that it will become easier for counties and the Commonwealth to share information and cross reference each other's plans. The 2007 plan cross referenced the Commonwealth's State Emergency Operation Plan (SEOP) and Governor's Executive Budget fairly extensively, especially in the Mitigation Strategy Section. For the 2010 update, PEMA, with the approval of the SPT and County staff, decided to re-focus the plan on mitigation and follow guidance provided from FEMA for hazard mitigation planning more closely. The *Pennsylvania 2010 SSAHMP* had extraneous information from the 2007 plan removed so the plan could focus on its purpose and not duplicate efforts addressed in other plans and planning processes. The 2010 SSAHMP had broad participation from a diverse State Planning Team representing 45 agencies, organizations, counties, and institutions statewide, including 26 new agencies. The following organizations, departments and agencies directly and indirectly participated in development of the 2010 SSAHMP:

- Clearfield County
- Community Research Associates, Inc.
- Delaware County Planning Department
- Delaware River Basin Commission
- Delaware Valley Regional Planning Commission
- Pennsylvania Department of Aging
- Pennsylvania Department of Agriculture
- Pennsylvania Department of Community and Economic Development
- Pennsylvania Department of Conservation and Natural Resources
- Pennsylvania Department of Corrections
- Pennsylvania Department of Education
- Pennsylvania Department of Environmental Protection
- Pennsylvania Department of General Services
- Pennsylvania Department of Health
- Pennsylvania Department of Labor and Industry
- Pennsylvania Department of Public Welfare
- Pennsylvania Department of Public Works
- Pennsylvania Department of State
- FEMA Region III
- Interstate Commission on the Potomac River Basin
- Lycoming County
- Millersville University
- Office of Administration
- Office of Budget
- Office of the Attorney General
- Office of the State Fire Commissioner
- Penn State Agricultural Extension
- Pennsylvania Chapter of American Planning Association
- Pennsylvania Climatology Office
- Pennsylvania Emergency Management Agency
- Pennsylvania Fish and Boat Commission
- Pennsylvania Game Commission

- Pennsylvania Human Relations Committee
- Pennsylvania State Police
- Pennsylvania State System of Higher Education
- Pennsylvania Treasury
- Pennsylvania Turnpike Commission
- PENNVEST
- Philadelphia Office of Emergency Management
- Public Utility Commission-Fixed Utility & Gas Safety
- Susquehanna River Basin Commission
- United States Army Corps of Engineers
- United States Department of Homeland Security
- United States General Service Administration
- United States Geological Survey
- Michael Baker Jr., Inc. and Dewberry.

The 2007 and 2010 SSAHMP update efforts solicited public input during the initial planning process at in-person public forums and via the PEMA Hazard Mitigation Planning website to provide input.

Documentation of the Triennial Planning Process in 2013

The 2013 update of the plan represents a significant revision to the 2010 plan. PEMA, with the approval of the SPT and County staff, decided that the outline of the Commonwealth Plan should closely match the Standard Operating Guide (SOG) developed for county plan updates in Pennsylvania. The SOG and related tools are discussed in further detail in Section 6.3.1.1. The benefit of having the Commonwealth and local hazard mitigation plans have information in similar sections is that it will become easier for counties and the Commonwealth to share information and cross reference each other's plans. The 2007 plan cross referenced the Commonwealth's State Emergency Operation Plan (SEOP) and Governor's Executive Budget fairly extensively, especially in the Mitigation Strategy Section. For the 2010 plan update, PEMA, with the approval of the SPT and County staff, decided to re-focus the plan on mitigation and follow guidance provided from FEMA for hazard mitigation planning more closely. Now, for the 2013 update, PEMA, with direction from FEMA, improved the plan to highlight mitigation success stories and capture the capabilities of the Commonwealth departments. PEMA also requested that THIRA be integrated as appropriate into the Risk Assessment section of the plan. The Pennsylvania 2010 SSAHMP had extraneous information from the 2007 plan removed, so the plan could focus on its purpose and not duplicate efforts addressed in other plans and planning processes.

The Planning Process was a top priority for the 2013 update. The SPT garnered participation from:

- Clearfield County
- County Commissioners Association of Pennsylvania

- Department of Agriculture
- Department of Community and Economic Development
- Department of Conservation and Natural Resources
- Department of Corrections
- Department of Environmental Protection (Including the Bureau of Radiation Protection)
- Department of General Services
- Department of Health
- Department of Insurance
- Department of Labor and Industry
- Department of Military and Veterans Affairs
- Department of Public Welfare
- Department of State
- Division of Facilities and Property Management
- Federal Emergency Management Agency, Region III
- Governor's Office of Homeland Security
- Keystone Emergency Management Association
- Millersville University
- Northampton County
- Office of Administration
- Penn State Capital College (Police Department)
- Pennsylvania Department of Transportation
- Pennsylvania State System of Higher Education
- Pennsylvania Emergency Management Agency
- Pennsylvania Housing Finance Agency
- Pennsylvania Treasury
- Pennsylvania Turnpike Commission
- PENNVEST
- Philadelphia Office of Emergency Management
- Salvation Army
- United States Army Corps of Engineers
- United States Department of Homeland Security (including Office of Infrastructure Protection)
- United States General Services Administration
- United States Geological Survey – Pennsylvania Water Science Center
- Michael Baker Jr., Inc. and Delta Development Group

In addition to SPT meetings and County focused presentations, public outreach was conducted in 2013. The outreach was interesting and fun. It included travel to the Carnegie Science Center in Pittsburgh to conduct experiments on flooding with children and tabling at Academy of

Science climate-related events. Though interesting, the public outreach process did not capture substantive input to the SSAHMP. The in-person public outreach process was not repeated in 2018 to focus on stakeholder engagement.

The process used to update the 2013 SSAHMP is described in the remaining elements of Section 3.

3.2. State Planning Team

The SPT brought together by PEMA for the 2018 plan built on the 2010 and 2013 SPTs, strong Pennsylvania Silver Jackets participation, and annual participation in SHMP updates. The 2018 SHMP update formally started with a kick-off meeting in October of 2016 that doubled as the annual plan review meeting; this meant that the plan update was spread-out over a two-year period. This allowed for consistent engagement and follow-up with stakeholders. Also, since the SPT was engaged for PEMA led updates in 2014 and 2015, this meant that the SPT met regularly to engage on hazard mitigation in the period between the 2013 and 2018 plans.

FEMA's *State Mitigation Plan Review Guide* of 2015 outlines that the plan update must engage, at minimum, stakeholders from the following sectors: Emergency Management, Economic Development, Land Use and Development, Housing, Health and Social Services, Infrastructure, and Natural and Cultural Resources. The SHMP had invited and gained attendees from these sectors in previous plan updates, though the SPT decided to work towards gaining additional SPT members in 2018. The effort was successful in increasing participation in each sector. Table 3.2-1 shows SPT participation by sector. Note that additional stakeholders participated in the planning process, but not the SPT and are addressed later in Section 3.

Table 3.2-1 SPT participation by sector.

SECTORS FOR ENGAGEMENT	COUNT OF AGENCIES IN SECTOR	
	2013	2018
A. Emergency Management	10	9
B. Economic Development	3	4
C. Land Use and Development	6	9
D. Housing	1	3
E. Health and Social Services	4	5
F. Infrastructure	4	7
G. Natural and Cultural Resources	4	8
H. Administration/Other	4	2
Grand Total	36	47

Please note that many of the SPT agencies bridge sectors. For instance, the Department of Community and Economic Development is both B. Economic Development, C. Land use and Development, and touches on the other sectors as well. When this happened the sector that best fit the regular participant was selected. Some agencies did not fit a sector and were included in 'H. Administration/Other': Department of State, Office of Administration, Pennsylvania State System of Higher Education, and Pennsylvania Office of Attorney General.

Bringing together individuals from multiple agencies and organizations throughout the Commonwealth to address mitigation has multiple benefits including leveraging each other's knowledge, resources, and funding. The role of the SPT was identified in the kick-off meeting on October 27, 2016 as the following:

- Provide new information. Information requested included GIS data, hazard information especially related to past occurrences and probability, new studies, and information on vulnerable populations and assets as well as provide progress on mitigation occurring statewide.
- Guide and provide input on overarching plan improvements including addressing climate change, historic preservation, and new hazards.
- Identify mitigation and funding opportunities.
- Review and evaluate the SHMP.

Attendees at the SPT meetings included representatives from 47 different agencies, organizations, and county and city government. Additionally, the SPT meetings were attended and supported by the Michael Baker International, Vernon Land Use, and Nurture Nature Center consultant team. 21 of the agencies that participated in 2013 also participated in 2018. There were 26 new agencies, organizations and local governments represented in 2018. New attendees came from a mix of county and state agencies and state-wide organizations. Several agencies and organizations sent multiple representatives to one meeting. Table 3.2-1 shows the agencies and organization that were represented at each meeting. The majority of the SPT members are representatives from state agencies. The state agencies were complimented by federal agencies and organizations that work within the Commonwealth. County and city representatives were involved in the SPT to bring local input to the SPT and to compliment the outreach to all counties' various public and stakeholder events and meetings. A summary of each of these outreach sessions is provided in Section 3.4.

Table 3.2-2 Summary of agencies participating on the State Planning Team in 2013.

ATTENDEES REPRESENTED	KICK-OFF MEETING 10/27/16	WEBINAR 12/6 & 13	RISK ASSESSMENT MEETING 5/3/17	CAPABILITY MEETING 8/2/17	WEBINAR 9/19/17	MITIGATION SOLUTIONS WORKSHOP 10/11/17	DRAFT PLAN REVIEW 5/23/18
Community Affairs and Development				Yes			
County Commissioners Association of Pennsylvania			Yes	Yes		Yes	
Cumberland County Planning Department				Yes			
Delaware Valley Regional Planning Commission				Yes			
Department of Agriculture			Yes				

Table 3.2-2 Summary of agencies participating on the State Planning Team in 2013.							
ATTENDEES REPRESENTED	**KICK-OFF MEETING 10/27/16**	**WEBINAR 12/6 & 13**	**RISK ASSESSMENT MEETING 5/3/17**	**CAPABILITY MEETING 8/2/17**	**WEBINAR 9/19/17**	**MITIGATION SOLUTIONS WORKSHOP 10/11/17**	**DRAFT PLAN REVIEW 5/23/18**
Department of Banking and Securities				Yes			
Department of Community and Economic Development	Yes		Yes	Yes		Yes	Yes
Department of Conservation and Natural Resources			Yes	Yes		Yes	
Department of Drug and Alcohol Programs	Yes						
Department of Environmental Protection	Yes		Yes	Yes		Yes	Yes
Department of General Services	Yes					Yes	
Department of Health			Yes	Yes			Yes
Department of Homeland Security				Yes			Yes
Department of Human Services			Yes	Yes		Yes	
Department of Labor & Industry				Yes			Yes
Department of Meteorology and Atmospheric Science, The Pennsylvania State University			Yes				
Fayette County Emergency Management		Yes					
Federal Emergency Management Agency, Region III	Yes	Yes	Yes				Yes
Franklin County Department of Emergency Services				Yes	Yes	Yes	Yes
Governor's Office of Homeland Security				Yes			
Housing Alliance of Pennsylvania							Yes
Lehigh County Emergency Management Agency		Yes			Yes		
Lower Merion Township Police Department							Yes
Millersville University Disaster Research Center			Yes				Yes
Northern Tier Regional Planning and Development Commission				Yes			
Penn State Capital College			Yes	Yes			
Penn State University Extension - Agriculture						Yes	
Pennsylvania Department of Transportation (PennDOT)			Yes			Yes	
Pennsylvania Association of Floodplain Managers	Yes						
Pennsylvania Emergency Management Agency	Yes	Yes	Yes	Yes	Yes	Yes	
Pennsylvania Historical and Museum Commission				Yes			Yes
Pennsylvania Housing Finance Agency			Yes	Yes	Yes	Yes	Yes

Table 3.2-2 Summary of agencies participating on the State Planning Team in 2013.

ATTENDEES REPRESENTED	KICK-OFF MEETING 10/27/16	WEBINAR 12/6 & 13	RISK ASSESSMENT MEETING 5/3/17	CAPABILITY MEETING 8/2/17	WEBINAR 9/19/17	MITIGATION SOLUTIONS WORKSHOP 10/11/17	DRAFT PLAN REVIEW 5/23/18
Pennsylvania Municipal League	Yes						
Pennsylvania Office of Attorney General				Yes			
Pennsylvania State Association of Township Supervisors		Yes		Yes		Yes	Yes
Pennsylvania State Police	Yes						
Pennsylvania's State System of Higher Education			Yes		Yes	Yes	Yes
PENNVEST			Yes				
Perry County	Yes						
Public Health Management Corporation		Yes	Yes			Yes	
Public Utility Commission			Yes	Yes		Yes	Yes
SEDA-Council of Governments			Yes			Yes	Yes
Tri County Regional Planning Commission					Yes		
U.S. Department of Homeland Security			Yes	Yes		Yes	Yes
U.S. Geological Survey - Pennsylvania Water Science Center			Yes	Yes		Yes	
United States Army Corps of Engineers	Yes					Yes	
Michael Baker International, Inc., Vernon Land Use, LLC, and Nurture Nature Center	Yes	Yes	Yes	Yes	Yes	Yes	Yes

The United States Army Corp of Engineers (USACE) Silver Jackets Initiative is a key part of mitigation implementation in the Commonwealth. Many of the Silver Jackets members also participate in the SPT and vice versa. Silver Jackets is an initiative to reduce flood risk by building relationships and leveraging funding between agencies and organizations. This entity built on the 2010 SPT’s initiatives to continue and evolve into a group that monitors and updates the SHMP and works to implement mitigation projects in the Commonwealth. The Baltimore District is designated the lead USACE Silver Jackets District for Pennsylvania. It is also supported by the Pittsburgh, Buffalo, and Philadelphia Districts since portions of Pennsylvania are within each of these District watersheds. The Silver Jackets initiative aims to provide education and mitigation strategies to combat flood risk and involves interagency participation amongst Federal, State, Regional, and Professional partners.

PEMA invited a broad spectrum of agencies and organizations to attend SPT meetings. A wide net was cast for invitations so that everyone interested in attending had the opportunity to become involved. The majority of the agencies and organizations that are closely linked to mitigation activities and risk assessment did attend. Action 2-5c in the 2013 Mitigation Strategy addresses the goal to continue to improve involvement in the mitigation planning process throughout the Commonwealth with the following action: *Reach out to agencies that were invited but did not participate in 2013 planning process.* The 2013 'Measure of Success' was attained by the 2018 SHMP update building on 2013 success and having 61 representatives of agencies, organizations, and counties participate in the SPT and another 83 representatives participate on webinars or and in-person training events.

3.3. Meetings and Documentation

The 2018 SHMP stakeholder planning process lasted from October 2016 through June 2018. SPT members were engaged through in-person meetings at PEMA headquarters and webinars. Additional stakeholders were engaged through webinars targeted at their sector or specialty, in-person and webinar-based training. Engagement reached 71 people from 47 agencies for the SPT and 83 people from more than 42 agencies for additional stakeholder outreach. This section summarizes the meetings that were held to engage stakeholders and provide input into developing a strong SHMP submission for 2018.

During the period between the 2013 and 2018 SHMP updates, PEMA continued to:

- Hold annual SHMP plan review meetings in 2014, 2015, 2016, and 2017.
- Compile, analyze, review and assist in implementing approved local hazard mitigation plans.
- Review and evaluate the performances of the intended system of integration of local plans into the SHMP.
- Coordinate mitigation funding.
- Work with FEMA on plan implementation, especially in the wake of several Disaster Declarations.
- Work through the Silver Jackets to enhance flood mitigation across agencies and levels of government.
- Host the three PEMA regional Hazard Mitigation Officers meet once a quarter with each section of their counties to discuss hazard mitigation related topics and concerns. At times these quarterly meetings coincided with the PEMA quarterly training.
- Have the Hazard Mitigation Planner meet with County officers, citizens groups, and regional planning agencies and present at conferences.
- Address plan maintenance by BORM staff on an as-needed basis.

Appendix C provides thorough documentation of the planning process. This appendix includes invitations, sign-in sheets, presentations and hand-outs, completed questionnaires and evaluation tools, meeting minutes and other items used to gather comprehensive input into the Commonwealth's SHMP.

In September 2016, PEMA selected a consultant team led by Michael Baker International, Inc. (Michael Baker) to update the SHMP, supported by Vernon Land Use, LLC and Nurture Nature Center. The update process formally began September 22, 2016 with a kick-off meeting with

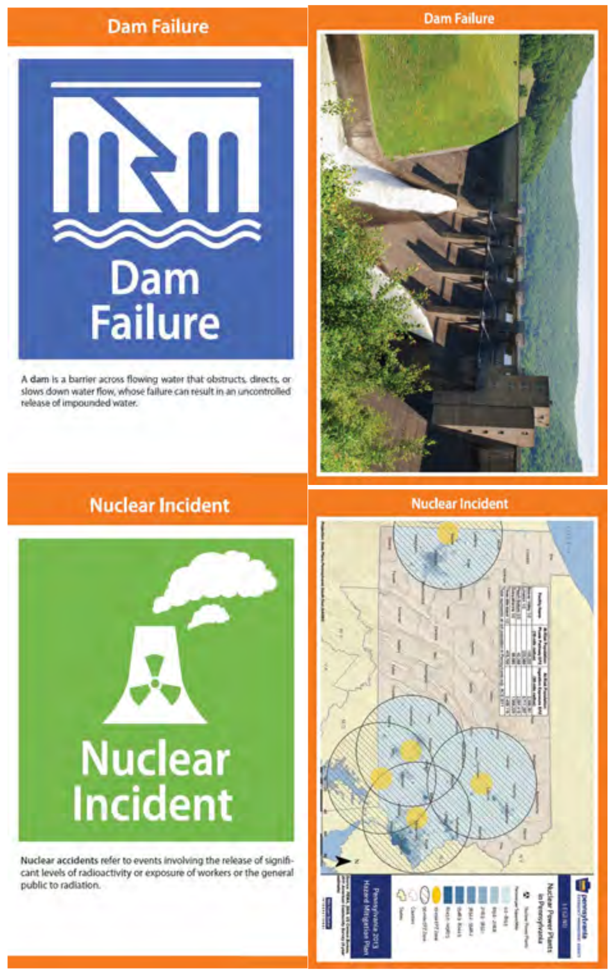
PEMA and consultants to begin planning and project management for completing the update. The calendar concludes on June 28, 2018, after the Red Team Review and the final county outreach session. Though not shown below, coordination and meetings between PEMA, FEMA Region III, stakeholders, and the consultant are expected between June and plan adoption.

Meetings throughout the process were introduced and moderated by the State Hazard Mitigation Officer (SHMO) and State Hazard Mitigation Planner. The consultant team supported the SHMO and Planner by providing presentations. At all meetings, there were multiple opportunities for input from attendees. The following list represents opportunities for engagement of stakeholders in the 2018 SHMP update:

- **Project Meeting with PEMA BORM Staff, September 22, 2016**: Reviewed PEMA priorities, steps to host kick-off and annual plan review meeting in October, notes from 2014 and 2015 annual reviews, project website, data collection, and schedule.
- **Project Meeting with PEMA Deputy Director, October 12, 2016**: Reviewed 2018 SHMP update approach, consultant team, requirements of new FEMA guidance, actions for upcoming meetings, mitigation success website and related planning processes for recovery and online planning tools.
- **State HMP Priorities Meeting with PEMA and FEMA, October 25, 2016**: Summarized the 2018 approach and contract addressing team, improved engagement and interaction for SPT meetings, historic property vulnerability analysis, data tools for counties, interactive web elements, and schedule. Discussed impact of new 2015 *State Mitigation Plan Review Guide* including plan to address climate change in future conditions sub-section of applicable hazards. Reviewed plans for data related to vulnerability analysis. Discussed Plan Review Tool application and PEMA's goal to move towards Enhanced Plan status.
- **SPT Kick-off Meeting and Annual Plan Review, October 27, 2016**: Welcomed the attendees to the start of the 2018 update process and reviewed keys priorities for update including addressing new FEMA guidance, climate change, historic preservation, and ideas from the SPT. The roles of PEMA and the SPT were defined. The SPT was introduced to the new plan website where communication and documentation of the process is accessible to the team and the public. Broke out into 3 smaller groups to review mitigation actions in detail and present back to larger group. Reviewed existing hazards and began conversation about new hazards to be added to the Risk Assessment profile. The SPT had interest to add the following new hazards:
    - Building and Structure Collapse due to the impact of aging infrastructure.
    - Cyber-terrorism was selected as a priority hazard to move out of the terrorism and utility outrage profiles and into its own unique profile due to the growing risk. This was selected for its own profile at the 2014 annual plan review update.
    - Environmental Hazard - Gas and Liquid Pipeline was added as an increasing risk. Also, the SPT concurred that it made sense to separate Environmental Hazards into their own profile but group them under the heading Environmental Hazard so that they are together in the same area of the SHMP.
    - Opioid Addiction was added as a hazard causing an alarming number of deaths and increasing response in the Commonwealth.

Hand-outs were not the focus of this meeting instead a facilitator and note taker joined each of the break-out sessions to collect ideas on mitigation strategy updates. Then the group discussions were also documented to guide the update process.

- **SPT Kick-off Meeting and Annual Plan Review Webinars, December 6 & 13, 2016:** A summary of the presentation and break-out sessions was provided by webinar twice in December to reach an additional six attendees.
- **Project Meeting with PEMA BORM Staff, January 10, 2017**: Reviewed hazards for profiling with BORM to direct data collection and analysis. Planned for Risk Assessment meeting, 3-year monitoring, Severe Repetitive Loss Strategy, and project website.
- **SPT Risk Assessment Meeting, May 3, 2017**: This meeting began with a general overview of the hazards planned for the risk assessment including sources of data and a review of climate change analysis as it relates to Pennsylvania. Then attendees were divided into small groups targeted at flood hazards, other natural hazards, and human-made hazards. Facilitators led the groups through a discussion guided questions including the following:
    - o Has the severity/magnitude of the hazard changed in Pennsylvania?
    - o Which hazard(s) pose the highest risk to Pennsylvanians?
    - o We know that climate change is expected to affect the intensity of severe weather and increase the frequency and severity of flooding. How do we address the impacts of climate change on other, less directly related hazards?
    - o Do you know of any new/existing data related to climate change/future conditions and these hazards in Pennsylvania that we could or should incorporate in the 2018 HMP?
    - o Has your agency/organization planned for or implemented mitigation actions related to these hazards that should be included in the 2018 HMP?



Sample of PA's hazard information cards

The discussions were also complemented by a series of hazard cards. The cards defined the hazard with the new Pennsylvania icon for the hazards, created by Nurture Nature Center, on one side and had an image or map of the hazard on the second side. The idea is that the cards would be finalized at the conclusion of the project and be available to share with counties updating their local hazard mitigation plans. The cards informed the SPT conversation and were viewed as a helpful tool for Counties at the conclusion of the project.

- **Enhanced Plan Meeting with PEMA and FEMA, June 19, 2017**: A meeting was held to describe how the 2018 SHMP update is exceeding standard requirements. The presentation by PEMA included:
  - Planning Process improvements for additional stakeholder and comprehensive hazard mitigation program engagement.
  - Risk Assessment tools and analysis being developed to support local planning and address climate change.
  - Capability improvements to integrate planning process, build on Silver Jackets.
  - Mitigation Strategy improvements include streamlining 3-year monitoring via survey, providing online tools to promote losses avoided and mitigation success, and streamlining the project prioritization process in the SOG.
- **Plan Integration and Capability Assessment Meeting, August 2, 2017**: The meeting focused on opportunities to leverage existing capabilities, build new capability and find solutions to capability gaps in mitigation action. The meeting began with a brief presentation and then the groups broke into breakout groups for facilitated conversations. Once the breakout session highlights were reviewed, consequence analysis forms were used to contribute to analysis in the base plan and in an appendix.
- **Webinars, October 2017**: Webinars were used to target and increase engagement from sectors that had not been as active in this and previous SHMP updates. Calls were planned to engage Universities, Land Use and Development, and Housing professionals. Additionally, a call was planned to engage existing and invited SPT representatives and a last call for hazards.
  - **Last Call for Hazards, September 19, 2017**: This call was to remind participants and potential participants that it is easy to add or modify hazards now, but harder to do once the analysis is complete. The call reviewed the final list of hazards to be profiled and gained concurrence for attendees with those who had been able to attend in-person meetings as well.
  - **A Call to Universities and Colleges, September 19, 2017**: This call tailored the information in the SHMP update to what would be valuable for universities. The call also encouraged universities to participant in local hazard mitigation plan in order to access mitigation funding opportunities. The call request input to the planning process and invited attendees to participate in SPT meetings.
  - **A Call to Planners, September 26, 2017**: This call targeted Metropolitan Planning Organizations, Planning Associations, and Councils of Government. It was an opportunity to review the plan, request input and educate planners on how the plan can inform safe and safer planning and development in their communities.

   - **A Call to Housing Professionals, September 26, 2017**: This call was planned, and invitations went out to 144 recipients. Unfortunately, the call was not attended by any new stakeholders. Therefore, the PEMA and Consultant PM team developed a strong Plan B and conducted presentations and trainings in coordination with the Housing Alliance of Pennsylvania and Pennsylvania Construction Code Academy in early 2018 that reached 64 people.
- **Housing Sector Presentations:** Presentations were provided focusing on the information available to housing associations and organizations, builders, code officials, and other local officials in the SHMP. Risk information is available to guide their planning and development. National resources for building safely and mitigating properties were provided. The NFIP was reviewed and input was gathered through polling questions. All 64 attendees will be notified when the draft SHMP is available for review and comment.
   - **Update for the PA Construction Code Academy, January 19, 2018**: Webinar with polling questions.
   - **Update for the Housing Alliance of Pennsylvania, January 19, 2018:** Webinar with polling questions.
   - **Update for the PA Construction Code Academy, March 28, 2018:** In-person training in King of Prussia with survey.
- **SPT Mitigation Solutions Meeting, October 11, 2017**: This meeting focused on review and improvement of the mitigation strategy. The goals and objectives were reviewed with the result being slight edits to the goals for clarity and some edits to objectives. Then the update thus far to mitigation actions was reviewed. Outstanding questions were reviewed with the group to gain information for follow-up. There was an opportunity for attendees to contribute to a collage on mitigation success.
- **Project Meeting with PEMA BORM Staff, January 5, 2018:** Reviewed 3-year monitoring status, upcoming outreach, outstanding data collection, and plan for summer website updates.
- **Mitigation and Recovery Plan Integration Meeting, January 5, 2018**: This meeting was attended by PEMA, DCED and consult team members to discuss opportunities for plan integration between the SHMP and Pennsylvania Disaster Recovery Plan (PDRP). Opportunities identified included including meeting in planning process, recognizing the PDRP in the SHMP and having resiliency addressed in the mitigation strategy. The existing SHMP was also used as a reference and tool in the development of the PDRP and contacts were shared to expand outreach on each plan.
- **Pre-Disaster Recovery Plan Integration Call, January 31, 2018**: The SHMP was presented on an existing PDRP call to Emergency Support Function representatives for comment and consideration. The Emergency Support Function representatives were also invited to the Draft Plan Review Meeting in May to learn more about the plan.
- **SPT Draft Plan Review Meeting, May 23, 2018:** The SPT convened to hear a summary of the Draft Plan contents. Highlights of the update were presented by section and attendees were encouraged to comment in person and to take time after the meeting to review in detail. Comments were requested by June 23, 2018 so that they could be incorporated into the FEMA plan submission.
- **County Draft Plan Review Outreach:** Outreach was planned in June to review the draft SHMP at the PEMA Area Quarterly Training. PEMA Area Quarterly Training reaches nearly every county in the Commonwealth with training and information. Back to back

sessions were planned to present the draft SHMP and then PDRP to further plan integration between these 2 elements and to gain input to improve the draft plans. Sessions were held:
   - **Central Area Quarterly Training, June 6, 2018**
   - **Eastern Area Quarterly Training, June 20, 2018**
   - **Western Area Quarterly Training, June 27, 2018**
- **PEMA Director and Deputy Director Draft Plan Review, June 25, 2018:** Once the plan is near final it is reviewed with PEMA's leadership to garner any additional comments or improvements. This also is an opportunity to brief leadership on next steps and prepare for FEMA review and Commonwealth adoption of SHMP.

See Appendix C for documentation of meetings, comments, and recommendations.

3.4. Public & Stakeholder Participation

The 2018 plan update focused on engaging new stakeholders from the sectors identified in the 2015 FEMA guidance. This approach increased total participation in the SPT from 47 to 71 and the agencies and organization represented in the SPT from 36 to 47. Then outreach and requests for input were targeted to the C. Land Use and Development and D. Housing with great success. Total stakeholder participation in the 2018 SHMP update increased by 228%. All sectors had an increase in participants with the exception of Economic Development. More representatives from Department of Labor & Industry and PENNVEST attended in 2013, though the same number of agencies are represented. The exciting result is a 6500% increase in Housing Sector participation. This can be attributed to strong collaboration with PA Construction Code Academy and Housing Alliance of Pennsylvania. Presentations and training reached a significant number of new stakeholders in the SHMP that work in a field which influences and direct safe building. This is an accomplishment that will be built upon in ongoing outreach and training.

Table 3.4-1 SPT participation by sector.

SECTORS FOR ENGAGEMENT	COUNT OF PARTICIPANTS BY SECTOR		% INCREASE
	2013	2018	
A. Emergency Management	12	21	75%
B. Economic Development	8	6	-25%
C. Land Use and Development	6	25	317%
D. Housing	1	66	6500%
E. Health and Social Services	5	6	20%
F. Infrastructure	5	14	180%
G. Natural and Cultural Resources	7	13	86%
H. Administration/Other	3	3	0%
Grand Total	47	154	228%

Public participation was not the focus of outreach for this update, though the Pennsylvania Hazard Mitigation Planning website provided opportunities for interested parties to engage in the planning process and learn more about mitigation. This website will continue to develop a tool for local officials and the general public.

County officials were engaged as stakeholders in Cumberland , Fayette, Franklin, Lehigh, and Perry Counties. Additionally, all counties were engaged in PEMA Area Quarterly Trainings during the draft plan review process.

4 Risk Assessment

4. Risk Assessment

4.1. Update Process Summary

At the SPT Kick-off meeting, the SPT reviewed the list of hazards profiled in the 2013 SSAHMP, evaluating and identifying potential new hazards, changes in risk, potential enhancements, and new/changed data. The SPT identified building and structure collapse, cyber-terrorism, opioid addiction response, and gas and liquid pipelines as new/emerging risks in Pennsylvania. Following the Kick-off meeting, the project team conducted research and analysis on these identified changing risks and presented the information at the Risk Assessment Meeting. Following discussion at that meeting, the SPT developed an approach for analyzing these risks. Climate change has been incorporated as a potential factor in future probability for all hazards it is expected to impact, including drought, hurricane, and temperature extremes. A summary of the 33 hazards identified and profiled for the 2018 SHMP is provided in Table 4.1-1 along with historical information regarding whether the hazard was profiled in the 2004, 2007, 2010, and 2013 SSAHMPs. This table shows an increase in the number of hazards identified and profiled in Pennsylvania since 2004.

Table 4.1-1 List of hazards identified and profiled in the 2004, 2007, 2010, 2013, and 2018 Pennsylvania SAHMPs.

HAZARD	YEAR PROFILED				
	2004	2007	2010	2013	2018
Building and Structure Collapse	No	No	No	No	Yes
Coastal Erosion	Yes	Yes	Yes	Yes	Yes
Drought	Yes	Yes	Yes	Yes	Yes
Earthquake	Yes	Yes	Yes	Yes	Yes
Extreme Temperature	Yes	Yes	Yes	Yes	Yes
Flood, Flash Flood, Ice Jam	Yes	Yes	Yes	Yes	Yes
Hailstorm	Yes	Yes	Yes	Yes	Yes
Hurricane, Tropical Storm, Nor'easter	No	No	Yes	Yes	Yes
Invasive Species	No	No	Yes	Yes	Yes
Landslide	Yes	Yes	Yes	Yes	Yes
Lightning Strike	Yes	Yes	Yes	Yes	Yes
Pandemic	No	Yes	Yes	Yes	Yes
Radon Exposure	Yes	Yes	Yes	Yes	Yes
Subsidence, Sinkhole	Yes	Yes	Yes	Yes	Yes
Tornado, Wind Storm	Yes	Yes	Yes	Yes	Yes
Wildfire	Yes	Yes	Yes	Yes	Yes
Winter Storm	Yes	Yes	Yes	Yes	Yes
Civil Disturbance	Yes	Yes	Yes	Yes	Yes
Cyber Terrorism	No	No	No	No	Yes
Dam Failure	Yes	Yes	Yes	Yes	Yes
Environmental Hazard – Coal Mining*	Yes	Yes	Yes	Yes	Yes

Table 4.1-1 List of hazards identified and profiled in the 2004, 2007, 2010, 2013, and 2018 Pennsylvania SAHMPs.					
HAZARD	**YEAR PROFILED**				
	2004	**2007**	**2010**	**2013**	**2018**
Environmental Hazard – Conventional Oil and Gas Wells*	Yes	Yes	Yes	Yes	Yes
Environmental Hazard – Gas and Liquid Pipelines*	No	No	No	No	Yes
Environmental Hazard – Hazardous Materials Releases*	Yes	Yes	Yes	Yes	Yes
Environmental Hazard – Unconventional Oil and Gas Wells*	No	No	No	Yes	Yes
Levee Failure	No	No	Yes	Yes	Yes
Mass Food and Animal Feed Contamination	No	No	No	Yes	Yes
Nuclear Incident	Yes	Yes	Yes	Yes	Yes
Opioid Addiction Response	No	No	No	No	Yes
Terrorism	Yes	Yes	Yes	Yes	Yes
Transportation Accident	Yes	Yes	Yes	Yes	Yes
Urban Fire and Explosion	Yes	Yes	Yes	Yes	Yes
Utility Interruption	Yes	Yes	Yes	Yes	Yes
*Note that not all Environmental Hazards are profiled with equal detail in each plan.					

Each hazard identified is profiled in Section 4.3 in order to:

- Estimate the location and extent of the area potentially impacted
- Describe the range of magnitude or severity of impacts that could potentially occur
- Identify and summarize the impacts of previous occurrences
- Estimate the probability of future occurrences
- Summarize environmental impacts most commonly experienced

The quality of a hazard profile is strongly dependent on the information available for use in characterizing the presence and impact of the hazard on Pennsylvania. Of the hazard profile categories described above, estimating the probability of future occurrences is often the most challenging. The probability of a hazard event of a given magnitude is usually expressed in terms of annual probability. Certain hazards (e.g., floods) have received detailed study and have well-understood probability distributions. For many hazards, however, probability information is lacking. In these cases, historical occurrences and input from members of the SPT are used to characterize the frequency of a given hazard as:

- *Unlikely*: Less than 1% annual probability
- *Possible*: Between 1 & 49.9% annual probability
- *Likely*: Between 50% and 90% annual probability
- *Highly Likely*: Greater than 90% annual probability

4.1.1. State Assets

A key component of the risk assessment process is the evaluation of potential losses to state assets. According to FEMA guidance, state assets “may include state-owned or operated buildings, infrastructure, and critical facilities.” Critical facilities, in turn, are described as those “structures that the state determines must continue to operate before, during, and after an emergency” (FEMA, 2015). The SPT decided to assess the vulnerability of two types of state assets: state-owned or leased facilities and state-identified critical facilities. The SPT defined critical facilities as assets that are essential to the Commonwealth’s security, public health and safety, economic vitality, and way of life. These assets are mostly privately-owned and operated and include facilities such as power grids and water filtration plants; national monuments and government facilities; telecommunications and transportation systems; and chemical facilities.

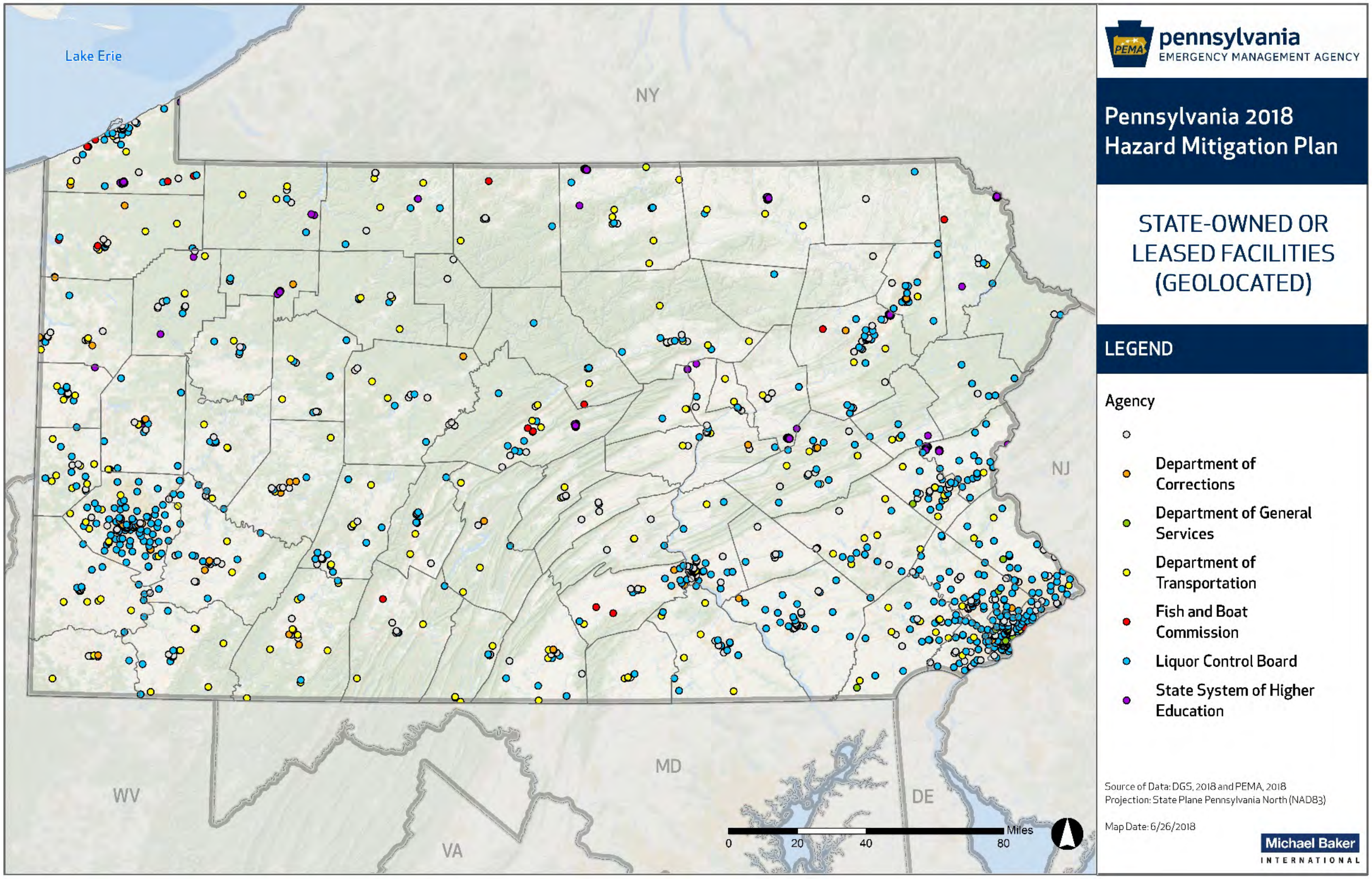
To perform the vulnerability assessment and loss estimation for state assets, an inventory of state-owned or leased facilities obtained from the Department of General Services (DGS) was combined with a PEMA inventory of Pennsylvania State System of Higher Education (PASSHE) facilities. The DGS inventory was delivered to the SPT on March 16, 2018 and includes more than 17,000 structures that are potentially owned or leased by the Commonwealth. The inventory is designed to provide information on more than 40 attributes for each facility, including information on structure type, name, location, and replacement value. The Pennsylvania Office of Administration is in the process of populating all this information. The PEMA inventory of PASSHE facilities includes 855 structures owned by PASSHEAs many facilities as possible were geolocated based on the provided latitude and longitude or the provided street address. Of the approximately 18,000 records in the combined inventories, only 4,460 included sufficient information to be geolocated. Table 4.1.1-1 shows the number and replacement value of geolocated state facilities, categorized by agency or department. Replacement values were not available for all facilities. The available values, however, were assumed to provide a representative sample. Figure 4.1.1-2 provides a map of all geolocated state facilities. Only those agencies with more than 100 geolocated facilities are denoted in the legend.

Table 4.1.1-1 Summary of state-owned or leased facilities included in the state vulnerability assessment (DGS, 2018 and PEMA, 2018).

DEPARTMENT	NUMBER OF FACILITIES	NUMBER OF GEOLOCATED FACILITIES	PERCENT GEOLOCATED	REPLACEMENT VALUE
Attorney General	13	9	69%	-
Department of Agriculture	30	16	53%	$33,546,430
Department of Banking and Securities	5	2	40%	-
Department of Community and Economic Development	4	4	100%	-
Department of Conservation and Natural Resources	4,843	2	0%	$1,300,000
Department of Corrections	1,340	696	52%	$880,660,437
Department of Education	5	1	20%	-
Department of Environmental Protection	93	13	14%	-
Department of General Services	275	131	48%	$2,182,487,819
Department of Health	65	48	74%	-
Department of Labor and Industry	90	69	77%	$126,178,237
Department of Military and Veterans Affairs	1,498	1	0%	-
Department of Public Welfare	820	98	12%	$17,385,000
Department of Revenue	18	10	56%	-
Department of Transportation	4,822	1,691	35%	$597,802,708
Drug and Alcohol Programs	1	1	100%	-
Emergency Management Agency	20	8	40%	$11,972,884
Executive Offices	2	2	100%	-
Fish and Boat Commission	648	154	24%	$13,134,279
Governor's Office	1	1	100%	-
Historical and Museum Commission	525	30	6%	$5,018,300
Insurance Department	2	2	100%	-
Liquor Control Board	632	546	86%	$23,000,000

Table 4.1.1-1 Summary of state-owned or leased facilities included in the state vulnerability assessment (DGS, 2018 and PEMA, 2018).				
DEPARTMENT	**NUMBER OF FACILITIES**	**NUMBER OF GEOLOCATED FACILITIES**	**PERCENT GEOLOCATED**	**REPLACEMENT VALUE**
Public School Employees' Retirement System	8	6	75%	-
State Civil Service Commission	2	1	50%	-
State Department	1	1	100%	-
State Employees' Retirement System	7	4	57%	-
State Police	107	36	34%	-
State System of Higher Education	855	855	100%	**-**
Thaddeus Stevens College of Technology	23	20	87%	$26,346,722
Treasury Department	3	2	67%	-
Total	**17,916**	**4,460**	**25%**	**$3,918,832,815**

Figure 4.1.1-2 Map of state-owned or leased facilities included in the state vulnerability assessment (DGS, 2018 and PEMA, 2018).



To perform the vulnerability assessment and loss estimation for critical facilities, an inventory of facilities deemed essential to the state by the SPT was compiled primarily from two publicly accessible databases: DHS's Homeland Infrastructure Foundation-Level Data (HIFLD) Open data portal, and FEMA's Comprehensive Data Management System (CDMS).

The HIFLD Open data portal is the result of more than 15 years of work by the U.S. Department of Homeland Security (DHS), the National Geospatial-Intelligence Agency (NGA), and other federal agencies. Following the attacks of September 11, 2001, federal agencies began aggregating data from hundreds of regional and local data providers to compile national datasets of essential assets and infrastructure. At first, these national data layers were disseminated through computer discs and access was restricted to FOUO – For Official Use Only. With time, however, DHS recognized the value of these data layers to support community preparedness, resiliency, research, and more, and decided to provide public access to a subset of the data. In 2016, the HIFLD Subcommittee released the HIFLD Open data portal, providing online access to 270+ dynamic, public domain datasets. As of 2018, this data portal provides access to over 330 national geospatial data layers within the open public domain (DHS HIFLD, 2018).

FEMA's CDMS was used to gather geospatial data for the few types of critical facilities not available through HIFLD Open. A component of FEMA's Hazus software, the CDMS allows users to export the default geospatial data that Hazus uses to estimate potential losses. This default geospatial data includes national data for essential facilities, high potential loss facilities, selected transportation and lifeline systems, agriculture, vehicles, and demographics. More information on the sources for the Hazus default data can be found at https://www.fema.gov/summary-databases-hazus-multi-hazard.

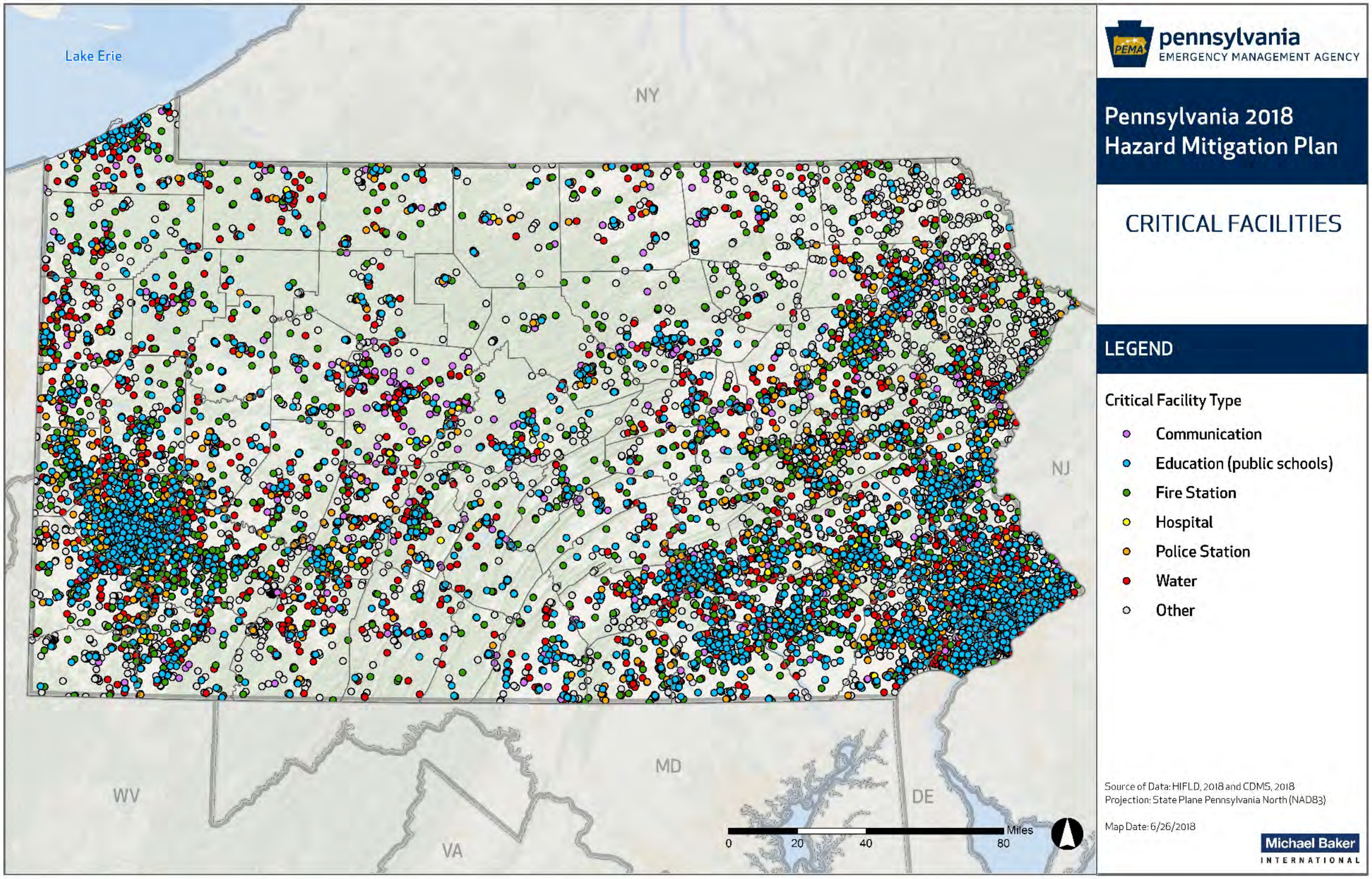
The critical facility inventory also includes a dam layer provided by PA DEP and not available for public use, and a national monument layer obtained from the NPS Integrated Resource Management Applications (IRMA) Portal. In addition, where available, replacement values were derived from FEMA's CDMS.The final critical facility inventory includes 14,011 critical facilities and 17 facility types. Table 4.1.1-2 shows the number and replacement value of geolocated critical facilities, as well as the data source for each facility type. Figure 4.1.1-3 provides a map of all geolocated critical facilities. Only those facility types with more than 300 geolocated facilities are denoted in the legend.

Table 4.1.1-2 Geolocated critical facilities (HIFLD, 2018 and CDMS, 2018).

CRITICAL FACILITY TYPE	NUMBER OF FACILITIES	REPLACEMENT VALUE	DATA SOURCE
Agricultural	275	-	HIFLD
Banking	3	-	HIFLD
Commercial	27	-	HIFLD
Communication	615	$116,850,000	CDMS
Dam	3,429	-	DEP
Education (colleges and universities)	159	$4,808,126,032	HIFLD

Table 4.1.1-2 Geolocated critical facilities (HIFLD, 2018 and CDMS, 2018).			
CRITICAL FACILITY TYPE	**NUMBER OF FACILITIES**	**REPLACEMENT VALUE**	**DATA SOURCE**
Education (public schools)	3,175	$56,383,834,400	HIFLD
Emergency Operation Center	69	$75,210,000	HIFLD
Energy	55	$6,594,500,000	HIFLD
Fire Station	2,708	$1,771,032,000	HIFLD
Government	25	$1,729,355,262	HIFLD
Hospital	342	$2,609,460,000	HIFLD
National Monument or Icon	6	-	NPS
Nuclear	5	-	CDMS
Police Station	1,245	$1,899,870,000	HIFLD
Transportation	75	$474,515,489	HIFLD
Water	1,798	$117,493,389,000	HIFLD and CDMS
Total	**14,011**	**$193,956,142,183**	

Figure 4.1.1-3 Map of critical facilities included in the state vulnerability assessment (HIFLD, 2018 and CDMS, 2018).



4.1.2. Jurisdictional Assets

Another key component of the risk assessment process is the evaluation of potential losses to jurisdictions within the Commonwealth. To perform the vulnerability assessment and loss estimation for Pennsylvania counties, the 2018 SHMP leverages Census data on population and Hazus data on generalized building stock. FEMA's Hazus v4.0 includes a default inventory of generalized building stock at both the census tract and census block scales. The information provided includes the number of residential, commercial, industrial, agricultural, and other buildings, as well as the estimated building value. To assess the relative vulnerability of jurisdictions to hazards, databases of population, building counts, and building value were assembled at two scales: the census tract scale, and the smaller census block scale. While it is not feasible to reproduce the tables at either of these scales, a table aggregated to the county scale is provided below (Table 4.1.2-1).

Table 4.1.2-1 Jurisdictional population and building stock.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $
Adams	101,759	41,876	$10,485,215
Allegheny	1,230,360	501,670	$162,158,360
Armstrong	67,512	32,065	$6,580,820
Beaver	169,205	73,797	$19,203,313
Bedford	48,852	24,592	$4,536,821
Berks	414,097	155,019	$44,982,283
Blair	125,917	53,225	$13,038,220
Bradford	61,808	28,862	$5,678,516
Bucks	626,220	229,503	$81,908,656
Butler	185,974	76,022	$21,424,680
Cambria	137,762	63,511	$15,890,834
Cameron	4,807	4,429	$890,359
Carbon	64,330	34,203	$7,327,097
Centre	159,178	51,853	$15,902,352
Chester	512,028	178,952	$68,456,575
Clarion	38,939	19,482	$4,144,992
Clearfield	81,170	38,265	$7,716,072
Clinton	39,536	18,059	$3,775,790
Columbia	66,772	28,471	$7,112,346
Crawford	87,027	44,439	$9,548,325
Cumberland	243,838	92,940	$28,208,368
Dauphin	271,962	107,000	$32,485,579
Delaware	562,316	196,456	$68,420,231
Elk	31,111	17,549	$4,163,676
Erie	279,133	107,829	$30,461,678

Table 4.1.2-1 Jurisdictional population and building stock.			
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $
Fayette	134,229	61,205	$12,455,931
Forest	7,493	8,846	$1,313,439
Franklin	152,707	61,517	$14,391,260
Fulton	14,653	7,423	$1,359,021
Greene	37,669	16,370	$3,410,883
Huntingdon	45,844	22,004	$4,178,057
Indiana	87,491	36,419	$8,257,699
Jefferson	44,575	22,310	$4,559,018
Juniata	24,811	10,842	$2,115,736
Lackawanna	213,006	86,014	$25,577,980
Lancaster	533,110	189,804	$54,619,855
Lawrence	88,528	39,907	$9,176,879
Lebanon	136,950	52,948	$14,293,394
Lehigh	358,792	128,014	$40,035,521
Luzerne	318,917	138,524	$35,272,088
Lycoming	116,313	49,663	$11,882,050
McKean	42,609	21,145	$4,665,899
Mercer	114,598	50,721	$13,089,860
Mifflin	46,585	21,202	$4,370,585
Monroe	167,126	78,643	$19,033,528
Montgomery	815,876	288,275	$114,243,338
Montour	18,404	7,708	$1,852,617
Northampton	300,520	113,956	$33,100,910
Northumberland	93,590	43,118	$9,584,186
Perry	45,647	20,310	$4,146,443
Philadelphia	1,559,938	534,077	$165,970,513
Pike	56,210	38,416	$8,457,874
Potter	17,239	13,236	$2,428,053
Schuylkill	145,503	67,956	$15,558,237
Snyder	40,246	16,013	$3,699,402
Somerset	76,201	38,169	$7,821,615
Sullivan	6,302	6,303	$1,014,082
Susquehanna	41,832	22,448	$4,158,351
Tioga	42,031	21,005	$4,033,074
Union	45,178	16,505	$4,099,142
Venango	53,460	26,993	$5,735,301
Warren	40,649	23,010	$4,773,178

Table 4.1.2-1 Jurisdictional population and building stock.			
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $
Washington	208,269	90,284	$23,606,898
Wayne	51,307	31,761	$6,146,092
Westmoreland	359,377	162,621	$41,191,281
Wyoming	27,975	13,262	$2,650,580
York	440,604	173,196	$47,895,886
Total	**12,783,977**	**5,092,212**	**$1,470,726,894**

In developing the 2018 SHMP, the SPT recognized the importance of protecting not just lives and property, but sense of place as well. Historic and cultural resources can be fundamental to a community's sense of place, "ground[ing] us to the past, the present, and the future" (PHMC, 2018). Understanding the vulnerability of these resources to the hazards that affect a community is therefore an important part of understanding the vulnerability of the community as a whole. To demonstrate one approach to assessing the vulnerability of historic resources, and to identify some of the jurisdictions whose historic resources are most at risk, the 2018 SHMP added an evaluation of historic resource vulnerability to the jurisdictional vulnerability assessment for three natural hazards: flood, hurricane, and wildfire. Of the five natural hazards ranked highest by the SPT, these three pose the most significant challenge to the preservation of historic places. The other two natural hazards ranked among the top five – extreme temperature and winter storm – are more likely to affect people than places.

To evaluate historic resource vulnerability to the selected natural hazards, the 2018 SHMP used Pennsylvania's Cultural Resources Geographic Information System (CRGIS). CRGIS is a map-based inventory of the historic and archaeological sites and surveys maintained by the Pennsylvania Historical and Museum Commission (PHMC), Pennsylvania State Historic Preservation Office (PA SHPO). The inventory reflects nearly a century of information collection, and includes 25,471 archaeological sites and 137,270 historic properties. For the 2018 plan update, PHMC provided the SPT with a statewide geospatial dataset including all the historic properties that could be shared with the public. Of the 137,270 historic properties in the inventory as of June 14, 2018, only 121,469 could be shared in a public database. Table 4.1.2-2 shows the distribution of these historic properties by resource type and National Register eligibility. In addition to buildings (such as houses, barns, or churches), historic properties in the CRGIS database include "structures" that are not intended primarily to provide shelter (such as tunnels or bridges), "objects" that are primarily artistic or are relatively small in scale (such as monuments or mileposts), "sites" that were the location of a significant event or building (such as battlefields or ruins), and "districts" that have a significant concentration of historically united features (such as canal systems or business districts). The CRGIS inventory classifies all of these historic properties in terms of their eligibility for the National Register of Historic Places. The National Register of Historic Places is the federal government's official list of the nation's historic places worthy of preservation. To be eligible for listing in the National Register, a property must meet several criteria for evaluation. For an eligible property to be listed in the National Register, the property must be nominated by the owner, and the nomination must be reviewed by the State Review Board and approved by the National Park Service. Properties that are designated by the Secretary of the Interior as National Historic Landmarks are also listed in the National Register of Historic Places.

Table 4.1.2-2 Properties in the Pennsylvania CRGIS (PHMC, as of June 14, 2018)

TYPE/STATUS	ELIGIBLE	LISTED	NATIONAL HISTORIC LANDMARK	NOT ELIGIBLE	DEMOLISHED	OTHER	TOTAL BY RESOURCE TYPE
Building	3,982	2,055	123	11,675	1,247	44,854	63,936
District	811	628	37	993	19	1,508	3,996
Object	40	5	0	32	4	148	229
Site	79	67	10	251	10	1,462	1,879
Structure	812	445	10	9,917	945	1,518	13,647
Unknown	233	0	4	594	43	36,908	37,782
Total by National Register status	5,957	3,200	184	23,462	2,268	86,398	121,469

For the purposes of this plan, only a subset of the 121,469 historic properties in the CRGIS were evaluated for vulnerability to the selected natural hazards. The resources considered of greatest importance for preservation were those classified as Eligible, Listed, and National Historic Landmark (NHL). In addition, the resource types considered of greatest relevance to the jurisdictional vulnerability assessment were historic buildings. The total number of historic buildings classified as Eligible, Listed, or National Historic Landmark is 6,160. While this list certainly does not include all the places that shape and define a community's character, it is likely to include a representative sample of these places. Similarly, the proportion of Eligible, Listed, and NHL properties within a community that is vulnerable to a given hazard is likely to reflect the vulnerability of all its historic and cultural resources. Table 4.1.2-3 shows the distribution of Eligible, Listed, and NHL buildings in the Commonwealth by county. The counties with the largest numbers of historic buildings include those in the greater Philadelphia and greater Pittsburgh regions, Lancaster County, and Washington County.

Table 4.1.2-3 Historic buildings in Pennsylvania by county (PHMC, as of June 14, 2018)

COUNTY	ELIGIBLE, LISTED, AND NHL BUILDINGS	% OF STATE TOTAL
Adams	55	0.9%
Allegheny	490	8.0%
Armstrong	24	0.4%
Beaver	53	0.9%
Bedford	54	0.9%
Berks	252	4.1%

Table 4.1.2-3 Historic buildings in Pennsylvania by county (PHMC, as of June 14, 2018)		
COUNTY	ELIGIBLE, LISTED, AND NHL BUILDINGS	% OF STATE TOTAL
Blair	50	0.8%
Bradford	32	0.5%
Bucks	304	4.9%
Butler	48	0.8%
Cambria	60	1.0%
Cameron	5	0.1%
Carbon	20	0.3%
Centre	80	1.3%
Chester	467	7.6%
Clarion	11	0.2%
Clearfield	20	0.3%
Clinton	17	0.3%
Columbia	25	0.4%
Crawford	35	0.6%
Cumberland	110	1.8%
Dauphin	147	2.4%
Delaware	186	3.0%
Elk	23	0.4%
Erie	116	1.9%
Fayette	129	2.1%
Forest	6	0.1%
Franklin	106	1.7%
Fulton	13	0.2%
Greene	45	0.7%
Huntingdon	50	0.8%
Indiana	45	0.7%
Jefferson	23	0.4%
Juniata	9	0.1%
Lackawanna	94	1.5%
Lancaster	329	5.3%
Lawrence	25	0.4%
Lebanon	68	1.1%
Lehigh	117	1.9%
Luzerne	95	1.5%
Lycoming	41	0.7%
McKean	21	0.3%
Mercer	23	0.4%
Mifflin	30	0.5%

Table 4.1.2-3 Historic buildings in Pennsylvania by county (PHMC, as of June 14, 2018)		
COUNTY	**ELIGIBLE, LISTED, AND NHL BUILDINGS**	**% OF STATE TOTAL**
Monroe	59	1.0%
Montgomery	385	6.3%
Montour	16	0.3%
Northampton	115	1.9%
Northumberland	53	0.9%
Perry	17	0.3%
Philadelphia	631	10.2%
Pike	32	0.5%
Potter	10	0.2%
Schuylkill	54	0.9%
Snyder	39	0.6%
Somerset	63	1.0%
Sullivan	6	0.1%
Susquehanna	16	0.3%
Tioga	32	0.5%
Union	27	0.4%
Venango	21	0.3%
Warren	16	0.3%
Washington	199	3.2%
Wayne	53	0.9%
Westmoreland	137	2.2%
Total	**6,160**	**100%**

4.1.3. Vulnerability Assessment and Loss Estimation Methodology

For the purposes of this SHMP, *vulnerability* refers to the exposure of people and property to a hazard. The 2018 SHMP update included a comprehensive vulnerability assessment for the state and jurisdictional assets discussed in Sections 4.1 and 4.2. In general, two types of methodologies were applied: a Hazus-based methodology, and an exposure-based methodology.

The Hazus-based methodology was applied to flood, earthquake, and hurricane hazards. This methodology used FEMA's Hazus v4.0 to estimate social and economic losses across the Commonwealth. Hazus divides the loss estimation process into three phases:

1. **Hazard Analysis Phase**. In this phase, the model analyses the physical processes that determine loss. In the case of flood hazards, for example, the model would determine the depth and velocity of flooding associated with different flood frequencies.

2. **Damage Estimation Phase**. In this phase, the model overlays the hazard layer with a set of inventory layers to identify the buildings and infrastructure exposed to the hazard,

then uses vulnerability curves to estimate the extent of structural damage. The default Hazus inventory consists of four components: 1) the general building stock (the number and characteristics of residential, commercial, industrial, agricultural, and other buildings), 2) essential facilities (e.g., police stations), 3) high potential loss facilities (e.g., dams), and 4) selected transportation and utility systems (e.g., highway bridges and water treatment plants). Hazus uses census data to determine the distribution of residential structures, and Dun & Bradstreet data to determine the distribution of non-residential structures. Hazus v4.0 uses data from the 2010 Census.

3. **Loss Estimation Phase**. In this phase, the model quantifies the social and economic losses caused by the estimated structural damage. Hazus measures social impact in terms of displaced households, shelter requirements, and other parameters, and economic impact in terms of direct building losses and business interruption losses. Direct building losses consist of the damage to structures and their contents (including inventory), while business interruption losses consist of the various losses that accrue while a business remains inoperable – including relocation expenses, employee wage loss, business income loss, and rental income loss. For more detailed information on the Hazus methodology, see the Hazus technical manuals for flood, earthquake, and hurricane hazards at https://www.fema.gov/hazus-mh-user-technical-manuals.

FEMA designed Hazus to be a flexible software tool that allows for varying levels of customization depending on user resources and needs. A Level 1 analysis relies mostly on Hazus default data, a Level 2 analysis augments the Hazus default data with more recent or detailed data for the study region, and a Level 3 analysis involves adjusting the built-in loss estimation models for the earthquake, flood, and hurricane loss analysis.

The 2018 SHMP used a Level 2 analysis to assess jurisdictional vulnerability to flood, earthquake, and hurricane wind hazards. The Hazus analyses conducted for the 2018 SHMP replaced the default essential facility data with the more recent and accurate critical facility data described in Section 4.1.1. In addition, the Level 2 flood analysis used detailed local flood depths derived from the latest available FEMA flood maps and the best available ground elevation data.

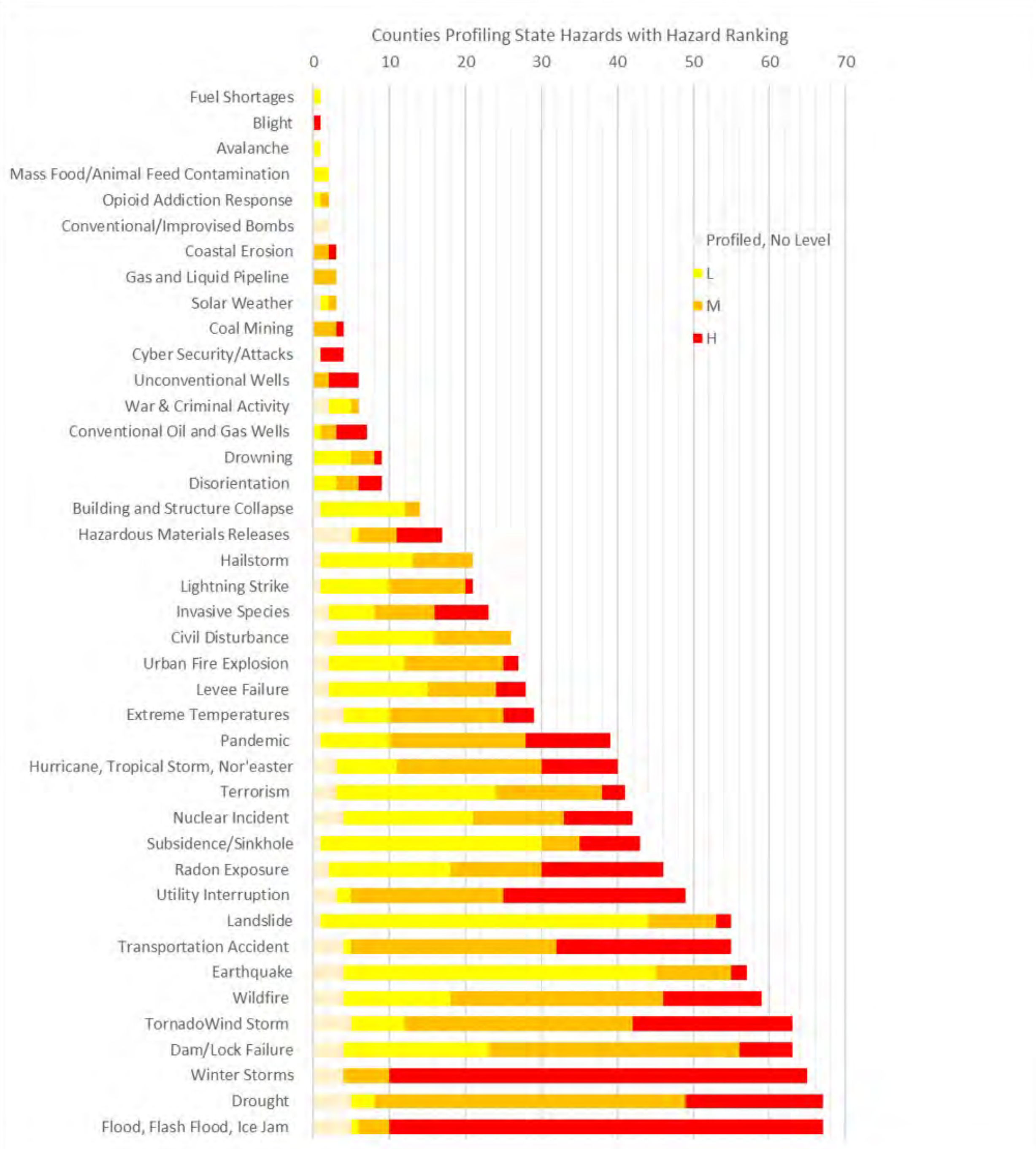
An exposure-based methodology was applied to assess jurisdictional vulnerability for the remaining natural and human-made hazards, and state asset vulnerability for all hazards. The exposure-based methodology was comparable to the first and second phases of the Hazus methodology. First, high hazard areas were identified for the hazard of interest. Second, high hazard areas were intersected with the distribution of population, buildings, and building value to estimate the number of exposed people and assets. Note that the exposure-based methodology is in some ways more conservative than the Hazus-based methodology, but in other ways less conservative. The exposure-based methodology does not distinguish between different levels of structural damage – reporting the cost to replace all affected structures, rather than the cost to repair the probable level of damage. On the other hand, the exposure-based methodology does not account for many of the economic and social impacts of hazard events. Unlike in the Hazus-based methodology, the exposure-based methodology does not account for losses to contents or inventory, does not account for business interruption losses, and does not account for social impacts such as displaced households and shelter requirements.

A more detailed summary of the loss estimation methodology for each profiled hazard is provided in Section 4.2.2.

4.1.4. Local and University Hazard Rankings

The HAZUS and GIS analysis described above will be available for future local risk assessments. It is based on state-wide data sources that had local input but did not come from local HMPs. In addition to vulnerability assessment results obtained through HAZUS and GIS analysis, HMPs for counties and universities throughout the Commonwealth were reviewed to determine the presence of each hazard on a jurisdictional basis and ensure that the 2018 SHMP incorporates information from local risk assessments, including which counties profile which hazards, and any hazard ranking provided at the local level. Figure 4.1.4-1 summarizes the results of this review of county HMPs. A complete summary of the hazards profiled in each county HMP is provided as an appendix.

Figure 4.1.4-1 Summary of hazards profiled in county HMPs throughout Pennsylvania.



Universities in the Pennsylvania State System of Higher Education (PASSHE) have also completed hazard mitigation plans with assistance from a Pre-Disaster Mitigation (PDM) grant. A summary of the hazards included in risk assessments for the fourteen available university HMPs is provided in Table 4.1.4-1. There are seventeen total hazards evaluated in the university HMPs; fourteen of which are considered by every institution to have potential impact. Note that all hazards identified in county and university HMPs throughout Pennsylvania are included in the risk assessment for the SHMP.

Table 4.1.4-1 Summary of hazards profiled in university HMPs throughout Pennsylvania.

HAZARD	UNIVERSITY														RANK *
	BLOOMSBURG UNIVERSITY	CALIFORNIA UNIVERSITY OF PENNSYLVANIA	CHEYNEY UNIVERSITY	CLARION UNIVERSITY	EAST STROUDSBURG UNIVERSITY	EDINBORO UNIVERSITY	INDIANA UNIVERSITY OF PENNSYLVANIA	KUTZTOWN UNIVERSITY	LOCK HAVEN UNIVERSITY	MANSFIELD UNIVERSITY	MILLERSVILLE UNIVERSITY	SHIPPENSBURG UNIVERSITY	SLIPPERY ROCK UNIVERSITY	WEST CHESTER UNIVERSITY	
Earthquake	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Environmental Hazards	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Extreme Temperature	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Flood, Flash Flood, Ice Jam	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Hailstorm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Landslides	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Lightning Strike	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Nuclear Incident	✓	✓	✓		✓	✓	✓	✓			✓	✓	✓	✓	15
Pandemic	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Subsidence, Sinkhole	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Terrorism	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Tornado, Wind Storm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Transportation Accident	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Urban Fire and Explosion											✓				17
Utility Interruption	✓			✓	✓	✓		✓			✓	✓		✓	16
Wildfire	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1
Winter Storm	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	1

* Each hazard is ranked by the total number of university HMPs which identify the individual hazard. There are fourteen hazards which every university HMP identifies. This results in fourteen counties being ranked as "1," causing the numbering scheme for *Rank* to skip from "1" to "15."

4.1.5. Risk Ranking Methodology and Risk Factor Analysis

At the conclusion of the risk assessment, all 33 hazards were ranked in terms of their overall impact on Pennsylvania. Ranking hazards helps the Commonwealth set goals and mitigation priorities. 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 be used to assist officials in ranking and prioritizing hazards that pose the most significant threat to Pennsylvania based on a variety of factors deemed important by the SPT and other stakeholders involved in the hazard mitigation planning process.

The RF system relies mainly on historical data, local knowledge, general consensus opinions from the SPT and information collected through development of the hazard profiles and vulnerability assessments 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.

The risk assessment categories and corresponding matrix shown in Table 4.1-10 are based on FEMA's Comprehensive Preparedness Guide (CPG) 101 (see pg. 3-11 of CPG-101). Similar matrices have been used in other states for hazard mitigation and emergency management planning. For example, the Arizona Emergency Management advocates using this approach, found online at: http://www.maricopa.gov/Emerg_Mgt/pdf/cpri%20guidance.pdf. Additionally, Pointe Coupee Parish, Louisiana, Lyon County, Kansas, Yucaipa County, California, Phelps County, Missouri, and the Commonwealth of Massachusetts use similar priority risk indices, which include the same *Probability* and *Impact* descriptions used since the Pennsylvania 2010 SSAHMP.

This approach compliments more quantitative analysis by capturing participants' qualitative analysis and providing a value to summarize and compare hazards. Pennsylvania recognizes limitations to this approach. There are numerous examples where risk levels may not be entirely compatible with all-hazard scenarios or events and particular indices may not reflect certain unique hazard classifications. There may also be differences in how hazards are scored in dense urban areas versus rural areas. Nonetheless, the method serves as a useful tool for providing systematic and consistent prioritization of qualitative hazard information. It is particularly helpful when evaluating hazards for which there have not been conclusive scientific studies of risk and probability.

RF values were obtained by assigning varying degrees of risk to five categories for each of the 33 hazards profiled in the 2018 SHMP. Those categories include: *probability*, *impact*, *spatial extent*, *warning time* and *duration*. Probability ranges from unlikely to highly likely, which gives an indication of how frequently a given hazard event will occur. They may not be catastrophic in scope; for example, floods of some magnitude occur each year in the Commonwealth. Similarly, winter storms, utility interruptions, wildfires, and transportation accidents are expected each year. Impact looks at the systemic loss of life, property, and economic well-being induced in a given hazard event. Spatial extent indicates the geographic area a given hazard event will cover and whether a hazard event is expected to be statewide, regional, or extremely localized. Warning time evaluates how far in advance a community will know of an impending hazard event, taking into account hazard-specific warning systems. Finally, duration indicates the length of time the hazard event will last, be it a multi-day winter storm event or a two-hour tornado. Each degree of risk was assigned a value ranging from 1 to 4. The weighting factor derived from a review of best practice plans and agreed upon by the SPT is shown in the blue box below. 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 example equation:

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

Table 4.1.7-2 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 4.1.5-1 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 & 49.9% ANNUAL PROBABILITY	2	
	LIKELY	BETWEEN 50 & 90% ANNUAL PROBABILITY	3	
	HIGHLY LIKELY	GREATER THAN 90% ANNUAL PROBABILTY	4	
IMPACT *In terms of injuries, damage, death, and economic impact, 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	

Using this methodology, Table 4.1.7-3 lists the Risk Factor calculated for each of the 33 potential hazards from high to low identified in the 2018 SHMP.

Table 4.1.5-2 Ranking results by hazard for Pennsylvania using the Risk Factor methodology.

HAZARD NATURAL(N) OR MAN-MADE(M)	RISK ASSESSMENT CATEGORY					RISK FACTOR (RF)
	PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
Flood, Flash Flood, Ice Jam (N)	4	3	3	4	3	3.4
Winter Storm (N)	4	2	4	2	3	3.1
Utility Interruption (M)	4	2	2	4	2	2.8
Hurricane, Tropical Storm, Nor'easter (N)	2	3	3	1	4	2.6
Cyber-terrorism (M)	2	3	2	4	2	2.5
EH - Hazardous Materials Release (M)	4	2	1	3	2	2.5
Dam Failure (M)	1	3	2	4	4	2.4
Nuclear Incident (M)	1	3	2	4	4	2.4
Transportation Accident (M)	4	1	2	4	1	2.4
Wildfire (N)	4	1	2	3	2	2.4
Extreme Temperature (N)	4	1	2	1	3	2.3
Coastal Erosion (N)	4	1	1	1	4	2.2
EH - Coal Mining (M)	2	2	2	3	3	2.2
EH - Gas and Liquid Pipelines (M)	2	2	2	3	3	2.2
EH - Unconventional Oil and Gas Wells (M)	2	2	2	3	3	2.2
EH -Conventional Oil and Gas Wells (M)	2	2	2	3	3	2.2
Landslide (N)	4	1	1	4	1	2.2
Lightning Strike (N)	4	1	1	4	1	2.2
Opioid Addiction Response (M)	3	2	1	4	1	2.2
Tornado, Wind Storm (N)	3	2	1	4	1	2.2
Invasive Species (N)	2	2	2	1	4	2.1
Radon Exposure (N)	3	1	2	1	4	2.1
Civil Disturbance (M)	3	1	1	4	2	2
Drought (N)	2	1	3	1	4	2
Pandemic (N)	2	1	3	1	4	2
Terrorism (M)	1	3	1	4	2	2
Building and Structure Collapse (M)	3	1	1	1	4	1.9
Earthquake (N)	2	2	1	4	1	1.9
Hailstorm (N)	3	1	1	4	1	1.9
Urban Fire and Explosion (M)	2	2	1	4	1	1.9
Levee Failure (M)	1	2	1	3	3	1.7
Mass Food/Animal Feed Contamination (M)	1	2	2	2	2	1.7
Subsidence, Sinkhole (N)	3	1	1	2	1	1.7

4.1.6. THIRA and SHMP Relationship

For the purposes of this SHMP, *risk* is defined as the potential for damage, injury, or death as a result of natural or human-made hazard events. The risk assessment included in this section seeks to determine which hazards are most significant in Pennsylvania, identify regions or jurisdictions most at risk, and provide guidance for development of mitigation actions. The structure of the information presented in the risk assessment is similar to what was included in the SHMPs since 2010. This structure helps to: 1) clearly and effectively communicate how and to what extent the Commonwealth is exposed to each hazard; 2) improve consistency of the plan with the *Disaster Mitigation Act of 2000 (DMA)* and requirements of *44 CFR Part 201*; and 3) follow the PA Standard Operating Guide and ease the risk roll-up from local plans to the SHMP. Data sources have been updated to include the best available information (see Section 2.5).

The SHMP Risk Assessment complements the 2017 Pennsylvania Threat and Hazard Identification and Risk Assessment (THIRA) completed by PEMA to meet the requirements of CPG 201. The THIRA, along with the State Homeland Security Strategy (SHSS), is a complementary planning processes that focus on identifying key gaps and accomplishments in core capabilities. Table 4.1.1-1 compares the THIRA and the SHMP.

Table 4.1.6-1 Comparison between SHMP and THIRA

SHMP AND HIRA	SHSS AND THIRA
Focus on mitigation	Focus on identifying capability and resource gaps
Detailed hazard profiles including geographic extent, range of magnitude, past occurrence, probability and future occurrence, environmental impacts, and loss estimation	Adds in a threat component and chooses natural, technological, and adversarial hazards that will stress the “overall system” the most.
The grant program primarily focuses on natural hazards and actions that can be taken to reduce/eliminate the impact of the hazard	The grant program focuses on identifying gaps and taking action to reduce the gaps in order to build, maintain, and sustain a capability

As mentioned in Section 5.5, the THIRA is an important planning mechanism to integrate into the SHMP. The THIRA process was used to develop and/or revise worst-case scenarios, and its ranking is referenced in each hazard profile (see Figure 4.1.8-1). There was also some discussion amongst the planning team as to whether the SHMP should only cover natural hazards while the THIRA should cover man-made hazards. However, the SPT decided to keep the plans as separate but complementary mechanisms to maintain the Commonwealth’s all-hazards approach to mitigation.

The RF ranking system is not that same as the ranking system used in the Pennsylvania THIRA. While the hazards listed in these two planning mechanisms are similar the THIRA must account for a threat component. The Pennsylvania THIRA also breaks out hazards in terms of natural, technological, and human caused. Threats and hazards were evaluated based on likelihood and vulnerability.

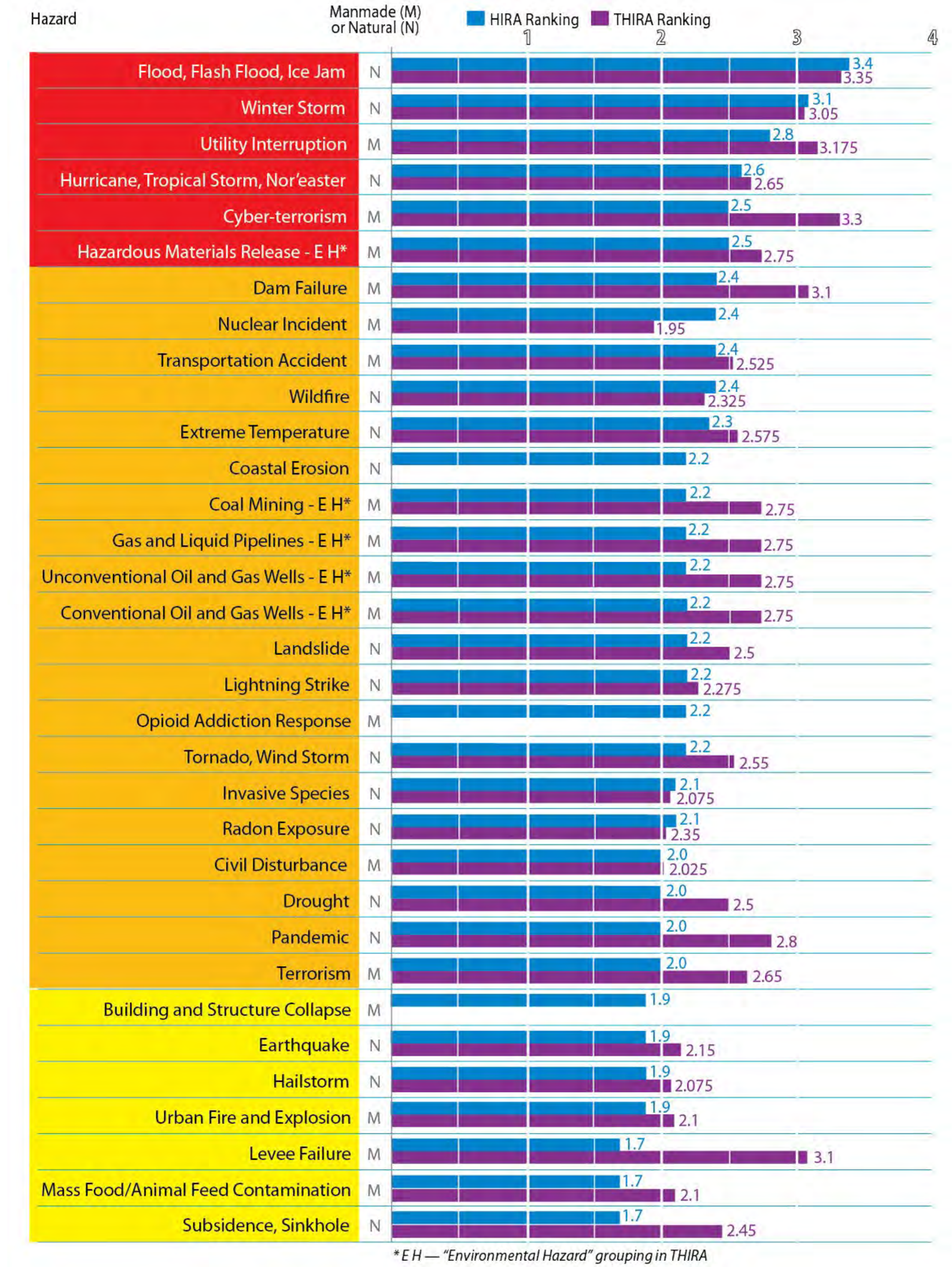
Likelihood was rated on a scale of 1 - 5 where 1 indicates unlikely occurrence and 5 indicates very high likelihood or imminent occurrence within the Commonwealth. The vulnerability of the Commonwealth to each threat and hazard was ranked using the following scale:

1) A potential incident would have a very small geographic footprint. People are easily protected by evacuation, sheltering in place or through other simple protective measures.
2) People are not so easily protected by evacuation or sheltering in place, but protective measures generally remain simple.
3) A potential incident would have a moderate geographical footprint. Buildings may be vulnerable to some damage and therefore may not offer protection to people in more prone areas of the building. Critical infrastructure, resources, industry, and systems may be vulnerable to some damage, interruption, and/or failure. Protective measures may be extensive.
4) Buildings may be vulnerable to moderate damage or more and therefore will only provide protection to people in designated safe areas. Advanced preparation for effective protective measures will be required. Critical infrastructure, resources, industry, and systems may be vulnerable to moderate damage, interruption, and/or failure.
5) A potential incident would have a large geographical footprint. During this incident, people, structures, critical infrastructure, resources, industry, and systems in the affected area are completely vulnerable and will likely be destroyed or severely damaged.

Worse “probable” case scenarios were developed for the hazards of concern. These scenarios were developed in order to create events that would stress the core capabilities as defined in the National Preparedness Goal and Comprehensive Preparedness Guide 201: Threat and Hazard Identification and Risk Assessment Guide (CPG 201). By stressing capabilities, the workgroup participants were able to identify gaps in core capabilities to guide further planning and investment justifications. The overall goal of the THIRA process is to evaluate the Commonwealth’s capabilities for addressing all-hazards events across the 5 Mission Areas: Prevention, Protection, Mitigation, Response, and Recovery.

Figure 4.1.6-2 shows the Risk Ranking results from the SHMP HIRA and the THIRA for comparison. Most hazards track similarly with some exceptions and emphasis placed on threat to increase rankings for some THIRA results.

Figure 4.1.6-2 Comparison of SHMP HIRA and THIRA Rankings



4.2. Hazard Identification

4.2.1. Table of Presidential and Other Disaster Declarations

Pennsylvania's disaster history helps provide direction on the identification of hazards and their significance. For purposes of providing government disaster assistance, a disaster can be declared at the federal level by a Presidential Disaster or Emergency Declaration or by the Small Business Administration, or at the state level through a Gubernatorial Disaster Declaration or Proclamation. Records of all disaster declarations in the Commonwealth since 1955 are available from FEMA, PEMA, and the Small Business Administration (SBA). Historically, flood events significantly outnumber other hazards in terms of disaster declarations. Hurricanes, tropical storms, winter storms, and urban fires and explosions have also generated a significant number of disaster declarations.

FEMA's declaration regulations outline the factors that the agency considers when evaluating a Governor's request for a Presidential Disaster or Emergency Declaration. The President can issue a Presidential Disaster Declaration for any natural event that "has caused damage of such severity that it is beyond the combined capabilities of state and local governments to respond" (FEMA, 2018). The President can issue an Emergency Declaration for any occasion when the President determines that federal assistance is needed. The scope and amount of assistance for Emergency Declarations is generally smaller, since Emergency Declarations are intended to supplement State and local government efforts.

In evaluating whether to recommend the provision of Public Assistance under a Presidential Disaster Declaration, FEMA compares the estimated per capita cost of public assistance (both Federal and non-Federal) to an indicator amount that is adjusted each year for inflation. In 2018, the county-level per capita impact indicator was $3.68, and the state-level indicator was $1.46.

Table 4.2.1-1 displays the Presidential Disaster and Emergency Declarations that have affected Pennsylvania since 1955, with the most recent events listed first.

Table 4.2.1-1 Presidential Disaster and Emergency Declarations affecting Pennsylvania.

DATE	EVENT	AFFECTED AREAS
December 2016	Severe Storms and Flooding	Bradford, Centre, Lycoming, Sullivan
March 2016	Severe Winter Storm, and Snowstorm	Adams, Bedford, Berks, Blair, Bucks, Chester, Cumberland, Dauphin, Fayette, Franklin, Fulton, Juniata, Lancaster, Lebanon, Lehigh, Montgomery, Northampton, Perry, Philadelphia, Schuylkill, Somerset, Westmoreland, York
February 2014	Severe Winter Storm	Bucks, Chester, Delaware, Lancaster, Montgomery, Philadelphia, York
October 2013	Severe Storms, Tornadoes, and Flooding	Allegheny, Centre, Clearfield, Clinton, Crawford, Fayette, Huntingdon, Jefferson, Lawrence, Venango, Wayne
January 2013	Hurricane Sandy	Bedford, Bucks, Cameron, Dauphin, Forest, Franklin, Fulton, Huntingdon, Juniata, Monroe, Northampton, Philadelphia, Pike, Potter, Somerset, Sullivan, Wyoming

Table 4.2.1-1 Presidential Disaster and Emergency Declarations affecting Pennsylvania.		
DATE	**EVENT**	**AFFECTED AREAS**
October 2012 (Emergency Declaration)	Proclamation of Emergency – Hurricane Sandy	Adams, Allegheny, Armstrong, Beaver, Bedford, Berks, Blair, Bradford, Bucks, Butler, Cambria, Cameron, Carbon, Centre, Chester, Clarion, Clearfield, Clinton, Columbia, Crawford, Cumberland, Dauphin, Delaware, Elk, Erie, Fayette, Forest, Franklin, Fulton, Greene, Huntingdon, Indiana, Jefferson, Juniata, Lackawanna, Lancaster, Lawrence, Lebanon, Lehigh, Luzerne, Lycoming, McKean, Mercer, Mifflin, Monroe, Montgomery, Montour, Northampton, Northumberland, Perry, Philadelphia, Pike, Potter, Schuylkill, Snyder, Somerset, Statewide, Sullivan, Susquehanna, Tioga, Union, Venango, Warren, Washington, Wayne, Westmoreland, Wyoming and York
September 2011 (Emergency Declaration)	Proclamation of Emergency – Remnants of Tropical Storm Lee	Adams, Bedford, Berks, Blair, Bradford, Bucks, Cambria, Carbon, Centre, Chester, Clinton, Clinton, Columbia, Cumberland, Dauphin, Delaware, Franklin, Fulton, Huntingdon, Juniata, Lackawanna, Lancaster, Lebanon, Lehigh, Luzerne, Lycoming, Mifflin, Monroe, Montgomery, Montour, Northumberland, Northampton, Perry, Philadelphia, Schuylkill, Snyder, Somerset, Sullivan, Susquehanna, Tioga, Union, Wyoming, York
September 2011	Remnants of Tropical Storm Lee	Adams, Bedford, Berks, Bradford, Bucks, Chester, Columbia, Dauphin, Huntingdon, Juniata, Lackawanna, Lancaster, Lebanon, Luzerne, Lycoming, Mifflin, Montgomery, Montour, Northampton, Northumberland, Perry, Schuylkill, Snyder, Sullivan, Susquehanna, Tioga, Union, Wayne, Wyoming, and York
September 2011	Hurricane Irene	Bucks, Chester, Delaware, Lehigh, Luzerne, Monroe, Montgomery, Northampton, Philadelphia, Pike, Sullivan, Susquehanna, Wayne, and Wyoming
August 2011 (Emergency Declaration)	Proclamation of Emergency – Hurricane Irene	Bucks, Chester, Delaware, Lehigh, Luzerne, Montgomery, Monroe, Northampton, Philadelphia, Pike, Sullivan, Wayne, Wyoming
July 2011	Severe Storms and Flooding	Bradford, Lycoming, Sullivan, Tioga, and Wyoming
April, 2010 (Emergency Declaration)	Severe Winter Storm	Adams, Allegheny, Armstrong, Beaver, Bedford, Blair, Butler, Cambria, Chester, Cumberland, Dauphin, Delaware, Fayette, Franklin, Fulton, Greene, Huntingdon, Indiana, Juniata, Lancaster, Lebanon, Perry, Philadelphia, Somerset, Westmoreland, and York Counties
June, 2006	Proclamation of Emergency - Flooding	Adams, Armstrong, Bedford, Berks, Blair, Bradford, Bucks, Carbon, Centre, Chester, Clinton, Columbia, Cumberland, Dauphin, Delaware, Franklin, Fulton, Huntingdon, Indiana, Jefferson, Juniata, Lackawanna, Lancaster, Lebanon, Lehigh, Luzerne, Lycoming, Mifflin, Monroe, Montgomery, Montour, Northampton, Northumberland, Perry, Philadelphia, Pike, Potter, Schuylkill, Snyder, Sullivan, Susquehanna, Tioga, Union, Wayne, Wyoming and York Counties

Table 4.2.1-1 Presidential Disaster and Emergency Declarations affecting Pennsylvania.		
DATE	**EVENT**	**AFFECTED AREAS**
November, 2006	Proclamation of Emergency - Flooding	Bradford, Lackawanna, Luzerne, Schuylkill, Sullivan, Susquehanna, Wayne and Wyoming Counties
April, 2005	Severe Storms, Flooding, and Mudslides	Bradford, Bucks, Columbia, Lackawanna, Luzerne, Monroe, Northampton, Pike, Susquehanna, Wayne and Wyoming Counties
September, 2005 (Emergency Declaration)	Proclamation of Emergency - Hurricane Katrina	All 67 counties - Proclamation of Emergency to Render Mutual Aid and to Receive and House Evacuees
August, 2004	Multiple Storm Systems	Delaware, Montgomery and Philadelphia Counties
September, 2004	Tropical Depression Ivan	Allegheny, Armstrong, Beaver, Bedford, Blair, Bradford, Bucks, Butler, Cameron, Carbon, Centre, Chester, Clarion, Clinton, Clearfield, Columbia, Crawford, Cumberland, Dauphin, Delaware, Franklin, Fulton, Greene, Huntingdon, Indiana, Jefferson, Juniata, Lackawanna, Lawrence, Lebanon, Lehigh, Luzerne, Lycoming, Mifflin, Monroe, Montour, Montgomery, Northampton, Northumberland, Perry, Philadelphia, Pike, Schuylkill, Snyder, Somerset, Sullivan, Susquehanna, Tioga, Union, Washington, Wayne, Westmoreland, Wyoming and York Counties
September, 2004	Tropical Depression Frances	Bedford, Beaver, Blair, Crawford, Erie, Huntingdon, Lawrence, Warren and Washington Counties
February, 2003 (Emergency Declaration)	Severe Winter Storm	Adams, Bedford, Berks, Blair, Cambria, Carbon, Chester, Clinton, Columbia, Cumberland, Dauphin, Delaware, Fayette, Franklin, Fulton, Greene, Huntingdon, Juniata, Lancaster, Lebanon, Lehigh, Lycoming, Mifflin, Montour, Montgomery, Northampton, Northumberland, Perry, Philadelphia, Schuylkill, Snyder, Somerset, Union, Washington, Westmoreland, and York Counties
August, 2003	High Winds and Heavy Rains	Crawford, Forest, Lackawanna, Mercer, McKean, Potter, Tioga, Venango, Warren, Wayne and Wyoming Counties
September, 2003	Hurricane Isabel/Henri	Statewide
June, 2001	Flash Flood (Tropical Storm Allison)	Bucks, Montgomery and Berks Counties
August, 1999	Flash Flooding	McKean and Juniata Counties
September, 1999	Hurricane Floyd	All 67 counties
September, 1999	Flash Flooding (Tropical Depression Dennis)	Dauphin, Lycoming, Northumberland, Snyder and Union Counties
June, 1998	Severe Storms/Tornadoes	Allegheny, Beaver, Berks, Chester, Delaware, Lancaster, McKean, Monroe, Montgomery, Northumberland, Philadelphia, Pike, Somerset, Susquehanna, Tioga and Wyoming Counties

Table 4.2.1-1 Presidential Disaster and Emergency Declarations affecting Pennsylvania.		
DATE	**EVENT**	**AFFECTED AREAS**
January, 1996	Severe Winter Storms	Adams, Allegheny, Armstrong, Beaver, Bedford, Berks, Blair, Bradford, Bucks, Cambria, Cameron, Carbon, Centre, Chester, Clearfield, Clinton, Columbia, Cumberland, Dauphin, Delaware, Elk, Fayette, Franklin, Fulton, Greene, Huntingdon, Indiana, Jefferson, Juniata, Lackawanna, Lancaster, Lebanon, Lehigh, Lycoming, Luzerne, McKean, Mifflin, Monroe, Montgomery, Montour, Northampton, Northumberland, Perry, Philadelphia, Pike, Potter, Schuylkill, Snyder, Somerset, Sullivan, Susquehanna, Tioga, Union, Wayne, Westmoreland, Wyoming and York Counties - Public Assistance; All 67 counties declared for Individual Assistance
January, 1996	Flooding	All counties
June, 1996	Flooding	Adams, Beaver, Bedford, Bucks, Cambria, Crawford, Franklin and Huntingdon Counties
July, 1996	Flooding	Armstrong, Blair, Cambria, Clarion, Clearfield, Crawford, Greene, Indiana, Jefferson, Mercer and Venango Counties
September, 1996	Flooding	Cumberland, Huntingdon, Juniata, Mifflin, Montgomery and Perry Counties
November, 1996	Flooding	Tioga County
January, 1994	Severe Winter Storms	All 67 counties (Centre County also received SBA - EIDL)
March, 1993 (Emergency Declaration)	Blizzard	All 67 counties
May, 1986	Flood	Allegheny County
July, 1986	Flood	Lancaster County
May, 1985	Tornado	Erie, Crawford, Warren, McKean, Mercer, Venango, Forest, Butler, Beaver, Clearfield, Lycoming, Union and Northumberland Counties
September, 1985	Flood	Lackawanna, Luzerne, Susquehanna, Wayne, Wyoming and Carbon Counties
November, 1985	Flood	Allegheny, Fayette, Greene, Somerset, Washington and Westmoreland Counties
August, 1984	Flood	Armstrong, Allegheny, McKean, Westmoreland, Bedford, Blair and Somerset Counties
February, 1982	Flash Flood/ Ice Jam	Venango County (Oil City)
June, 1981	Flash Flood	Venango, Clarion, Mercer, Jefferson and Crawford Counties
June, 1980	Tornado	Armstrong and Westmoreland Counties
August, 1980	Flash Flood	Armstrong, Butler and Clarion Counties
April, 1978	Fire	Monroe County (East Stroudsburg)
January, 1977 (Emergency Declaration)	Gas Shortage/ Severe Winter Weather	Beaver, Cambria, Carbon, Clarion, Clearfield, Crawford, Erie, Fayette, Indiana, Jefferson, Lawrence, Luzerne, Mercer, Potter, Schuylkill, Somerset, Tioga, Venango, Washington, Wayne and Westmoreland Counties

Table 4.2.1-1 Presidential Disaster and Emergency Declarations affecting Pennsylvania.		
DATE	EVENT	AFFECTED AREAS
July, 1977	Flash Flood	Bedford, Cambria, Clearfield, Crawford, Indiana, Jefferson, Somerset and Westmoreland Counties
July, 1976	Flood	Tioga County
October, 1976	Flood	Adams, Bradford, Columbia, Cumberland, Dauphin, Franklin, Juniata, Lackawanna, Lancaster, Lebanon, Luzerne, Mifflin, Northumberland, Perry, Schuylkill, Snyder, Sullivan, Susquehanna, Wayne, Wyoming and York Counties
September, 1975	Flood (Eloise)	Adams, Berks, Bradford, Centre, Clinton, Columbia, Cumberland, Dauphin, Franklin, Juniata, Lackawanna, Lancaster, Lebanon, Luzerne, Lycoming, Mifflin, Montour, Northampton, Perry, Potter, Schuylkill, Snyder, Sullivan, Susquehanna, Tioga, Union, Wayne, Wyoming and York Counties
August, 1974 (Emergency Declaration)	Flash Flood	Westmoreland County
July, 1973	Flood	Berks, Bucks, Chester, Columbia, Delaware, Lancaster, Monroe, Montgomery, Northampton and Wayne Counties
June, 1972	Flood (Agnes)	All 67 counties
September, 1972	Flood	Indiana County
September, 1971	Flood	Bucks, Chester, Delaware, Montgomery, and Philadelphia Counties
July, 1969 (Emergency Declaration)	Flash Flood	Monroe County
August, 1969	Flood	Carbon, Monroe and Schuylkill Counties
August, 1965	Drought	Delaware River Basin
September, 1963	Drought	Numerous Communities Statewide
January, 1959	Mine Flood	Luzerne County (Pittston)
March, 1956	Flood	Warren and Venango Counties
May, 1956	Flood	Western counties
August, 1956	Flood	Beaver, Greene and Washington
August, 1955	Flood (Diane)	Northeastern counties
October, 1954	Flood (Hazel)	Southwestern counties

In addition to these Presidentially-declared disasters, 66 disaster events warranted Gubernatorial Disaster Declarations (Table 4.2.1-2).

Table 4.2.1-2 Pennsylvania Gubernatorial Disaster Emergency Declarations or Proclamations

DATE	EVENT	AFFECTED AREAS
March, 2018	Proclamation of Emergency-- Opioid Crisis, Severe Winter Storms	Berks, Bradford, Bucks, Carbon, Chester, Columbia, Dauphin, Delaware, Lackawanna, Lancaster, Lebanon, Lehigh, Luzerne, Monroe Montgomery, Montour, Northampton, Northumberland, Philadelphia, Pike, Schuylkill, Sullivan, Susquehanna, Wayne, Wyoming, and York because of the continuing severe winter weather pattern. Transfer of $5,000,000 in unused appropriated funds to PEMA and additional $1,000,000
January, 2018	Proclamation of Disaster Emergency--Opioid Crisis	All 67 counties
March, 2017	Proclamation of Emergency-- Severe Winter Storm	All 67 counties--resources determined by Department of Transportation
March, 2017	Proclamation of Emergency-- Severe Winter Storm	All 67 counties
November, 2016	Proclamation of Disaster--Flash Flooding	Bradford, Centre, Lycoming, and Sullivan Counties--transfer of $500,000 in funds to PEMA
January, 2016	Proclamation of Emergency--Severe Winter Storm	All 67 counties--$500,000 in funds transferred to PEMA
August, 2015	Proclamation of Emergency-- Severe Storms	All 67 counties
January, 2015	Proclamation of Emergency-- Severe Winter Storms	All 67 counties--$250,00 in funds transferred to PEMA

Table 4.2.1-2 Pennsylvania Gubernatorial Disaster Emergency Declarations or Proclamations		
DATE	**EVENT**	**AFFECTED AREAS**
September, 2014	Proclamation of Emergency -- Terrorism, Civil Disturbance	Pike County-$500,000 provided to PEMA, amount may be increased or decreased as conditions require
February, 2014	Proclamation of Disaster--Severe Winter Storm	All 67 counties
February, 2014	Proclamation of Disaster--Severe Winter Storm	All 67 counties--transfer of $500,000 in funds to PEMA
February, 2014	Proclamation of Disaster Emergency--Severe Winter Storm	All 67 counties--transfer of $500,000 in funds to PEMA
January, 2014	Proclamation of Disaster Emergency--Extreme Weather, Utility Interruption	All 67 counties
June, 2013	Proclamation of Emergency – High Winds, Thunderstorms, Heavy Rain, Tornado, Flooding	All 67 counties - to utilize all available resources and personnel as is deemed necessary to cope with the magnitude and severity of this emergency situation; to provide $200,000 in funds to PEMA for disaster-related expenses
May, 2013	Proclamation of Emergency – Dauphin Bridge Fire	Dauphin, Cumberland, Perry, York, and Lebanon Counties - to utilize all available resources and personnel as is deemed necessary to cope with the situation; to provide $2,00,000 in funds to PEMA and other state agencies for disaster-related expenses
October, 2012	Proclamation of Emergency – Hurricane Sandy	All 67 counties - to utilize all available resources and personnel as is deemed necessary to cope with the magnitude and severity of this emergency situation; to provide $5 million in funds to PEMA for disaster-related expenses
April, 2012	Proclamation of Emergency – Spring Winter Storms	All 67 counties - to utilize all available resources and personnel as is deemed necessary to cope with the magnitude of this emergency situation

Table 4.2.1-2 Pennsylvania Gubernatorial Disaster Emergency Declarations or Proclamations

DATE	EVENT	AFFECTED AREAS
August, 2011 (amended September 2011)	Proclamation of Emergency - Severe Storms and Flooding (Lee/Irene)	All 67 counties - to utilize all available resources and personnel as is deemed necessary to cope with the magnitude and severity of this emergency situation; to provide $15 million in funds to PEMA for disaster-related expenses
January, 2011	Proclamation of Emergency - Severe Winter Storm	All 67 counties - to utilize all available resources and personnel as is deemed necessary to cope with the magnitude and severity of this emergency situation
February, 2010	Proclamation of Emergency - Severe Winter Storm	All 67 counties - to utilize all available resources and personnel as is deemed necessary to supplement county and municipal efforts
April, 2007	Severe Storm	All 67 counties - to utilize all available resources and personnel as is deemed necessary to supplement county and municipal efforts
February, 2007	Proclamation of Emergency - Severe Winter Storm	All 67 counties - to utilize all available resources and personnel as is deemed necessary to cope with the magnitude and severity of this emergency situation
February, 2007	Proclamation of Emergency - Regulations	All 67 counties - waive the regulations regarding hours of service limitations for drivers of commercial vehicles
April, 2007	Proclamation of Emergency - Severe Winter Storm	All 67 counties - to utilize all available resources and personnel as is deemed necessary to cope with the magnitude and severity of this emergency situation
April, 2006	Proclamation of Emergency - Regulations	Southeast Region of the Commonwealth - for greater flexibility in truck driver regulations to accommodate truck drivers in the finding and transporting of fuel
September, 2006	Proclamation of Emergency - Tropical Depression Ernesto	All 67 counties - utilize all available resources and personnel as deemed necessary to cope with the magnitude and severity of the emergency situation
March, 2005	Heavy Rainfall/ Snowstorm/Embankment Failures	Beaver, Greene, Washington and Westmoreland Counties
September, 2005	Proclamation of Emergency - Hurricane Katrina	All 67 counties - regarding waiving enforcement of applicable state laws & regulations that govern transport of oversized loads
January, 2004	Sinkhole	Northampton County
December, 2003*	High Winds and Heavy Rains	Greene County

Table 4.2.1-2 Pennsylvania Gubernatorial Disaster Emergency Declarations or Proclamations		
DATE	**EVENT**	**AFFECTED AREAS**
February, 2002	Drought & Water Shortage	Adams, Bedford, Berks, Bucks, Carbon, Chester, Cumberland, Dauphin, Delaware, Franklin, Fulton, Huntingdon, Lancaster, Lebanon, Lehigh, Montgomery, Monroe, Northampton, Perry, Philadelphia, Pike, Schuylkill, Wayne and York Counties
September, 2001	Terrorism	Somerset County
February, 2000*	Flooding	Allegheny, Fayette, Washington and Westmoreland Counties
August, 2000	Flooding	Bucks County
July, 1999	Drought	Adams, Allegheny, Beaver, Bedford, Berks, Blair, Bradford, Bucks, Cambria, Cameron, Carbon, Centre, Chester, Clearfield, Clinton, Columbia, Cumberland, Dauphin, Delaware, Fayette, Franklin, Fulton, Greene, Huntingdon, Indiana, Juniata, Lackawanna, Lancaster, Lawrence, Lebanon, Lehigh, Luzerne, Lycoming, Mifflin, Monroe, Montgomery, Montour, Northampton, Northumberland, Perry, Philadelphia, Pike, Potter, Schuylkill, Snyder, Somerset, Sullivan, Susquehanna, Tioga, Union, Washington, Wayne, Westmoreland, Wyoming and York Counties
May, 1998	I-95 Highway Disaster	Delaware County
December, 1998	Drought	Bedford, Blair, Cambria, Cameron, Clarion, Clearfield, Clinton, Crawford, Elk, Erie, Jefferson, Lycoming, Snyder and Somerset Counties
March, 1997	Tire Fire	Washington County
April, 1997	Snowstorm	Carbon, Chester, Lackawanna, Luzerne, Monroe, Pike, Schuylkill and Wayne Counties
March, 1996	Highway Bridge (I-95) Destruction	Philadelphia County
September, 1995	Drought	Adams, Berks, Bradford, Bucks, Cameron, Carbon, Centre, Chester, Clearfield, Clinton, Columbia, Delaware, Lackawanna, Lehigh, Luzerne, Lycoming, Monroe, Montgomery, Montour, Northampton, Northumberland, Philadelphia, Pike, Potter, Schuylkill, Snyder, Sullivan, Susquehanna, Tioga, Union, Wayne, and Wyoming Counties
August, 1994*	Flooding	Bradford, Lycoming and Tioga Counties
September, 1994	Airplane Crash	Allegheny and Beaver Counties

Table 4.2.1-2 Pennsylvania Gubernatorial Disaster Emergency Declarations or Proclamations		
DATE	**EVENT**	**AFFECTED AREAS**
January, 1988	Oil Spill	Allegheny, Beaver and Washington Counties
November, 1980	Drought Emergency	Berks, Bucks, Carbon, Chester, Delaware, Lackawanna, Lebanon, Lehigh, Luzerne, Monroe, Montgomery, Northampton, Philadelphia, Pike, Schuylkill and Wayne Counties, plus 34 Central/ Eastern Counties
January, 1978	Heavy Snow	All 67 counties
February, 1978	Blizzard	All 67 counties
March, 1976	Heavy Rain/Ice	Erie County
May, 1976	Fire	Allegheny County (McKeesport)
July, 1976	Flood	Armstrong, Tioga and Wayne Counties
July, 1976	High Winds/ Flooding	Jefferson and Westmoreland Counties
February, 1974	Truckers Strike	Statewide
July, 1974	Flood	Western and Northern Central Counties
August, 1974	Flood	Jefferson and Westmoreland Counties
December, 1974	Heavy Snow/ Power Outage	Southwestern Counties
February, 1972	Heavy Snow	Statewide
December, 1972	Steam Heat Problem	Philadelphia County (Lower Merion)
March, 1971	Drought	Allegheny County
March, 1971	Land Subsidence	Beaver County
January, 1966	Heavy Snow	Statewide
March, 1964	Flood	Allegheny River, W. Branch Susquehanna River
March, 1963	Ice Jam	Susquehanna-Juniata Rivers
August, 1963	Violent Wind	Allegheny County
August, 1962	Refuse Bank Fire	Luzerne County (Plymouth)

Table 4.2.1-2 Pennsylvania Gubernatorial Disaster Emergency Declarations or Proclamations		
DATE	EVENT	AFFECTED AREAS
February, 1958	Heavy Snow	Berks, Bucks, Chester, Dauphin, Delaware, Lancaster, Lebanon, Lehigh, Montgomery, Northampton and York Counties and the City of Philadelphia
September, 1955	Drought	Adams, Berks, Bradford, Bucks, Cameron, Carbon, Centre, Chester, Clearfield, Clinton, Columbia, Delaware, Lackawanna, Lehigh, Luzerne, Lycoming, Monroe, Montgomery, Montour, Northampton, Northumberland, Philadelphia, Pike, Potter, Schuylkill, Snyder, Sullivan, Susquehanna, Tioga, Union, Wayne and Wyoming Counties
*Event also received Small Business Administration Loan Assistance		

Pennsylvania has also received Small Business Administration (SBA) Assistance for a number of disaster events. A Small Business Administration Disaster Declaration qualifies communities for access to affordable, timely, and accessible financial assistance. The 89 Pennsylvania events receiving Small Business Administration disaster-related loan assistance are listed in Table 4.2.1-3. It is important to note that SBA loans are also made available after Presidential Disasters, so SBA assistance has also been available for the events shown in Table 4.2.1-1.

Table 4.2.1-3 Pennsylvania Disaster Events Receiving Small Business Administration Loan Assistance		
DATE	EVENT	AFFECTED AREAS
June, 2017	Fire	Allegheny County and the adjacent counties of Armstrong, Beaver, Butler, Washington and Westmoreland
November, 2016	Flash Flooding	Centre and Lycoming counties and the adjacent counties of: Blair, Bradford, Clearfield, Clinton, Columbia, Huntingdon, Mifflin, Montour, Northumberland, Potter, Sullivan, Tioga, and Union
September, 2016	Flash Flooding	Fayette, Greene, Somerset, Washington and Westmoreland
July, 2016	Flash Flooding	Adams, Bedford, Berks, Blair, Bucks, Chester, Cumberland, Dauphin, Fayette, Franklin, Fulton, Juniata, Lancaster, Lebanon, Lehigh, Montgomery, Northampton, Perry, Philadelphia, Schuylkill, Somerset, Westmoreland and York
June, 2014	Severe Storms and Flooding	Elk County and the adjacent counties of Cameron, Clearfield, Forest, Jefferson, McKean and Warren
April, 2014	Severe Winter Storms	Berks, Bucks, Chester, Delaware, Lancaster, Lehigh Philadelphia and Montgomery
September, 2013	Storms and Severe Weather	Armstrong County and the adjacent counties of Allegheny, Butler, Clarion, Indiana, Jefferson and Westmoreland
August, 2013	Severe Storms and Flooding	Lawrence County and the adjacent counties of Beaver, Butler and Mercer

Table 4.2.1-3 Pennsylvania Disaster Events Receiving Small Business Administration Loan Assistance		
DATE	**EVENT**	**AFFECTED AREAS**
July, 2013	Severe Storms and Flooding	Allegheny County and the adjacent counties of Armstrong, Beaver, Butler, Washington and Westmoreland
July, 2013	Severe Storms and Flooding	Clearfield, Fayette and Jefferson counties and the adjacent counties of Armstrong, Blair, Cambria, Cameron, Centre, Clarion, Clinton, Elk, Forest, Greene, Indiana, Somerset, Washington and Westmoreland
October, 2012	Fire	Montgomery County (Cheltenham Township)
September, 2012	Fire	Centre County (Bellefonte Borough)
October, 2009	Fire	Columbia, Luzerne, Lycoming, Montour, Northumberland, Schuylkill and Sullivan Counties
August, 2009	Storms and Flooding	Berks, Bucks, Chester, Delaware, Lehigh, Montgomery and Philadelphia Counties
July, 2009	Fire	Adams, Cumberland, Dauphin, Lancaster and York Counties
June, 2009	Severe Storms and Flooding	Allegheny, Armstrong, Beaver, Butler, Cambria, Crawford, Erie, Fayette, Indiana, Somerset, Warren, Washington and Westmoreland Counties
March, 2009	Fire	Crawford, Erie and Warren Counties
January, 2009	Fire	Berks, Chester, Delaware, Lancaster and Montgomery Counties
September, 2008	Fire	Berks, Bucks, Chester, Delaware, Lehigh, Montgomery and Philadelphia Counties
August, 2008	Fire	Berks, Bucks, Chester, Delaware, Lehigh, Montgomery and Philadelphia Counties
July, 2008	Fire	Allegheny, Armstrong, Beaver, Butler, Washington and Westmoreland Counties
November, 2007	Fire	Berks, Bucks, Chester, Delaware, Lehigh, Montgomery and Philadelphia Counties
August, 2007	Severe Storms and Flooding	Allegheny, Armstrong, Beaver, Butler, Cambria, Fayette, Indiana, Somerset and Westmoreland Counties
August, 2007	Hail and High Winds	Bucks County
August, 2007	Hail	Carbon, Lehigh, Luzerne, Monroe, Northampton and Schuylkill Counties
July, 2007	Severe Storms and Flooding	Allegheny, Beaver, Butler, Lawrence and Washington Counties
July, 2007	Severe Storms and Flash Flooding	Wayne County
July, 2007	Drought	McKean, Potter and Warren Counties
May, 2007	Drought	Erie and Warren Counties
April, 2007	Drought and Extreme Heat	Beaver, Crawford, Erie, Lawrence and Mercer Counties
April, 2007	Severe Storms and Flooding	Pike County
April, 2007	Severe Storms and Flooding	Bucks and Philadelphia Counties

Table 4.2.1-3 Pennsylvania Disaster Events Receiving Small Business Administration Loan Assistance		
DATE	**EVENT**	**AFFECTED AREAS**
April, 2007	Severe Storms and Flooding	Delaware County
January, 2007	Fire	Bedford, Blair, Cambria, Fulton, Huntingdon, and Somerset Counties
December, 2006	Severe Storms and Tornadoes	Carbon, Columbia, Lackawanna, Luzerne, Monroe, Schuylkill, Sullivan and Wyoming Counties
November, 2006	Severe Storms and Flooding	Carbon, Columbia, Lackawanna, Luzerne, Monroe, Schuylkill, Sullivan and Wyoming Counties
August, 2006	Excessive Rain, Flooding and Flash Flooding	Erie, McKean, Potter and Warren Counties
June, 2004	Heavy Rain, High Winds and Flooding	Allegheny, Beaver, Butler, Lawrence, Mercer and Washington Counties
May, 2004	Heavy Rain, High Winds and Flooding	Adams, Cumberland, Dauphin, Lancaster and York Counties
April, 2003	Fire	Forest, Clarion, Elk, Jefferson, McKean, Venango and Warren Counties
March, 2003	Fire, Borough of Emporium	Cameron, Clearfield, Clinton, Elk, McKean and Potter Counties
August, 2002	Severe Storms - May 31	Armstrong, Beaver, Butler, Washington and Westmoreland Counties
July, 2002	Flash Flood	Washington County
October, 2001	Fire	Philadelphia
August, 2001	Flooding	Lehigh, Berks, Bucks, Carbon, Montgomery, Northampton and Schuylkill Counties
May, 2001	Fire	Montgomery, Bucks, Berks, Chester, Delaware, Lehigh and Philadelphia Counties
March, 2001	Fire	Montgomery, Bucks, Berks, Chester, Delaware, Lehigh and Philadelphia Counties
August, 2000	Flooding	Allegheny, Armstrong, Beaver, Butler, Cambria, Fayette, Indiana, Somerset, Washington and Westmoreland Counties
December, 1999	Fire	Cumberland County
February, 1999	West Shore Farmer's Market Fire	Adams, Cumberland, Dauphin, Franklin, Perry and York Counties
January, 1998	Fire	Philadelphia County
July, 1997	Flooding	Allegheny County
January, 1997	Fire	Allegheny County
September, 1996	Flooding	Erie County
January, 1996	Fire	Bucks County
October, 1995	Fire	Monroe County
March, 1995	Fire	Montgomery County
December, 1994	Fire	Blair County
July, 1994	Flood	Philadelphia County
December, 1993	Fire	Cumberland County
August, 1993	Flash Flood	Bucks County
April, 1993	Flash Flood	Wyoming County
March, 1993	Fire	Philadelphia County

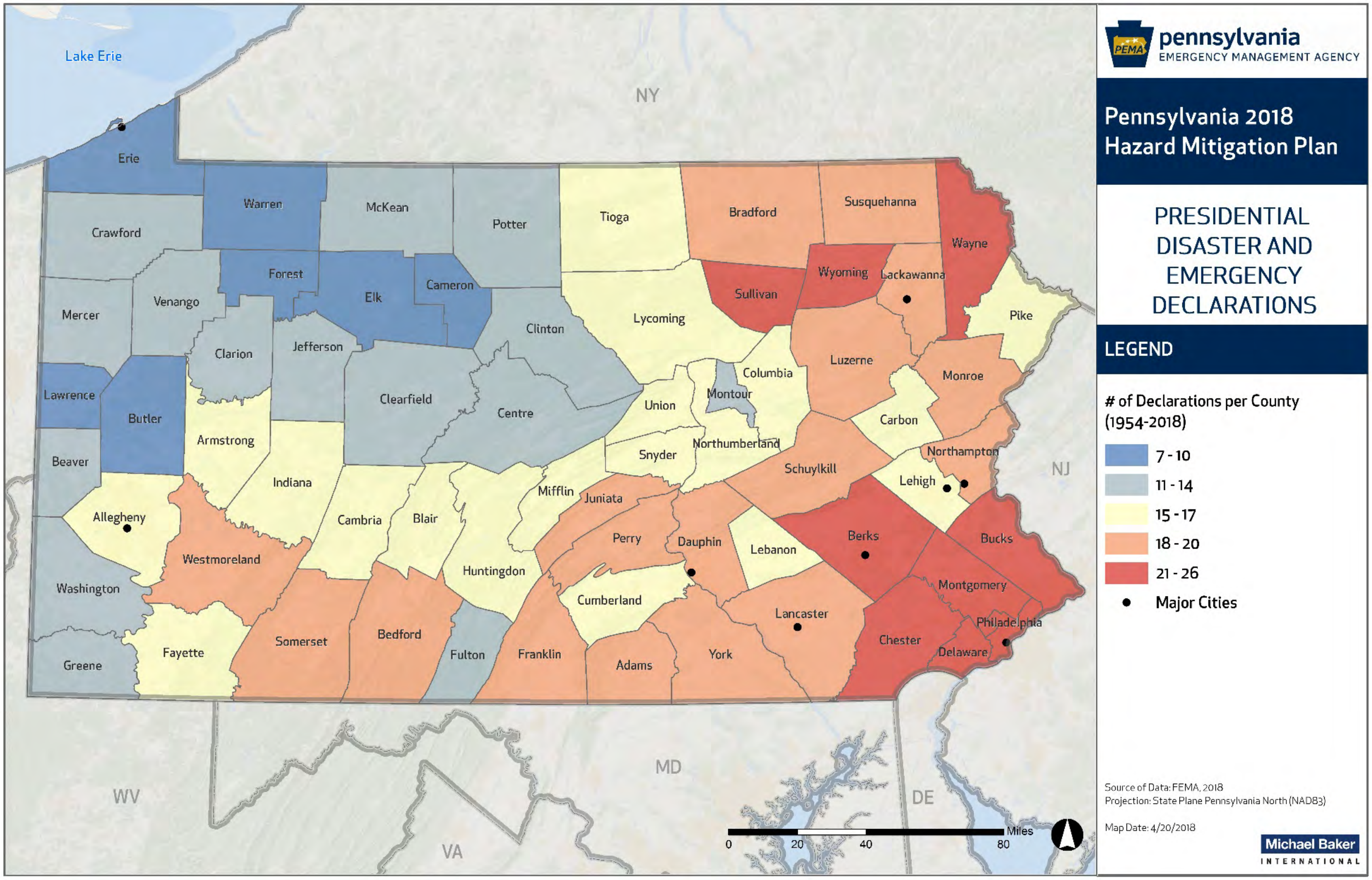
Table 4.2.1-3 Pennsylvania Disaster Events Receiving Small Business Administration Loan Assistance		
DATE	**EVENT**	**AFFECTED AREAS**
February, 1993	Fire	Bucks County
January, 1993	Fire	Allegheny County
August, 1992	Fire	Chester County
July, 1992	Fire	Philadelphia County
July, 1992	Flood	Warren County
June, 1992	Fire	Bucks County
March, 1992	Fire	Clearfield County
August, 1991	Flash Flood	Delaware County
July, 1991	Drought	Adams, Bedford, Blair, Bradford, Cambria, Cameron, Carbon, Centre, Clearfield, Clinton, Columbia, Cumberland, Dauphin, Franklin, Fulton, Huntingdon, Juniata, Lackawanna, Lancaster, Lebanon, Luzerne, Lycoming, Mifflin, Monroe, Montour, Northumberland, Perry, Pike, Potter, Schuylkill, Snyder, Somerset, Sullivan, Susquehanna, Tioga, Union, Wayne, Wyoming and York Counties
June, 1991	Fire	Dauphin County
May, 1990	Fire	Bucks County
April, 1990	Petroleum Spill	Allegheny, Armstrong, Beaver and Butler Counties
January, 1990	Fire	Dauphin County
September, 1989	Flood	Berks, Carbon, Lancaster, Lehigh and Northampton Counties
July, 1989	Flood	Chester and Delaware Counties
March, 1989	Fire	Montgomery County
February, 1989	Fire	Chester County
December, 1988	Fire	Bucks County
January, 1988	Fire	Luzerne County
December, 1987	Fire	Lycoming County
September, 1987	Flood	Berks, Lehigh and Northampton Counties
June, 1987	Fire	Bucks County
November, 1985	Flash Flood	Fayette, Greene and Westmoreland Counties
September, 1985	Flood	Carbon, Lackawanna, Luzerne, Monroe, Wayne, Wyoming and Susquehanna Counties
February, 1981	Flash Flood	Pike County (Matamoras)
February, 1981	Flash Flood/ Ice Jam	Venango County (Oil City)
January, 1981	Fire	Washington County (Charleroi)

Finally, a number of disaster events in Pennsylvania's history were reported as having no action taken, displayed in Table 4.2.1-4. These "No Action" events are disaster events that occurred but did not result in any type of disaster declaration – Presidential, Gubernatorial, or Small Business Administration. These events were recorded from 1967 to 1980, but have not been recorded after 1980. These events are included in the state's disaster history because in the past, disasters were recorded regardless of their declaration status. Currently, only events that result in a declaration are recorded in the Commonwealth's disaster history.

Table 4.2.1-4	Disaster events where no declaration occurred.	
DATE	**TYPE**	**AFFECTED AREAS**
June, 1980	Fire	Indiana County (Indiana Borough)
June, 1980	High Winds/Hail	York County
August, 1980	Flash Flood	Allegheny
January, 1979	Flood	Lackawanna, Lebanon, Lehigh, Luzerne, Mifflin and Montgomery Counties
February, 1979	Fire	Warren County (Tidioute)
March, 1979	Fire	Lycoming County (Williamsport)
March, 1979	Nuclear Facility Incident (TMI)	Dauphin, Lancaster, York, Cumberland, Perry and Lebanon Counties
July, 1979	Flood	Bucks County
January, 1978	Flood	Bradford, Lancaster and Northumberland Counties
July, 1978	High Winds	Armstrong, Clarion and Jefferson Counties
December, 1978	Fire	Delaware County (Morton)
April, 1977	Tornado	Dauphin County
June, 1977	Tornado	Armstrong County
July, 1977	Flash Flood	Allegheny, Snyder and Warren Counties
September, 1977	Tornado	Erie County (Lake City)
September, 1977	Tornado	Erie County (Washington Township)
March, 1976	Tornado	York County
July, 1976	Tornado	Lycoming County
March, 1975	Tornado	Beaver County
April, 1975	High Winds	Statewide
January, 1974	Flood	Allegheny, Fayette and Lawrence Counties
April, 1974	Flood	Erie and Lawrence Counties
May, 1974	Flood	Crawford and Erie Counties
July, 1974	Flash Flood	Fulton County (Ft. Littleton Scout Camp)
July, 1974	Windstorm	Mifflin County
September, 1974	Flood	Indiana, Jefferson and Sullivan Counties
September, 1973	Flood	Washington County
December, 1973	Flood	Montgomery County
November, 1972	Flood	Erie County
November, 1972	Flood	Bucks County
December, 1972	Flood	Westmoreland County
August, 1967	Flash Flood	Northampton County

Geographically, the highest concentration of Presidential Disaster and Emergency Declarations is located in the Commonwealth's most densely populated areas in the eastern half of the state. Montgomery County had the most Presidential Disaster or Emergency Declarations, with a total of 26. Bucks, Chester, Wyoming, Philadelphia, Wayne, Berks, Delaware, and Sullivan have also experienced over 20 Presidential Disaster or Emergency Declarations, as shown in Figure 4.2.1-1. Each county in Pennsylvania has experienced at least 7 Presidential Disaster or Emergency Declarations since 1954. Note that these totals do not include the two statewide declarations that have occurred, one for Hurricane Sandy in October 2012, and one for severe storms, tornadoes and flooding in August 2003.

Figure 4.2.1-2 Total Presidential disaster declarations in Pennsylvania by county between 1954 and 2018.



4.2.2. Summary of Hazards

Using previous disaster declaration history, the 2004, 2007, 2010, and 2013 HMPs, County HMPs, and input from the SPT (as described in Section 2.1), the 33 hazards selected for profiling in the 2018 SHMP are provided in Table 4.2.2-1 along with hazard descriptions. To navigate to maps showing the distribution of hazard and vulnerability, please see the Table of Figures at the start of this plan. All hazards that were profiled in the 2010 plan were also profiled in 2013. Three new hazards were added to the Commonwealth's risk assessment: Building and Structure Collapse, Cyber-Terrorism, and Opioid Addiction Response. In addition, the Environmental Hazards profile from the 2013 plan was divided into five separate profiles, and a more thorough assessment was developed for the environmental hazards posed by gas and liquid pipelines.

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.

PROFILED HAZARDS	DESCRIPTION
NATURAL	
Coastal Erosion	Coastal erosion is a natural coastal process in which sediment outflow exceeds sediment inflow at a particular location. These sediments are typically transported from one location to another by wind, waves, currents, tides, wind-driven water, waterborne ice, runoff of surface waters, or groundwater seepage. Depending on the location and processes in place, coastal erosion can take place very slowly, whereby the shoreline shifts only inches to a foot per year; or more rapidly, whereby changes can exceed ten feet per year. Intense storms and human interference can result in avulsive events where large portions of a beach or dune are washed away by strong currents and large waves. With the exception of portions of Erie County, coastal erosion is not a hazard for communities in Pennsylvania. (FEMA, 1997).
Drought	Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought. This hazard is of particular concern in Pennsylvania due to the presence of farms as well as water-dependent industries and recreation areas across the Commonwealth. A prolonged drought could severely impact these sectors of the local economy, as well as residents who depend on wells for drinking water and other personal uses. (National Drought Mitigation Center, 2006).
Earthquake	An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10-20 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).

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Extreme Temperature	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 (Lawrence County, PA SSAHMP, 2004).
Flood, Flash Flood, Ice Jam	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. (NOAA, 2009). 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 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 (USACE, 2007).
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 2 hailstorms per year while areas in western Pennsylvania experience 2-3 annually.

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Hurricane, Tropical Storm, Nor'easter	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 counter-clockwise (in the Northern Hemisphere) and whose diameter averages 10-30 miles across. While most of Pennsylvania is not directly affected by the devastating impacts cyclonic systems can have on coastal regions, many areas in the state are subject to the primary damaging forces associated with these storms including high-level sustained winds, heavy precipitation, and tornadoes. Areas in southeastern Pennsylvania could be susceptible to storm surge and tidal flooding. The majority of hurricanes and tropical storms form in the Atlantic Ocean, Caribbean Sea, and Gulf of Mexico during the official Atlantic hurricane season (June through November). (FEMA, 1997).
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 or environmental harm or harm to human health. These species can be any type of organism: plant, fish, invertebrate, mammal, bird, disease, or pathogen. Infestations may not necessarily impact human health, but can create a nuisance or agricultural hardships by destroying crops, defoliating populations of native plant and tree species, or interfering with ecological systems (Governor’s Invasive Species Council of Pennsylvania, 2009).
Landslide	A landslide is the downward and outward movement of slope-forming soil, rock, and vegetation reacting to the force of gravity. Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes due to construction or erosion, earthquakes, and changes in groundwater levels. Mudflows, mudslides, rockfalls, rockslides, and rock topples are all forms of a landslide. Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, developed hillsides, and areas recently burned by forest and brush fires. (Delano & Wilshusen, 2001).
Lightning Strike	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, 89 people are killed each year by lightning strikes in the United States. Within Pennsylvania, the annual average number of thunder and lightning events a given area can expect ranges between 40-70 events per year (FEMA, 1997).
Pandemic and Infectious Disease	A pandemic occurs when infection from of a new strain of a certain disease, to which most humans have no immunity, substantially exceeds the number of expected cases over a given period of time. Such a disease may or may not be transferable between humans and animals. (Martin & Martin-Granel, 2006).

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Radon Exposure	Radon is a cancer-causing natural radioactive gas that you can't see, smell, or taste. It is a large component of the natural radiation that humans are exposed to and can pose a serious threat to public health when it accumulates in poorly ventilated residential and occupation settings. According to the EPA, radon is estimated to cause about 21,000 lung cancer deaths per year, second only to smoking as the leading cause of lung cancer (EPA 402-R-03-003: EPA Assessment…, 2003). An estimated 40% of the homes in Pennsylvania are believed to have elevated radon levels (Pennsylvania Department of Environmental Protection, 2009).
Subsidence, Sinkhole	Subsidence is a natural geologic process that commonly occurs in areas with underlying limestone bedrock and other rock types that are soluble in water. Water passing through naturally occurring fractures dissolves these materials leaving underground voids. Eventually, overburden on top of the voids causes a collapse which can damage structures with low strain tolerances. This collapse can take place slowly over time or quickly in a single event, but in either case. Karst topography describes a landscape that contains characteristic structures such as sinkholes, linear depressions, and caves. In addition to natural processes, human activity such as water, natural gas, and oil extraction can cause subsidence and sinkhole formations. (FEMA, 1997).
Tornado, Wind Storm	A wind storm can occur during severe thunderstorms, winter storms, coastal storms, or tornadoes. Straight-line winds such as a downburst have the potential to cause wind gusts that exceed 100 miles per hour. Based on 40 years of tornado history and over 100 years of hurricane history, FEMA identifies western and central Pennsylvania as being more susceptible to higher winds than eastern Pennsylvania. (FEMA, 1997). A tornado is a violent windstorm characterized by a twisting, funnel-shaped cloud extending to the ground. Tornadoes are most often generated by thunderstorm activity (but sometimes result from hurricanes or tropical storms) when cool, dry air intersects and overrides a layer of warm, moist air forcing the warm air to rise rapidly. The damage caused by a tornado is a result of high wind velocities and wind-blown debris. According to the National Weather Service, tornado wind speeds can range between 30 to more than 300 miles per hour. They are more likely to occur during the spring and early summer months of March through June and are most likely to form in the late afternoon and early evening. Most tornadoes are a few dozen yards wide and touch down briefly, but even small, short-lived tornadoes can inflict tremendous damage. Destruction ranges from minor to catastrophic depending on the intensity, size, and duration of the storm. Structures made of light materials such as mobile homes are most susceptible to damage. Waterspouts are weak tornadoes that form over warm water and are relatively uncommon in Pennsylvania. Each year, an average of over 800 tornadoes is reported nationwide, resulting in an average of 80 deaths and 1,500 injuries (NOAA, 2002). Based on NOAA Storm Prediction Center Statistics, the number of recorded F3, F4, & F5 tornadoes between 1950-1998 ranges from <1 to 15 per 3,700 square mile area across Pennsylvania (FEMA, 2009). A water spout is a tornado over a body of water (American Meteorological Society, 2009).

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Wildfire	A wildfire is a raging, uncontrolled fire that spreads rapidly through vegetative fuels, exposing and possibly consuming structures. Wildfires often begin unnoticed and can spread quickly, creating dense smoke that can be seen for miles. Wildfires can occur at any time of the year, but mostly occur during long, dry hot spells. Any small fire in a wooded area, if not quickly detected and suppressed, can get out of control. Most wildfires are caused by human carelessness, negligence, and ignorance. However, some are precipitated by lightning strikes and in rare instances, spontaneous combustion. Wildfires in Pennsylvania can occur in fields, grass, brush, and forests. 98% of wildfires in Pennsylvania are a direct result of people, often caused by debris burns (PA DCNR, 1999).
Winter Storm	Winter storms may include snow, sleet, freezing rain, or a mix of these wintry forms of precipitation. 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. Many winter storms are accompanied by low temperatures and heavy and/or blowing snow, which can severely impair visibility and disrupt transportation. The Commonwealth of Pennsylvania has a long history of severe winter weather. (NOAA, 2009).
HUMAN-MADE	
Civil Disturbance	Civil disturbance hazards encompass a set of hazards emanating from a wide range of possible events that cause civil disorder, confusion, strife, and economic hardship. Civil disturbance hazards include the following: • **Famine**; involving a widespread scarcity of food leading to malnutrition and increased mortality (Robson, 1981). • **Economic Collapse, Recession**; Very slow or negative growth, for example (Economist, 2009). • **Misinformation**; erroneous information spread unintentionally (Makkai, 1970). • **Civil Disturbance, Public Unrest, Mass Hysteria, Riot**; group acts of violence against property and individuals, for example (18 U.S.C. § 232, 2008). • **Strike, Labor Dispute**; controversies related to the terms and conditions of employment, for example (29 U.S.C. § 113, 2008). In 2018, the DLI Office of Unemployment Compensation listed school strikes and healthcare strikes as two types of labor disputes with the potential to cause civil disturbance hazards in Pennsylvania.

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Cyber Terrorism	Cyber terrorism is a broad term that refers to acts associated with the convergence of terrorism and cyberspace. Generally, cyberterrorism involves unlawful attacks or threats against computers, networks, and the information stored therein to intimidate or coerce a government or its people to achieve political or social objectives (Denning, 2000). These acts can range from taking control of a host website, to using networked resources to directly cause destruction and harm. The Pennsylvania Department of Homeland Security defines the following types and methods of cyberattacks: Botnet, card skimming, denial-of-service attack, malicious code, pharming, phishing, spam, spear phishing, spoofing, spyware, trojan horse, virus, and worm.
Dam 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, PA, 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).
Environmental Hazards – Coal Mining	Major impacts from mining include surface-elevation changes and subsidence, modification of vegetation, the chemical degradation and flow redistribution of surface water and groundwater, the creation of mine voids and entry openings, adverse aesthetic impacts, and changes in land use. In addition, active and abandoned mines can also result in injury and loss of human life. This can occur in active mines where workers are injured or killed by mine collapse, entrapment, poisonous gases, inundation, explosions, fires, equipment malfunction, and improper ventilation. Injuries and death, such as All-Terrain Vehicle (ATV) accidents, falling, and drowning, can also occur in abandoned mines.
Environmental Hazards – Conventional Oil and Gas Wells	As is the case with all-natural resource extraction, a variety of potential hazards exist with oil and gas extraction. Abandoned oil and gas wells that are not properly plugged can contaminate groundwater and consequently domestic 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 degrade public drinking water supplies and be particularly detrimental to vegetation and aquatic animals.

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Environmental Hazards – Gas and Liquid Pipelines	Pipeline failures are low-probability, potentially high-consequence events. Although gas and liquid pipeline failures are infrequent, the hazardous and inflammable materials released by these events can pose a significant threat to public safety and the built and natural environment. Explosions associated with pipeline failures, for example, can cause severe injury to nearby residents and destroy homes and other property.
Environmental Hazards – Hazardous Materials Releases	Hazardous material releases can contaminate air, water, and soils possibly resulting in death and/or injuries. Dispersion can take place rapidly when transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. As previously mentioned, 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.
Environmental Hazards – Unconventional Oil and Gas Wells	In addition to the traditional hazards associated with oil and gas well drilling, potential impacts from Marcellus Shale gas well drilling include: surface water depletion from high consumptive use with low return rates affecting drinking water supplies, and aquatic ecosystems and organisms; contaminated surface and groundwater resulting from hydraulic fracturing and the recovery of contaminated hydraulic fracturing fluid; and mishandling of solid toxic waste
Levee Failure	A levee is a human-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water so as to provide protection from temporary flooding (Interagency Levee Policy Review Committee, 2006). Levee failures or breaches occur when a levee fails to contain the floodwaters for which it is designed to control or floodwaters exceed the height of the constructed levee. 51 of Pennsylvania's 67 counties have been identified as having at least one levee (FEMA Region III, 2013).
Mass Food/Animal Feed Contamination	Mass food or animal feed contamination hazards occur when food or food sources are contaminated with pathogenic bacteria, viruses, or parasites, as well as chemical or natural toxins. They may lead to foodborne illnesses and/or interruptions in the food supply. Contamination may occur due to natural foodborne illnesses and chemical, biological, radiological, or nuclear exposure. Most foodborne illnesses are caused by *Campylobacter* in poultry, *E. Coli* in beef, leafy greens, and raw milk, *Listeria* in deli meats, unpasteurized soft cheeses, and produce, *Salmonella* in eggs, poultry, meat, and produce, *Vibrio* in raw oysters, *Norovirus* in many foods, and *Toxoplasma* in meats (CDC, 2013). Contamination usually occurs accidentally during the production/preparation process but can also be the result of intentional acts.

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Nuclear Incident	Nuclear incidents generally refer to events involving the release of significant levels of radioactivity or exposure of workers or the general public to radiation (FEMA, 1997). Nuclear accidents/incidents can be placed into three categories: 1) Criticality accidents which involve loss of control of nuclear assemblies or power reactors, 2) Loss-of-coolant accidents which result whenever a reactor coolant system experiences a break or opening large enough so that the coolant inventory in the system cannot be maintained by the normally operating make-up system, and 3) Loss-of-containment accidents which involve the release of radioactivity. The primary concern following such an incident or accident is the extent of radiation, inhalation, and ingestion of radioactive isotopes which can cause acute health effects (e.g. death, burns, severe impairment), chronic health effects (e.g. cancer), and psychological effects. (FEMA, 1997).
Opioid Addiction Response	Opioid addiction occurs when an individual becomes physically dependent on opioids, which include opiates and narcotics. Opioids are a synthetic substance found in certain prescription pain medications: morphine, codeine, methadone, oxycodone, hydrocodone, fentanyl, and hydromorphone, and street drugs like heroine. These drugs can be highly addictive, which often lead to misuse and overdosing. Opioids block the body's ability to feel pain and can create a sense of euphoria. Individuals often build a tolerance to the opioid drugs, which leads them to take more of the medication than originally prescribed. The most dangerous side effect of an opioid overdose is depressed breathing. The lack of oxygen to the brain causes permanent brain damage, leading to organ failure, and eventually, death.
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 (FEMA, 2009). Increasingly, cyber-attacks have become a more pressing concern for governments across America.
Transportation Accident	Transportation accidents can result from any form of air, rail, water, or road travel. It is unlikely that small accidents would significantly impact the larger community. However, certain accidents could have secondary regional impacts such as a hazardous materials release or disruption in critical supply/access routes, especially if vital transportation corridors or junctions are present. (Research and Innovative Technology Administration, 2009). Traffic congestion in certain circumstances can also be hazardous. Traffic congestion is a condition that occurs when traffic demand approaches or exceeds the available capacity of the road network. This hazard should be carefully evaluated during emergency planning since it is a key factor in timely disaster or hazard response, especially in areas with high population density. (Federal Highway Administration, 2009).

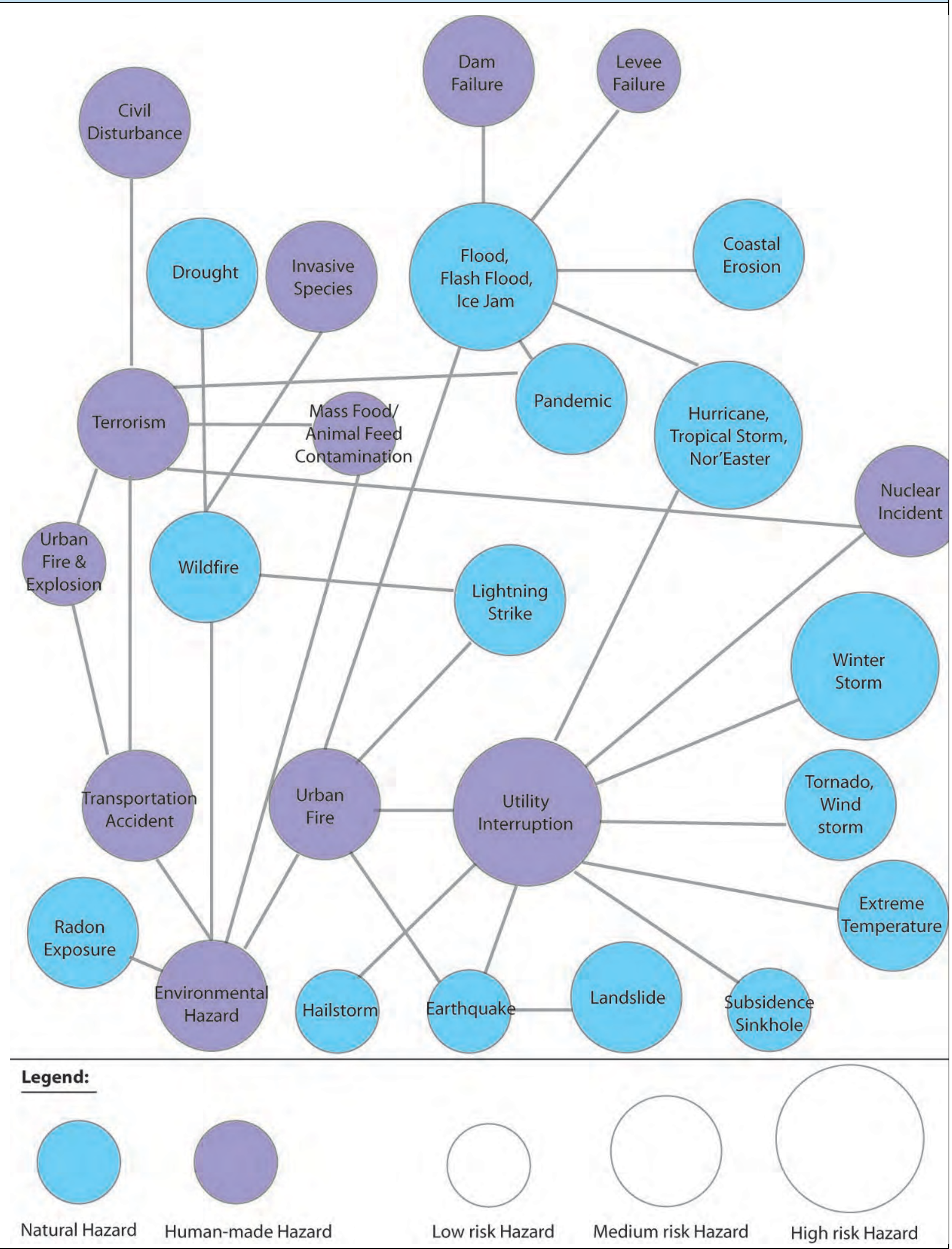
Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Urban Fire and Explosion	An urban fire involves a structure or property within an urban or developed area. For hazard mitigation purposes, major urban fires involving large buildings and/or multiple properties are of primary concern. The effects of a major urban fire include minor to significant property damage, loss of life, and residential or business displacement. Explosions are extremely rapid releases of energy that usually generate high temperatures and often lead to fires. The risk of severe explosions can be reduced through careful management of flammable and explosive hazardous materials. (FEMA, 1997).

Table 4.2.2-1 List of hazards profiled in the 2018 Pennsylvania SHMP with associated descriptions.	
PROFILED HAZARDS	**DESCRIPTION**
Utility Interruption	Utility interruption hazards are hazards that impair the functioning of important utilities in the energy, telecommunications, public works, and information network sectors. Utility interruption hazards include the following: • **Geomagnetic Storms**; including temporary disturbances of the Earth's magnetic field resulting in disruptions of communication, navigation, and satellite systems (National Research Council et al., 1986). • **Fuel or Resource Shortage**; resulting from supply chain breaks or secondary to other hazard events, for example (Mercer County, PA, 2005). • **Electromagnetic Pulse**; originating from an explosion or fluctuating magnetic field and causing damaging current surges in electrical and electronic systems (Institute for Telecommunications Sciences, 1996). • **Information Technology Failure**; due to software bugs, viruses, or improper use (Rainer Jr., et al, 1991). • **Ancillary Support Equipment**; electrical generating, transmission, system-control, and distribution-system equipment for the energy industry (Hirst & Kirby, 1996). • **Public Works Failure**; damage to or failure of highways, flood control systems, deep-water ports and harbors, public buildings, bridges, dams, for example (United States Senate Committee on Environment and Public Works, 2009). • **Telecommunications System Failure**; Damage to data transfer, communications, and processing equipment, for example (FEMA, 1997) • **Transmission Facility or Linear Utility Accident**; liquefied natural gas leakages, explosions, facility problems, for example (United States Department of Energy, 2005) • **Major Energy, Power, Utility Failure**; interruptions of generation and distribution, power outages, for example (United States Department of Energy, 2000). Internet interruptions/internet failures are an increasingly important kind of utility interruption as more of the day-to-day business of the Commonwealth is conducted over the internet.

Several hazards including avalanche; building or structure collapse; disorientation; drowning; dust and sand storm; expansive soils; tsunami; volcano; and war and criminal activity were not profiled in 2004, 2007, 2010, or 2013. Each of these hazards either overlapped significantly with hazards profiled (e.g. building or structure collapse and war and criminal activity) or were not considered by the SPT to have notable effects on the Commonwealth. The SPT also determined that a more robust assessment of climate change impacts should be included in the Future Occurrence section of each hazard profile.

These hazards do not exist in a vacuum and typically are very inter-related. Figure 4.2.2-2 illustrates these relationships. For example, utility interruption, a highly ranked hazard, typically occurs in conjunction with or because of a winter storm, tornado, hurricane, flood, or hailstorm. Flood events and their impacts can be related to dam failures and levee failures.

Figure 4.2.2-2 Inter-relationships between hazard events in Pennsylvania.



A summary of the potential losses associated with the hazards identified in the 2018 SHMP is presented in Table 4.2.2-2. For each hazard, the potential losses shown include the number of state assets at risk, the total population at risk, and the estimated building value at risk. It is important to note that the exposed building value for hazards that did not use Hazus modeling represents the total replacement value for all buildings determined to be at risk, while the exposed building value for hazards that did use Hazus modeling (flood, earthquake, and hurricane wind) represents the estimated cost to repair or replace the damage caused to buildings and their contents. In other words, the values derived with Hazus account for the level of exposure to the hazard and the vulnerability of structures, while the values derived without Hazus reflect the replacement cost if all structures were entirely destroyed. For those values derived without Hazus, the exposed building value therefore errs on the side of safety. It is also important to note that some hazards do not cause direct damage to buildings (e.g., pandemics). The metric of Exposed Building Value is not relevant to these hazards, and no value is listed.

The final column of Table 4.2.2-2 summarizes the methodology for estimating potential losses associated with each hazard. The loss estimation methodology is further explained in Sections 4.1 and 4.3. See Section 4.1 for a general summary of the data sources and methodology, and the hazard profiles in Section 4.3 for a more detailed description of the data used and assumptions made.

Table 4.2.2-2 Overview of vulnerable state assets and loss estimates per hazard.

HAZARDS	VULNERABLE STATE FACILITIES	VULNERABLE CRITICAL FACILITIES	VULERABLE POPULATION	EXPOSED BUILDING VALUE	METHODOLOGY FOR IDENTIFYING VULNERABLE STRUCTURES AND POTENTIAL LOSSES
Building or Structure Collapse	NA	NA	2,613,816	$267,795,879	Vulnerable facilities, population, and building value were estimated based on location within high-risk census tracts. Census tracts were defined as high risk when more than 75 percent of housing units were built before 1960.
Civil Disturbance	NA	31	NA	NA	Vulnerable facilities were identified based on use rather than location. Government buildings and national monuments/icons were assumed to be at greatest risk.
Coastal Erosion	0	0	NA	$26,959,950	Vulnerable building value was estimated based on location within high-risk areas. Areas were defined as high risk when located within the Erie County 100-year Erosion Hazard Area.
Cyber-Terrorism	NA	NA	NA	NA	Distribution of hazard and vulnerability is highly uncertain.
Dam Failure	Protected	Protected	Protected	Protected	This data is protected by PA DEP.
Drought	30	275	6,186,034		Vulnerable facilities were identified based on types and use rather than location. State facilities with uses listed as animal facility, greenhouse, agricultural-storage, or land and critical facilities with type listed as agricultural were assumed to be at greatest risk. Vulnerable population was identified based on location in high-risk areas. Census tracts were defined as high risk when affected by moderate drought or greater for at least 3.5% of weeks between 2000 and 2016

Table 4.2.2-2	Overview of vulnerable state assets and loss estimates per hazard.				
HAZARDS	VULNERABLE STATE FACILITIES	VULNERABLE CRITICAL FACILITIES	VULERABLE POPULATION	EXPOSED BUILDING VALUE	METHODOLOGY FOR IDENTIFYING VULNERABLE STRUCTURES AND POTENTIAL LOSSES
Earthquake	683	2,716	NA	$ 14,707,270,327	Vulnerable state facilities were identified based on location within areas of relatively high risk. High risk areas were defined as those in which the Peak Ground Acceleration for ground shaking event with a 2 percent probability of exceedance in 50 years is estimated to be greater than 8 %g. Vulnerable populations and building value were estimated using Hazus v4.0. A Level II analysis was conducted to estimate average annualized losses in each census tract.
Environmental Hazards (Coal Mine Incidents)	1,026	3,344	2,303,503	$255,171,122	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when within 1.5 miles of an active or abandoned coal mine.
Environmental Hazards (Conventional Oil & Gas Well Incidents)	766	2,315	1,762,162	$193,779,437	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when within 1,000 yards of an active or abandoned well.
Environmental Hazards (Gas and Liquid Pipelines)	446	1,278	1,231,518	151,100,335	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located within 0.25 miles of major gas or liquid pipelines.
Environmental Hazards (HazMat Releases)	3,877	9,762	8,541,021	1,033,928,225	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located within 0.25 miles of major Interstates, US highways, state highways, and rail lines, and areas within 1.5 miles of hazardous materials sites extracted from CDMS.

Table 4.2.2-2 Overview of vulnerable state assets and loss estimates per hazard.					
HAZARDS	**VULNERABLE STATE FACILITIES**	**VULNERABLE CRITICAL FACILITIES**	**VULERABLE POPULATION**	**EXPOSED BUILDING VALUE**	**METHODOLOGY FOR IDENTIFYING VULNERABLE STRUCTURES AND POTENTIAL LOSSES**
Environmental Hazards (Marcellus/Other Shale Oil & Gas Well Incidents)	87	326	180,213	16,242,107	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when within 1,000 yards of an active, inactive, or unplugged well.
Extreme Temperature (Cold)	304	1,107	353,863	$37,896,651	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located in census tracts with greater than 32 excessive cold and wind chill warnings between 2005 and 2017.
Extreme Temperature (Heat)	494	2,208	3,727,073	$457,041,972	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located in census tracts with greater than 100 heatwave warnings between 2005 and 2017.
Flood, Flash Flood, Ice Jam	164	2,004	110,336 (Households Displaced)	$22,329,000,00 0	Vulnerable state facilities were identified based on location within areas of relatively high risk. High risk areas were defined as those in the FEMA 1%-annual-chance floodplain. Vulnerable populations and building value were estimated using Hazus v4.0. A Level II analysis was conducted to estimate the 1%-annual-chance losses in each census block.
Hailstorm	620	2,166	2,060,680	$251,653,206	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located in census tracts with greater than 2,800 hail reports between 1986 and 2016.

Table 4.2.2-2 Overview of vulnerable state assets and loss estimates per hazard.

HAZARDS	VULNERABLE STATE FACILITIES	VULNERABLE CRITICAL FACILITIES	VULERABLE POPULATION	EXPOSED BUILDING VALUE	METHODOLOGY FOR IDENTIFYING VULNERABLE STRUCTURES AND POTENTIAL LOSSES
Hurricane, Tropical Storm, Nor'easter	155	877	NA	$18,808,722	Vulnerable state facilities were identified based on location within areas of relatively high risk. Areas were identified as high risk when located in census tracts that overlapped with at least one hurricane path between 1851 and 2015. Vulnerable populations and building value were estimated using Hazus v4.0. A Level II analysis was conducted to estimate average annualized losses in each census tract.
Invasive Species	NA	NA	NA	NA	Distribution of hazard and vulnerability is highly uncertain.
Landslide	2183	6,318	4,479,572	$510,058,831	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located in areas classified as high-incidence or high-susceptibility by USGS.
Levee Failure	250	402	269,330	33,483,028	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located within 2,000 feet of a levee identified in the USACE National Levee Database.
Lightning Strike	433	1,425	959,633	$105,793,771	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located in census tracts with greater than 180 observed lightning flashes between 1991 and 2016.
Mass Food and Animal Feed Contamination	NA	NA	NA	NA	Distribution of hazard and vulnerability is highly uncertain.

Table 4.2.2-2 Overview of vulnerable state assets and loss estimates per hazard.					
HAZARDS	**VULNERABLE STATE FACILITIES**	**VULNERABLE CRITICAL FACILITIES**	**VULERABLE POPULATION**	**EXPOSED BUILDING VALUE**	**METHODOLOGY FOR IDENTIFYING VULNERABLE STRUCTURES AND POTENTIAL LOSSES**
Nuclear Incident	105	672	666,326	$75,598,585	Vulnerable state facilities were identified based on a combination of location and use. All facilities within the 10-mile Plume Exposure EPZ and all agricultural facilities within the 50-mile Ingestion Exposure EPZ were identified as vulnerable. Vulnerable populations and building value were estimated based on location only. Areas were defined as high-risk when located within the 10-mile Plume Exposure EPZ.
Opioid Addition Response	NA	NA	NA	NA	Insufficient data available.
Pandemic and Infectious Disease	NA	NA	NA	NA	Distribution of hazard and vulnerability is highly uncertain.
Radon Exposure	NA	NA	NA	$1,175,157,120	Vulnerable building value was estimated based on location within high-risk areas. Areas were defined as high risk when located within zip codes with average radon readings of greater than 4pCi/L. To estimate building-related loss, the average radon mitigation system cost of $1,200 was applied to 20 percent of high risk buildings.
Subsidence, Sinkhole	1,384	3,101	2,998,832	$334,196,792	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when underlain by carbonate rocks at or near the land surface or carbonate rocks buried less than 50 feet deep.
Terrorism	NA	NA	NA	NA	Distribution of hazard and vulnerability is highly uncertain.

Table 4.2.2-2 Overview of vulnerable state assets and loss estimates per hazard.					
HAZARDS	VULNERABLE STATE FACILITIES	VULNERABLE CRITICAL FACILITIES	VULERABLE POPULATION	EXPOSED BUILDING VALUE	METHODOLOGY FOR IDENTIFYING VULNERABLE STRUCTURES AND POTENTIAL LOSSES
Tornado & Wind Storm	1,600	4,718	4,824,978	$553,935,555	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located in census tracts where maximum number of tornado touchdowns between 1986 and 2016 exceeded 590.
Transportation Accident (highway)	2,878	6,278	4,241,287	553,586,841	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located within 0.25 miles of major Interstates, US highways, or state highways.
Transportation Accident (air)	225	874	1,148,538	128,638,342	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located within 5 miles of public or private airports or heliports with more than 1,000 enplanements per year.
Transportation Accident (rail)	1,022	3,001	2,475,199	337,875,048	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Areas were defined as high risk when located within 0.25 miles of active rail lines.
Urban Fire and Explosion	1,561	5,243	6,043,102	$680,553,080	Vulnerable facilities, population, and building value were estimated based on location within high-risk census tracts. Census tracts were defined as high risk when more than 60 percent of housing units were built before 1970.
Utility Interruption	NA	NA	NA	NA	Distribution of hazard and vulnerability is highly uncertain.

Table 4.2.2-2 Overview of vulnerable state assets and loss estimates per hazard.

HAZARDS	VULNERABLE STATE FACILITIES	VULNERABLE CRITICAL FACILITIES	VULERABLE POPULATION	EXPOSED BUILDING VALUE	METHODOLOGY FOR IDENTIFYING VULNERABLE STRUCTURES AND POTENTIAL LOSSES
Wildfire	85	191	141,601	$16,434,043	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Census tracts were defined as high risk when the area of moderate to high wildfire hazard potential exceeds 10 percent of the total area of the census tract.
Winter Storm	643	1,675	1,567,026	$183,139,911	Vulnerable facilities, population, and building value were estimated based on location within high-risk areas. Census tracts were defined as high risk when the number of winter weather warnings between 2005 and 2016 exceeded 270.

4.3. Hazard Profiles and Vulnerability Analysis

NATURAL HAZARDS

4.3.1. Coastal Erosion

4.3.1.1. Location and Extent

A coastal zone is the area where the land meets the sea and includes both coastal waters and adjacent shore lands. These areas face increasing pressure from development, shoreline erosion, biodiversity losses, and nonpoint source pollution (PA DEP CRM, 2018). Pennsylvania has two coastal zones that are subject to potential coastal erosion hazards; the coastlines along Lake Erie and the Delaware River.

The Lake Erie coastline in Pennsylvania stretches approximately 77 miles across the northern border of Erie County. The Lake Erie coastal zone in Erie County includes shorelines of major tributaries and the highest bluffs anywhere on the Lake Erie shore.

Lake Erie also contains Presque Isle State Park, which is the only significant coastal depositional feature on the south shore of the lake. It is a compound re-curved spit made up of beach, dune, and inter-dune-pond features which protects Erie Harbor. Most of the Pennsylvania lake shore consists of narrow beaches lakeward of bluffs, five to 180 feet high (PA DEP, 2002). The glaciers that carved out the Great Lakes basin resulted in the deposition of sediments that make up the bluffs. These unconsolidated glacial sediments include sand, gravel, and clay, all of which are very vulnerable to erosion when exposed to the forces of direct wave contact, groundwater flows, surface water runoff, ice, wind and rain. In some areas along the Lake Erie coast, the bluffs have a bottom layer of exposed bedrock or shale, which is often weathered and undercut over the long-term by wave action.

There are 112 miles of coastline along the Delaware Estuary. The Delaware Estuary coastal zone lies within Bucks, Philadelphia, and Delaware Counties and contains islands, marshes and shore lands of tributary streams that are tidally influenced (PA DEP CRM, 2018). While it is subject to coastal or wetland erosion, the high degree of urbanization along the southeastern Pennsylvania Delaware River shoreline has resulted in a significant amount of shoreline hardening with structures such as bulkheads, piers, and marginal wharves. Although detailed structure inventories have not been performed, these structures greatly reduce erosion hazards along most of the Delaware River shoreline. Therefore, Lake Erie is the area of primary concern for coastal erosion hazards and is the focus of the risk assessment.

Figure 4.3.1-1 depicts the Bluff Recession Hazard Areas (BRHAs) identified by the Pennsylvania Department of Environmental Protection (PA DEP) Coastal Resources Management Program (CRMP). BRHAs are defined in Section 3 of the Bluff Recession and Setback Act as “an area or zone where the rate of progressive bluff recession creates a substantial threat to the safety or stability of nearby or future structures or utility facilities.” These bluffs are present along the majority of Erie County’s border with Lake Erie and present a hazard. Original designations of BRHAs, codified at 25 Pa. Code § 85.26, are based on a 1975 study titled *Shoreline Erosion and Flooding – Erie County* (PA DEP, 2004). Current designations were established in 2009 based on a 2004 study titled, *Study to Tentatively Designate Bluff*

Recession Hazard Areas. All BHRAs were first established in 1980 except for the BRHA within the City of Erie, which was established during the 2009 update (Pennsylvania Bulletin, 2009).

The BRHAs determine where along the shoreline development will be subject to Minimum Bluff Setback Distances. Sections of shoreline that are not identified as a BRHA (e.g. beach and dune areas, headlands, armored shorelines, etc.) may not be subject to bluff recession, but remain vulnerable to shoreline erosion.

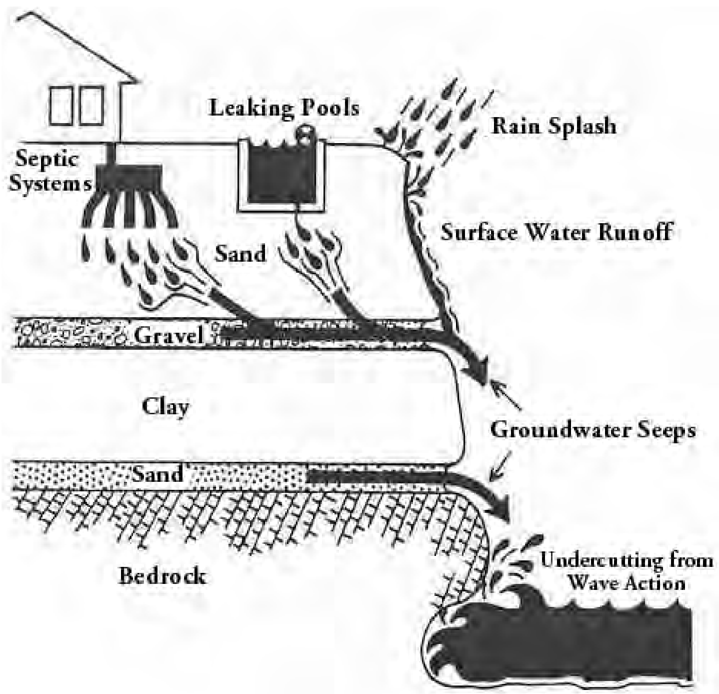
Figure 4.3.1-1 Bluff Recession Hazard Areas along the Lake Erie Shoreline (PA DEP, 2011).

4.3.1.2. Range of Magnitude

Bluff recession and shoreline erosion events can take place gradually over decades or abruptly during a single storm event. The magnitude of bluff recession and shoreline erosion events depends greatly on fluctuating lake levels and the amount of beach material along the shoreline. However, other factors that affect rate of change include surrounding land use, precipitation, storm impacts, vegetative cover, soil type, depth of unconsolidated soils, hydrology, bedrock geology, slope gradient, offshore bathymetry, and human activity. Figure 4.3.1-2 illustrates both the natural and human-induced processes that influence bluff recession rates of change.

Bluff instability often occurs from erosion of foreshore beach materials and the undercutting of bluffs by wave attack. However, slumping and mass-wasting of the bluff face can also occur without the presence of direct wave attack. Erosion of the bluffs may be accelerated by groundwater seepage, surface water runoff, and human activity or changes in land use that would alter the hydrology or vegetation on a site.

Figure 4.3.1-2 Diagram of the Natural and Human-Induced Processes that Influence Coastal Erosion



In beach and dune areas such as Presque Isle, wind-driven waves, especially during periods of high lake levels, can inundate natural protective beaches and allow water and damaging waves to reach the back-beach areas. During prolonged periods of inundation, large quantities of beach material can be moved offshore. It is during these periods that the greatest threat of property damage and site instability occurs.

Much of Lake Erie and its beaches and bluffs are frozen during winter, inhibiting the formation of storm waves and reducing erosion. However, during ice formation in early winter and during the spring thaw, ice processes can accelerate erosion and recession. Spring rains, snowmelt, and low evaporation rates cause Lake Erie's average water level in June to be more than 30 centimeters above the typical January level. Several years of above-normal precipitation, as in the mid-1980s, can cause Lake Erie's water level to rise significantly above its long-term average, increasing the likelihood of erosion.

Lake Erie is the shallowest of the Great Lakes, reaching a maximum depth of 210 feet in the eastern basin. The lake topography coupled with changing water levels can have extreme effects on the shoreline. Because the lake is shallow, the effects of storm-driven waves are amplified. The axis of the lake runs from southwest to northeast, corresponding to the direction of prevailing winds. Strong winds can push water toward one end of Lake Erie (setup) and may create a difference in elevation of over 15 feet. When the wind stops, the water will rebound creating a seiche effect which causes the water to move back and forth across the lake. Strong winds or northeasters can also be a problem, driving storm waves opposite of their normal path. Elevated water levels associated with these seiche events can result in significant erosion events.

The impacts of bluff recession and shoreline erosion may be minimal in areas where buildings and infrastructure have been constructed at an adequate setback distance or erosion mitigation measures have been employed. However, development within designated hazard areas can result in damage or complete destruction of property and public infrastructure, as well as threaten public health and safety. A worst-case scenario for coastal erosion would be if coastal erosion from a strong storm occurred, causing a slumping or mass-wasting of a bluff and numerous homes on the bluff to collapse. This could result in not only property damage, but loss of life or injuries if the homes are occupied at the time of the slope collapse. Figure 4.3.1-3 shows an example of a building imminently threatened by significant bluff recession, dating back to the 1970s. Figure 4.3.1-4 shows an example of a collapsed retaining structure.

Figure 4.3.1-3 Photograph of Large Avulsion Event along the Lake Erie, PA Shoreline (USGS, 2009 and the PA DEP Coastal Resource Management Program).

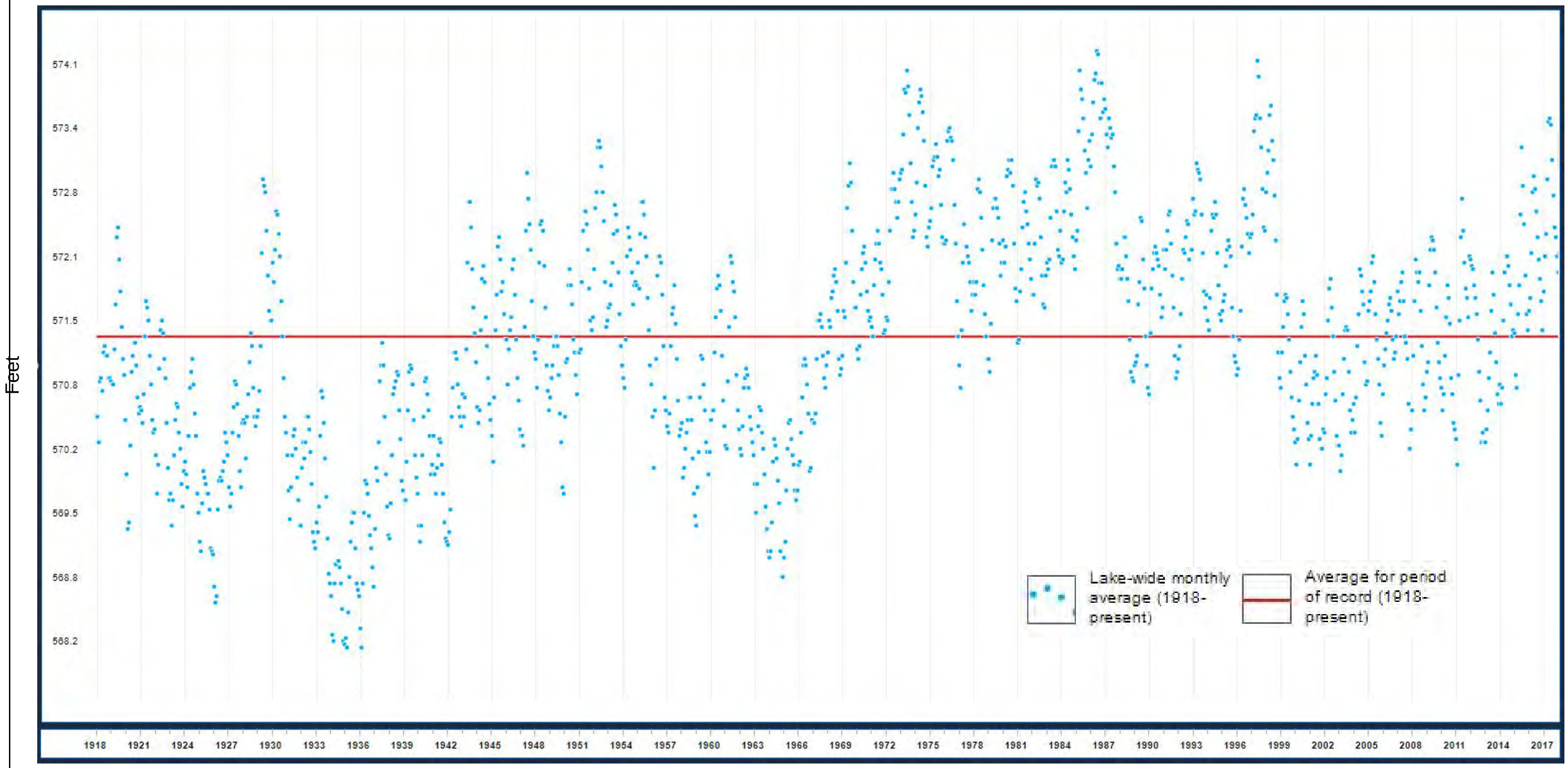
Figure 4.3.1-4 Photograph of Collapsed Retaining Wall Structure along the Lake Erie, PA Shoreline (PA DEP, 2011).

A cycle of bluff erosion generally begins with high lake levels and direct wave erosion of the base of the bluff. This steepens the total bluff profile, and a variety of mass movement processes lead to progressive failure of the upper bluff face. These are basically landslide processes and include topple and fall of blocks of jointed diamict, liquefaction, flow of well-sorted silts and sands, and slump of blocks of sediment held together by tree roots. Groundwater seepage from the face of the bluff is an important factor in many of the bluff-face processes. Grain-by-grain erosion of sand and silt in some cases leads to development of large soil pipes. These can be 20 feet in diameter and can extend into the bluff face for tens of feet. When the roof of a pipe collapses, large embayments in the top of the bluff result.

Accumulation of material at the toe of the bluff provides some protection from further retreat at the toe, but the colluvial sediment can be quickly removed by storm waves at times of high lake levels. Significant erosional waves typically occur during spring and fall storms. Winter storms may have more energy, but ice build-up protects the shore from erosion.

Lake levels significantly influence erosion and bluff recession rates. Periods of rising lake levels resulted in increased erosion rates. Glacial isostatic rebound may still be a small factor in changing lake levels, but most modern lake-level changes are attributable to climatic factors. Long-term changes are caused by variations in precipitation and evapotranspiration rates. Figure 4.3.1-5 shows average annual lake levels of Lake Erie for the period between 1918 and 2017. Lake levels have varied on the order of approximately six feet over this period. The droughts of the 1930's and 1960's are clearly reflected in the low lake levels. An annual cycle and short-term changes related to weather also affect the lake level.

Figure 4.3.1-5 Lake Erie Water Levels Between 1918 and 2017 (NOAA GLERL, 2018)



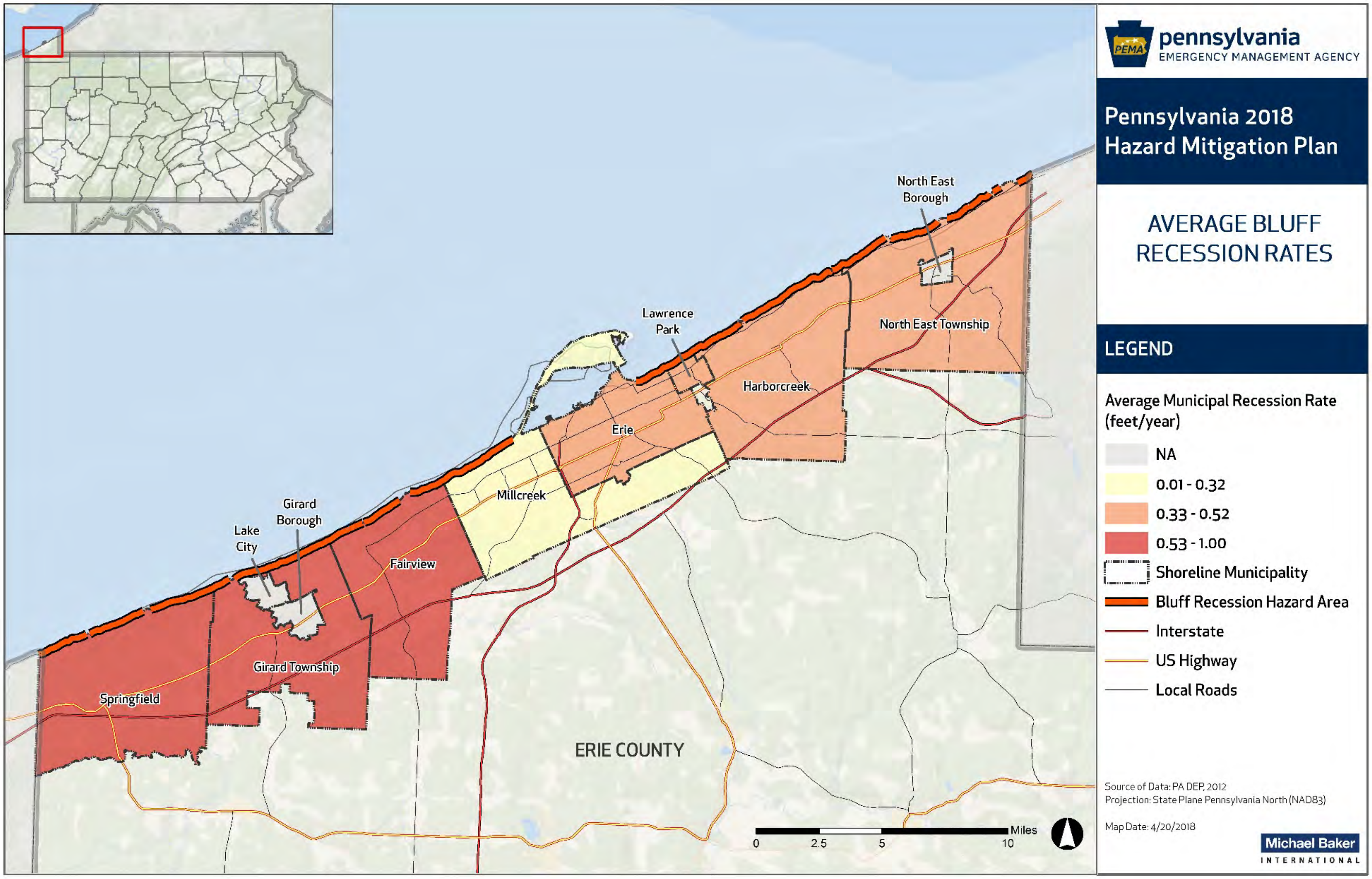
The most severe erosion events occur when lake levels are at their highest. This is reflected in the fact that 1987 and 1998 erosion events referenced in Section 4.3.1.3 correspond with lake-level peaks shown in Figure 4.3.1-55.

4.3.1.3. Past Occurrence

PA DEP's CRMP monitors coastal erosion along the Lake Erie shoreline with approximately 130 established control points. The first control point was established in 1975, but the monitoring program formally began in 1982 (PA DEP CRM, 2018a). Average recession rates are measured by municipality and range from approximately 0.3 feet per year to nearly one foot per year in the easternmost municipality of Springfield. The long-term average recession for the Pennsylvania Lake Erie Coastal Zone is 0.75 feet per year; however, losses of up to twenty feet in a single year have been observed (Hapke et al., 2009 and Pennsylvania Sea Grant, 2002). Figure 4.3.1-6 displays average bluff recession rates along the Pennsylvania Lake Erie shoreline as calculated in 2012; more recent data on recession rates were not available. Erosion and recession rates are generally spatially variable and temporally episodic. However, as evident in the map, the highest average recession rates appear to occur in the eastern part of the shoreline; the lowest rates have occurred near the of the shoreline in Erie County. A study performed by the U.S. Geological Survey (USGS) in cooperation with the CRMP divided the Pennsylvania Lake Erie shoreline into two areas along which recession rates were calculated (Hapke et al., 2009). Using data from 1938 to 2006, the study area extending southwest of Presque Isle had an average rate of recession of 0.98 +/- 0.33 feet per year. Using data from 1938 to 1998, the study area extending northeast of Presque Isle had an average rate of recession of 0.66 +/- 0.33 feet per year. A maximum rate of 3.28 +/- 0.33 feet per year was measured in each study area, both occurring in predominantly agricultural areas.

While average recession rate data is valuable for long-term planning purposes, as discussed, these rates vary spatially and can be episodic. Therefore, the limitations of these rates must be recognized, and data must be used appropriately for purposes of evaluating risk.

Figure 4.3.1-6 Average Bluff Recession Rates along the Pennsylvania Lake Erie Shoreline (PA DEP, 2012).



Record high lake-levels caused significant erosion events on the Lake Erie shoreline in 1987 and 1998 (Malone, 2010). Table 4.3.1-1 shows the results of a damage assessment that was completed for the 1987 event by PA DEP's CRMP (PA DEP, 1987). This data is from 1987 and a more recent study is not available. No significant long-term trends or short-term erosion events have been identified for the Delaware River shoreline.

Table 4.3.1-1 Summary Damages Caused by High Water Levels in the Pennsylvania Coastal Zone in Erie County, 1985-1987 (PA DEP 1987)

Item	Number Affected (Total)	# Affected by Flooding	# Affected by Shoreline Erosion	# of People Affected
PUBLIC FACILITIES				
Water Plants	1	1	0	0
Sewage Plants	0	0	0	0
Marinas, Decks	12	12	0	300
Parks/Beaches	12	12	11	0
Roadways	6	6	0	0
Hospitals	0	0	0	0
Schools	0	0	0	0
Sewer Facilities Systems	3	3	0	0
Airports	0	0	0	0
Sanitary Landfills	0	0	0	0
PRIVATE FACILITIES				
Commercial	7	3	5	15
Industrial	0	0	0	0
Residential	180	136	144	474
Power Plants	0	0	0	0
OTHER				
Seasonal Residences	31	14	20	65
Boathouses	5	0	5	37
Bathhouse/Comfort Stations	3	3	0	0 (other facilities available)

Various studies, notably those developed by the U.S. Army Corps of Engineers (Buffalo District) and the Coastal Resources Management Program, have assessed shoreline damage statistics and the costs of protection. Shore structure inventories have also been prepared. These documents provide useful information for measuring losses and recording efforts made to mitigate damage. However, studies more recent than the 1987 damage assessment are not currently available.

More recently, due to excessive precipitation in the Spring of 2011, several lakefront properties experienced significant bluff recession. One of the properties affected by this event receded approximately 100 feet (ECDPS, 2011). Presque Isle has also experienced significant erosion and an estimated 38,000 cubic yards of sand is used to offset this erosion annually (ECDPS, 2018).

4.3.1.4. Future Occurrence

Future shoreline erosion and bluff recession can be considered highly likely, as defined by the Risk Factor Methodology probability criteria. While the geological processes along the Lake Erie shoreline are continuous, rates of change vary as a result of the natural and human-caused influences previously described. Rates of change will vary over time, primarily as a function of changing lake levels. Historical rates described in Section 4.3.1.3 can help to serve as estimates of future changes. Additionally, FEMA is in the process of completing a Great Lakes Coastal Flood Study which will also address coastal erosion as it relates to flood hazards for the Lake Erie Coastline in Pennsylvania.

Coastal erosion will also be influenced by future climate-related changes projected for Pennsylvania such as warmer temperatures, increases in the frequency and severity of storm events, and increases in precipitation. According to the United States Environmental Protection Agency (EPA), increasing temperatures and changing precipitation patterns will likely intensify flood and drought events in the Commonwealth (EPA, 2016a). Extreme changes between these events can cause increased variability in lake levels and increase the risk of coastal erosion. Additionally, precipitation is likely to increase during the winter and rising temperatures will melt snow earlier in spring (EPA, 2016a). The changes could influence the level of ice build-up during the winter, which typically protects the coastline against severe winter storms. Additionally, ice formation and thawing processes can accelerate erosion and recession.

4.3.1.5. Environmental Impacts

In the absence of development, the environmental impacts of coastal erosion are minimal. It is a geological process through which shorelines naturally evolve. However, if erosion occurs near development or infrastructure, impacts may include the release of chemically hazardous (e.g. heating fuels) or biohazardous materials (e.g. sewage), or contamination of beaches with construction materials (i.e. asphalt, siding, lumber, shingles, etc.).

4.3.1.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to coastal erosion, all state facilities in Erie County located in areas characterized as high risk were identified. High-risk areas were defined as areas within 75 feet of the Lake Erie shoreline. This criterion was determined based on the average recession rate of 0.75 feet per year and the 100-year maximum planning horizon used to calculate MBSDs. The resulting high-risk area is a rough estimate and does not account for observed spatial variability in erosion rates along the shoreline.

No state-owned or leased facilities were identified in areas at high risk of coastal erosion. Therefore, there is no estimated loss or value of structures at risk for such facilities. However, it should be noted that degradation of Presque Isle State Park due to coastal erosion could lead to losses related to tourism dollars and incalculable damage to the unique natural environment. Additionally, no critical facilities were identified in areas at high risk of coastal erosion.

4.3.1.7. Jurisdictional Vulnerability Assessment and Loss Estimation

As previously mentioned, Erie County is the only jurisdiction in the Commonwealth that is significantly threatened by coastal erosion. Since passage of the Bluff Recession and Setback Act in 1980, structures are required to be set back from areas determined to be hazardous due to bluff recession and coastline erosion. PA DEP's CRMP has calculated bluff recession rates to determine setback distances and periodically recommends setback modifications to municipalities along Lake Erie.

Within Erie County, Springfield Township has the highest average bluff recession rate (0.99 feet per year) among all jurisdictions monitored (PA DEP CRM, 2018b). However, it is important to note that vulnerability is ultimately dependent on development density near receding shorelines. For more information on vulnerability for specific municipalities, see *Bluff Recession Hazard Area Designations* at: http://www.dep.state.pa.us/river/reference/brha.htm.

The Bluff Recession and Setback Act was passed in 1980 and requires that new residential, commercial, and industrial structures will be constructed landward of Minimum Bluff Setback Distances (MBSD). Such setbacks protect the health and safety of residents, as well as property investments. The statutory authority of the Act only applies to Lake Erie. There are nine municipalities along Pennsylvania's Lake Erie coast that have designated BRHAs and enacted ordinances. Table 4.3.1-2 provides a summary of the life span used to calculate MBSDs based on structure type, where:

Bluff Recession Rate (ft/yr) x Appropriate Life Span of Structure (yrs) = MBSD (ft)

Table 4.3.1-2 Summary of Life Spans Used to Calculate Minimum Bluff Setback Distances for Development in Lake Erie Bluff Recession Hazard Areas.

TYPE OF STRUCTURE	APPROPRIATE LIFE SPAN (YEARS)
Residential	50
Commercial	75
Industrial	100

Note: MBSDs are determined by and currently set in 25 Pa. Code § 85.26(c). Some municipalities have enacted setback requirements which are greater than the MBSDs published in Chapter 85.

For purposes of the risk assessment, an investigation of properties located within a 100-year bluff recession hazard area was performed. Based on historical recession rates, properties located within BRHAs that are considered at risk from bluff recession over the next 100 years were identified and analyzed. A planning horizon of 100 years was used since it is the longest of the three life spans used to calculate Minimum Bluff Setback Distances under the Bluff Recession and Setback Act. While this assessment was initially conducted in 2013, more recent data on bluff recession rates have not been made available. Additionally, the assessment was based on a 100-year hazard area. Therefore, the 2013 assessment remains relevant today. The assessment was conducted as follows.

Using building footprints provided by the Erie County Planning Department, the distance of each structure was measured from the approximate bluff edge. The current approximate setback distance was then divided by a representative historical erosion rate (see Figure 4.3.1-7) to determine which buildings are located along areas of the Lake Erie shoreline expected to erode over the 100 years. A summary of these buildings is provided in Table 4.3.1-3 by municipality, along with total building value information. Building location and building value information is based on 2011 tax assessment data provided by Erie County.

The following assumptions should be considered when interpreting assessment results:

- Long-term bluff recession rates were used to determine setback life. Natural (e.g. changing lake levels) or human influences (e.g. construction of shore protection structures) that will alter future recession rates are not considered.
- Control point monuments are typically located every 1,650 feet along the Lake Erie shoreline. The recession rate from the nearest control point monument was applied to each structure; however, this monument may not always be most representative of erosion risk for a given structure.
- Only buildings located adjacent to the BRHAs were included in this assessment. Additional buildings that may be at risk (e.g. buildings located between breaks in BRHA or in non-bluff areas) were not included. While the number of excluded buildings potentially at risk is considered to be relatively small compared to overall assessment results, it is worth noting as results likely serve as conservative estimates of properties at risk over the next 100 years.
- Setback measurements used in the assessment are determined based on the distance of a given building footprint to the approximate bluff edge. The property on which a building is located, as well as surrounding infrastructure, are likely at risk prior to damage to the building itself.
- By regulation, MBSDs are measured from the bluff crest, which due to its dynamic nature, is determined on a case by case basis through field surveys. For purposes of this assessment, a delineation of the bluff edge was created based on the most recent aerial imagery available from the Esri World Imagery dataset. While this delineation is reasonably accurate, it was not verified with topographic data or field survey data and should therefore be considered approximate.
- New or future development is not accounted for; this assessment is based on development as of 2011 only.

Table 4.3.1-3 Buildings identified in 100-yr Erosion Hazard Area by community with associated building and land value data.

MUNICIPALITY	NO. OF BUILDINGS IN 100-YR EROSION HAZARD AREA (PERCENT OF TOTAL BUILDINGS THROUGHOUT COUNTY IN 100-YR EROSION HAZARD AREA)	TOTAL BUILDING VALUE	TOTAL LAND VALUE	TOTAL LAND & BUILDING VALUE
Erie City	25 (9.4%)	$316,540	$3,340,650	$3,657,190

MUNICIPALITY	NO. OF BUILDINGS IN 100-YR EROSION HAZARD AREA (PERCENT OF TOTAL BUILDINGS THROUGHOUT COUNTY IN 100-YR EROSION HAZARD AREA)	TOTAL BUILDING VALUE	TOTAL LAND VALUE	TOTAL LAND & BUILDING VALUE
Fairview Township	11 (4.2%)	$4,039,100	$2,647,700	$6,686,800
Girard Township	14 (5.3%)	$1,165,600	$6,349,200	$7,514,800
Harborcreek Township	51 (19.2%)	$4,249,070	$8,166,500	$12,415,570
Lake City Borough	0 (0.0%)	$0	$0	$0
Lawrence Park Township	3 (1.1%)	$281,000	$333,200	$614,200
Millcreek Township	111 (41.9%)	$8,842,640	$10,030,000	$18,872,640
North East Township	33 (12.5%)	$2,446,500	$3,240,300	$5,686,800
Springfield Township	17 (6.4%)	$5,619,500	$4,635,300	$10,254,800
TOTAL	**265**	**$26,959,950**	**$38,742,850**	**$65,702,800**

Table 4.3.1-3 Buildings identified in 100-yr Erosion Hazard Area by community with associated building and land value data.

Based on results from this assessment, 265 structures along the Lake Erie shoreline are considered at risk of significant damage or complete destruction from coastal erosion over the next 100 years. These buildings are spread across eight municipalities with over 40% of them located in Millcreek Township. Based on 2011 tax assessment data provided by Erie County, these 265 buildings have a total value of $26,959,950. In addition, the total value of land associated with these properties and potentially at risk from coastal erosion losses equals $38,742,850.

It is imperative that residents living near the shoreline are well-educated on shoreline erosion and bluff recession hazards. Appropriate mitigation measures also need to be established to help lessen the impact of shoreline erosion, bluff recession, and flooding on coastal structures, residents, land, and wildlife.

In addition, because Lake Erie bluffs are reshaped daily by the natural forces of gravity, water, and wind, through proper land-use management practices, bluff recession can be slowed, but not prevented. Since the majority of bluff recession-related problems start at the base of the bluff as a result of wave damage, the following measures can be used to stabilize the shoreline. Note that recent events have shown these measures to be relatively ineffective in protecting bluff areas from groundwater-induced recession:

- Revetments: concrete blocks placed on banks to absorb the energy of incoming waves. These structures protect only the land immediately behind them, not adjacent areas.
- Groins: concrete structures that extend perpendicular from the shore. Groins interrupt the natural wave movement of beach sediment by trapping and retaining sand on the up-drift side of the groin.

Once the shoreline is secured, the following bluff face re-contouring and stabilization practices can be undertaken:

- Biotechnical slope protection: combines the use of biodegradable wood cribbing and appropriate vegetation. The structure provides support for the bluff at a groundwater seepage area, while the vegetation absorbs the groundwater, eventually stabilizing the bluff face.
- Dewatering: intercepts groundwater before it reaches the bluff face. Wells and groundwater trenches collect groundwater and re-channel it through pipes over the bluff face to the base of the bluff.
- Vegetation: naturally and inexpensively protects the bluffs. Root systems absorb groundwater and hold the soil together. Leaves intercept the impact of raindrops and transfer water absorbed by the root systems into the atmosphere through evapotranspiration.

The PA DEP CRMP provides funding as well as technical assistance for projects located within the 77 miles of coastline and landward to the Lake Erie watershed boundary. Grant funds can be used for many types of projects including education, construction, research, planning, acquisition, and design. The program's main goal is to balance coastal land use with conservation and protection of water-related resources.

4.3.2. Drought

4.3.2.1. Location and Extent

The current climate in Pennsylvania, when compared to many other states across the U.S., is generally water-rich. However, like all other states, Pennsylvania is subject to periodic droughts that impact the Commonwealth's ability to meet its water needs. Droughts are regional climatic events which can impact large areas ranging from several counties in Pennsylvania to the entire mid-Atlantic region. While large geographic areas can be impacted by a given drought, areas with extensive agricultural land use can experience particularly significant impacts.

4.3.2.2. Range of Magnitude

Droughts can have varying effects, depending upon what month they occur, severity, duration and location. Some droughts may have their greatest impact on agriculture and even short-term droughts, when coupled with extreme temperatures can be devastating. Others may impact water supply or other water use activities such as recreation. Most droughts cause direct impacts to aquatic resources. Drought events are defined by rainfall amounts, vegetation conditions, soil-moisture conditions, water levels in reservoirs, stream flow, agricultural productivity, or economic impacts.

Hydrologic drought events result in a reduction of stream flows, reduction of lake/reservoir storage, and reduced groundwater levels. These events have a significant adverse impact on public water supplies for human consumption, rural water supplies for livestock consumption and agricultural operations, water quality, natural soil water or irrigation water for agriculture, soil moisture, conditions conducive to wildfire events and water for navigation and recreation. PEMA has primary responsibility for managing droughts with direct support from PA DEP. According to *Drought Management in Pennsylvania* (2016), PEMA and PA DEP use the following three stages to describe and manage droughts. They are listed in order of increasing severity:

- **Drought Watch:** A period to alert government agencies, public water suppliers, water users and the public regarding the potential for future drought-related problems. Drought Watches are invoked when three or more drought indicators are present for a county or group of counties. The focus is on increased monitoring, awareness and preparation for response if conditions worsen. A request for voluntary water conservation is made. The objective of voluntary water conservation measures during a drought watch is to reduce water uses by 5 percent in the affected areas. Due to varying conditions, individual water suppliers or municipalities may be asking for more stringent conservation actions.

- **Drought Warning:** This phase involves a coordinated response to imminent drought conditions and potential water supply shortages through concerted voluntary conservation measures to avoid or reduce shortages, relieve stressed sources, develop new sources, and if possible, forestall the need to impose mandatory water use restrictions. The objective of voluntary water conservation measures during a drought warning is to reduce overall water uses by 10-15 percent in the affected areas. Due to varying conditions, individual water suppliers or municipalities may be asking for more stringent conservation actions.

- **Drought Emergency:** This stage is a phase of concerted management operations to marshal all available resources to respond to actual emergency conditions, to avoid depletion of water sources, to assure at least minimum water supplies to protect public health and safety, to support essential and high priority water uses and to avoid unnecessary economic dislocations. It is possible during this phase to impose mandatory restrictions on non-essential water uses that are provided in the Pennsylvania Code (Chapter 119), if deemed necessary and if ordered by the Governor of Pennsylvania. The objective of water use restrictions (mandatory or voluntary) and other conservation measures during this phase is to reduce consumptive water use in the affected area by 15 percent, and to reduce total use to the extent necessary to preserve public water system supplies, to avoid or mitigate local or area shortages and to assure equitable sharing of limited supplies.

- **Local Water Rationing:** Although not a drought phase, local municipalities may, with the approval of the PA 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 the Pennsylvania 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.

The Commonwealth uses five indicators to assess drought conditions: 1) Precipitation Deficits, 2) Stream Flows, 3) Groundwater Levels, 4) Soil Moisture, and 5) Reservoir Storage.

Precipitation Deficits

Because rainfall provides the basis for ground and surface water resources, measuring the difference in precipitation from the normal (30-year average) tends to be the earliest indicator that a drought is possible in an area. The PA DEP will compare the cumulative precipitation for varying time periods (minimum of 3 months, maximum of 12 months) each month against the normal, 30-year average value for each same time-period. Any duration that has less than the normal is considered to have had a deficit, represented by a percentage less than the normal precipitation. Table 4.3.2-1 shows what the deficit values need to be for each time period in order to qualify for each drought stage.

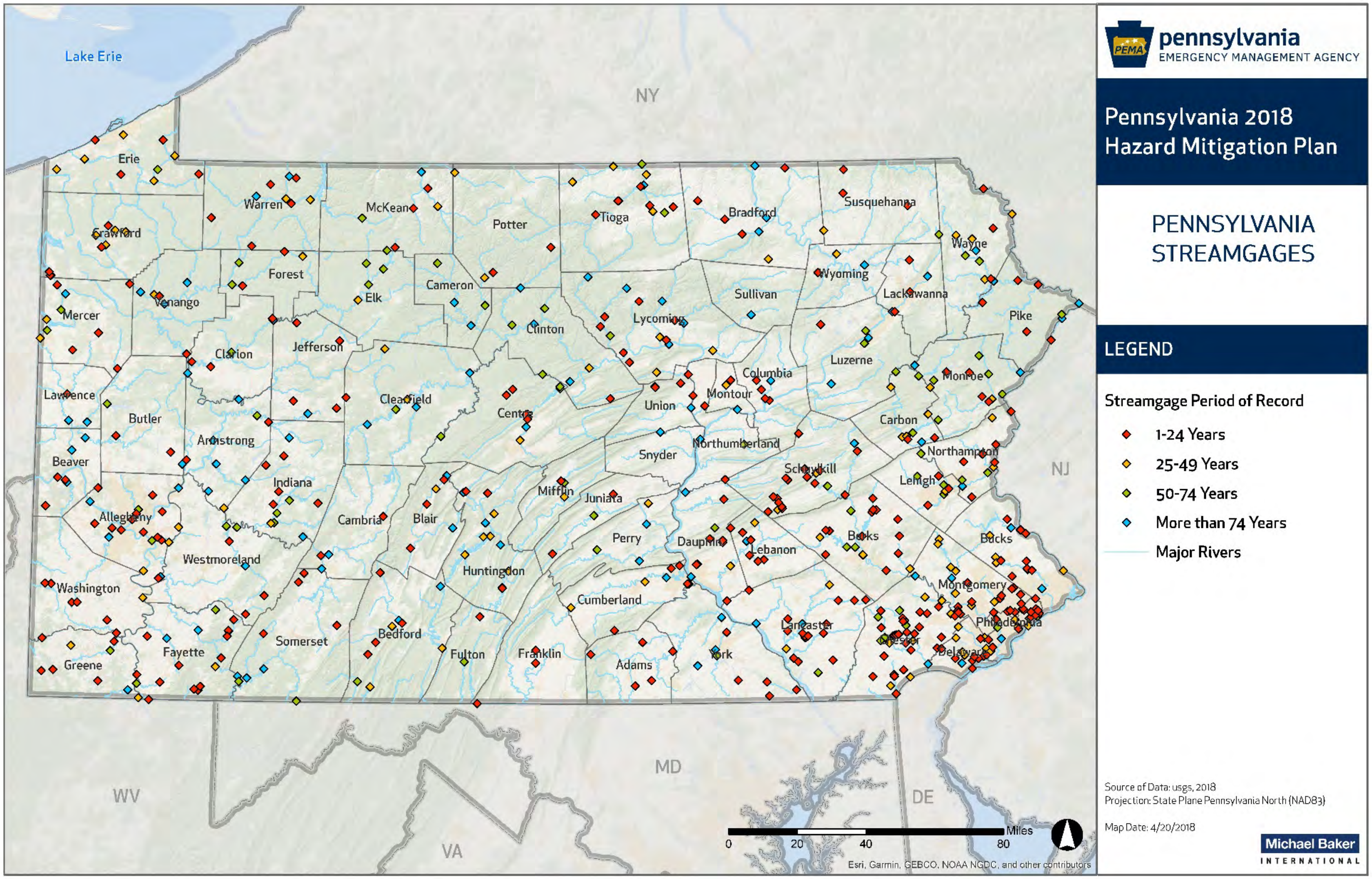
Table 4.3.2-1 Precipitation deficit drought indicators for Pennsylvania (PA DEP, 2016)

DURATION OF DEFICIT ACCUMULATION (months)	DROUGHT WATCH (deficit as percent of normal precipitation)	DROUGHT WARNING (deficit as percent of normal precipitation)	DROUGHT EMERGENCY (deficit as percent of normal precipitation)
3	25	35	45
4	20	30	40
5	20	30	40
6	20	30	40
7	18.5	28.5	38.5
8	17.5	27.5	37.5
9	16.5	26.5	36.5
10	15	25	35
11	15	25	35
12	15	25	35

Stream Flows

The next earliest indicator that a drought is developing is stream flow measurements. Figure 4.3.2-1 shows the 61 USGS stream gages that the DEP currently uses to monitor droughts across the state. The DEP calculates and maintains 30-day average values for stream flow based on the entire period of recording for each gage. Compared to precipitation, stream flow measurements lag by about a month or two when signaling a drought. For example, the Susquehanna River gage at Harrisburg has more than 110 years of record from which the long-term 30-day average, or normal, flows are now determined.

Figure 4.3.2-1 Stream gage locations and period of record (USGS, 2018).



Drought status is determined from stream flows based on percentiles, or exceedances, rather than percentages. Exceedances are similar to percentiles; a 75-percent exceedance flow value means that the current 30-day average flow is exceeded in the stream 75-percent of the time; in other words, the 30-day average flow in the stream is less than that value only 25-percent of the time. Similarly, with a 90-percent exceedance flow value, the 30-day average flows in the stream would be less than that value only 10-percent of the time, and only 5-percent of the time for a 95-percent exceedance. For stream flows, the 75-, 90-, and 95-percent exceedance 30-day average flows are used as indicators for drought watch, warning, and emergency, respectively.

Groundwater Levels

There is about 80 trillion gallons of groundwater stored in the soil beneath Pennsylvania. Groundwater levels for each day are used to calculate the average level of the preceding 30 days. This 30-day value is compared to the values derived from historical records yielding a percentile indicating how much time the groundwater levels have been below the historical average levels. The USGS also maintains a network of groundwater monitoring wells, just recently upgraded to at least one well in each county. Groundwater is used to indicate drought status in a manner similar to stream flows. Groundwater level exceedances of 75, 90 and 95 percent are used to indicate watch, warning and emergency status. In this case, it is the 30-day average depth to groundwater that is measured and monitored, again in relation to long-term 30-day averages based on the period of record for each county well. An example of the monitoring performed by other agencies and utilized by the Commonwealth is shown for Bucks County at:
http://waterdata.usgs.gov/pa/nwis/uv/?site_no=402643075150501&PARAmeter_cd=72019.

Soil Moisture

Soil moisture is measured using an algorithm calibrated for relatively homogeneous regions which measures dryness based on temperature and precipitation in the area, information which is provided by the National Oceanic and Atmospheric Administration (NOAA). This generates a value called the Palmer Drought Severity Index (PDSI), which is compiled by the Climate Prediction Center of the National Weather Service on a weekly basis. A PDSI of -4.00 or less indicates a drought emergency; a value between -3.00 and -3.99 indicates a drought warning, and a value between -2.00 and -2.99 indicates a drought watch.

Reservoir Storage Levels

Water level storage in several large public water supply reservoirs (especially three New York City reservoirs in the Upper Delaware River Basin) is the fifth indicator that the PA DEP uses for drought monitoring. Depending on the total quantity of storage and the length of the refill period for the various reservoirs, PA DEP uses varying percentages of storage draw down to indicate the three drought stages for each of the reservoirs.

4.3.2.3. Past Occurrence

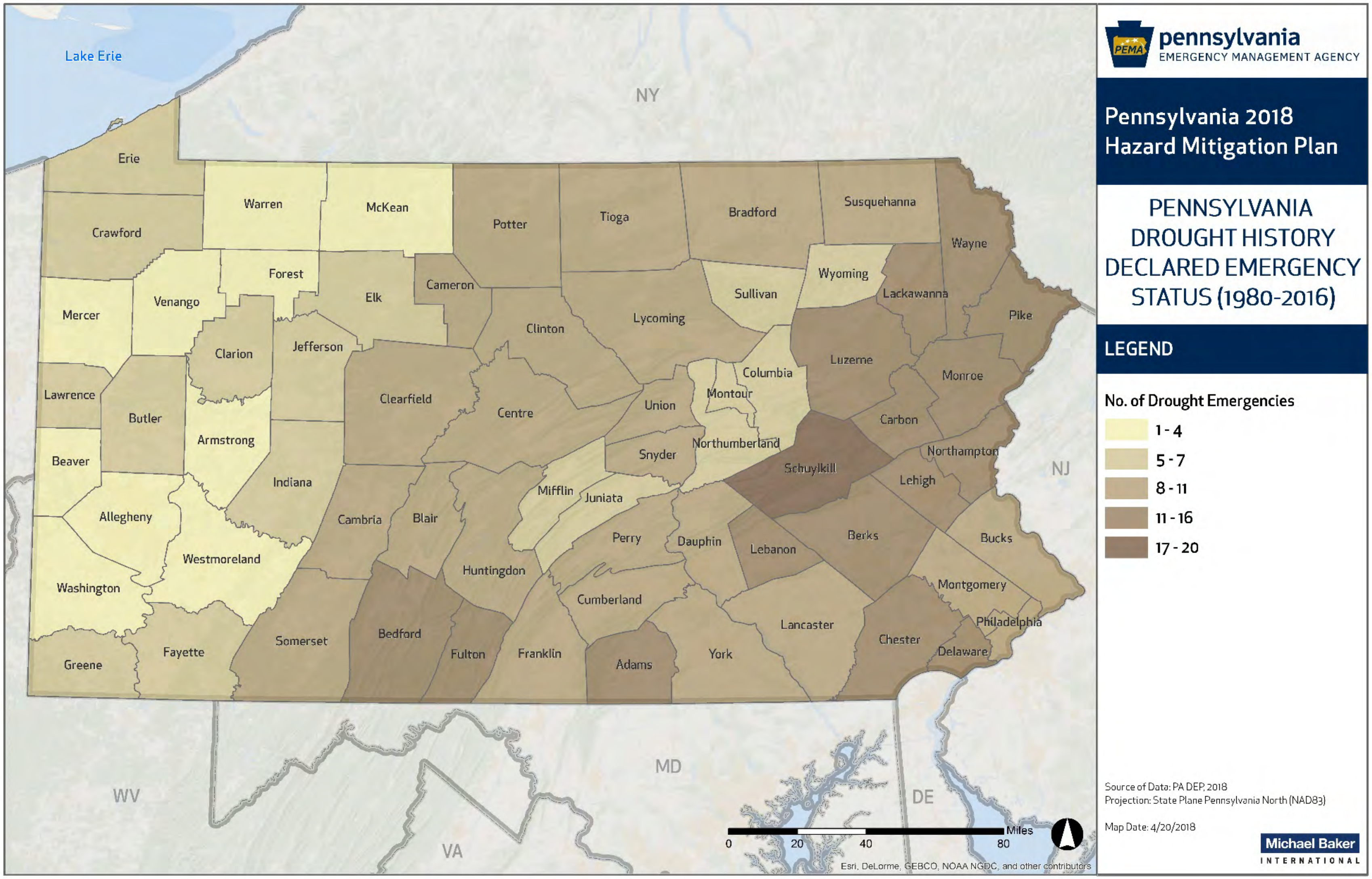
A summary of declared drought status for each county in Pennsylvania between November 1980 and May 2017 is provided in Table 4.3.2-2. Figure 4.3.2-2 shows the number of drought *emergency* declarations for each county in Pennsylvania from 1980 to August 2016.

Table 4.3.2-2 Summary of declared drought status from 1980 to 2016 by county (PA DEP, 2018).			
COUNTY	TOTAL DROUGHT WATCHES	TOTAL DROUGHT WARNINGS	TOTAL DROUGHT EMERGENCIES
Adams	24	14	12
Allegheny	20	13	1
Armstrong	23	11	4
Beaver	25	11	1
Bedford	24	13	14
Berks	22	20	12
Blair	29	10	9
Bradford	31	10	8
Bucks	16	22	10
Butler	24	10	5
Cambria	27	12	9
Cameron	26	13	10
Carbon	21	17	16
Centre	26	14	10
Chester	19	18	14
Clarion	21	12	6
Clearfield	23	13	10
Clinton	27	14	9
Columbia	25	15	6
Crawford	26	8	6
Cumberland	25	14	11
Dauphin	28	12	9
Delaware	17	19	12
Elk	31	8	7
Erie	27	9	6
Fayette	20	9	5
Forest	28	8	4
Franklin	26	13	10
Fulton	28	11	12
Greene	26	9	5
Huntingdon	25	14	8
Indiana	28	11	6
Jefferson	20	11	6
Juniata	29	16	7
Lackawanna	19	15	12
Lancaster	24	16	10
Lawrence	26	10	5
Lebanon	20	19	14

Table 4.3.2-2 Summary of declared drought status from 1980 to 2016 by county (PA DEP, 2018).

COUNTY	TOTAL DROUGHT WATCHES	TOTAL DROUGHT WARNINGS	TOTAL DROUGHT EMERGENCIES
Lehigh	18	21	12
Luzerne	22	16	15
Lycoming	31	10	10
McKean	31	9	4
Mercer	30	10	4
Mifflin	28	14	7
Monroe	21	16	14
Montgomery	14	23	10
Montour	26	16	6
Northampton	17	21	14
Northumberland	25	17	6
Perry	26	15	9
Philadelphia	14	23	10
Pike	20	16	13
Potter	28	14	9
Schuylkill	21	17	20
Snyder	26	15	10
Somerset	21	9	9
Sullivan	30	11	6
Susquehanna	25	10	8
Tioga	29	10	8
Union	29	15	8
Venango	28	7	4
Warren	24	9	4
Washington	26	10	3
Wayne	20	14	14
Westmoreland	22	10	1
Wyoming	27	11	6
York	26	14	10

Figure 4.3.2-2 Number of emergency drought declarations in Pennsylvania by county between 1980 and 2016 (PA DEP, 2018).



Instrumental records of drought for the United States extend back approximately 100 years. These records capture the major 20th century droughts, but are too short to assess the reoccurrence of major droughts such as those of the 1930s and 1950s. As droughts continue to have increasingly costly and devastating impacts on our society, economy and environment, it is becoming even more important to put the severe droughts of the 20th-century into a long-term perspective. This perspective can be gained through the use of paleoclimatic records of drought.

Data from a variety of paleoclimate sources document drought conditions across North America over the last 10,000 years. These records, with decade to century resolution, document extended periods of extremely dry conditions in different regions of North America. This paleoclimatic record of past droughts is considered by scientists as a better guide than what is provided by the instrumental record alone of what we should expect in terms of the magnitude and duration of future droughts. For example, paleoclimatic data suggest that droughts as severe at the 1950s drought have occurred in central North America several times a century over the past 300-400 years, and thus we should expect (and plan for) similar droughts in the future. The paleoclimatic record also indicates that droughts of a much greater duration than any in 20th century have occurred in parts of North American as recently as 500 years ago. These data indicate that we should be aware of the possibility of such droughts occurring in the future as well. The occurrence of such sustained drought conditions today would be a natural disaster of a magnitude unprecedented in the 20th century. Although severe droughts have occurred in the 20th century, a more long-term look at past droughts, when climate conditions appear to have been similar to today, indicates that 20th century droughts do not represent the possible range of drought variability.

The worst drought event on record 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 shriveled in parched field, 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.

4.3.2.4. Future Occurrence

It is difficult to forecast the severity and frequency of future drought events in Pennsylvania. However, two important studies were performed which provide suggest probability of future occurrence. A study by Sheffield and Wood (2007) shows that there has been relatively little change in PDSI values over the 50-year period ending in 2004. This research is interpreted to indicate that soil moisture and drought conditions can be relatively equivalent to the average PDSI values experienced over the period 1954 to 2004. In addition, based on data from 2000 to 2016, drought frequency by census tract shows the percent of weeks in moderate or greater drought status as reported by the U.S. Drought Monitor (see Figure 4.3.2-3).

Please note, the data in Figure 4.3.2-3 shows the percent of time sections of Pennsylvania were in moderate or greater drought over a 16-year period, while the data in Figure 4.3.2-2 shows the total number of drought emergencies by county for a 29-year period. The data was collected by different agencies using different periods of time and units of measurement. Combined this analysis suggests the Eastern portion of the Commonwealth has a higher risk for drought than the Western portion. Since the data is based on different sources and methodologies, it should be considered as providing complementary information about drought risk in Pennsylvania. Overall, though, with all of the Commonwealth being in moderate or greater drought less than 7% of the time, the probability of future droughts is considered low but possible.

Uncertainty regarding the future occurrence of droughts exists due to the potential impacts of climate change. Increased evapotranspiration due to higher temperatures is projected to create surface soil moisture deficits (Wehner et al. 2017) for much of the United States, but there is low confidence in seasonal precipitation deficits other than the Southwest. It is likely that agricultural droughts will occur more frequently and with higher magnitude with increased evapotranspiration especially in the late summer and early fall (see Figure 4.3.2-4 from the Fourth National Climate Assessment showing projected changes in soil moisture by the end of the century). According to the Pennsylvania Climate Impacts Assessment 2015 Update, the likelihood for drought will decrease by the middle of the 21st century as months with above-normal precipitation increase but drying of surface soil across the coterminous United States in all seasons is still projected due to enhanced evapotranspiration. Soil moisture at root depth of crops is more useful for estimating agricultural drought. Resolution constraints and lack of detailed evapotranspiration process representation lead to lower confidence in projections with the soil moisture budget being less constrained (Wehner et al. 2017).

Figure 4.3.2-3 Percent of weeks areas have been in moderate drought or greater (FEMA NRI, 2018).

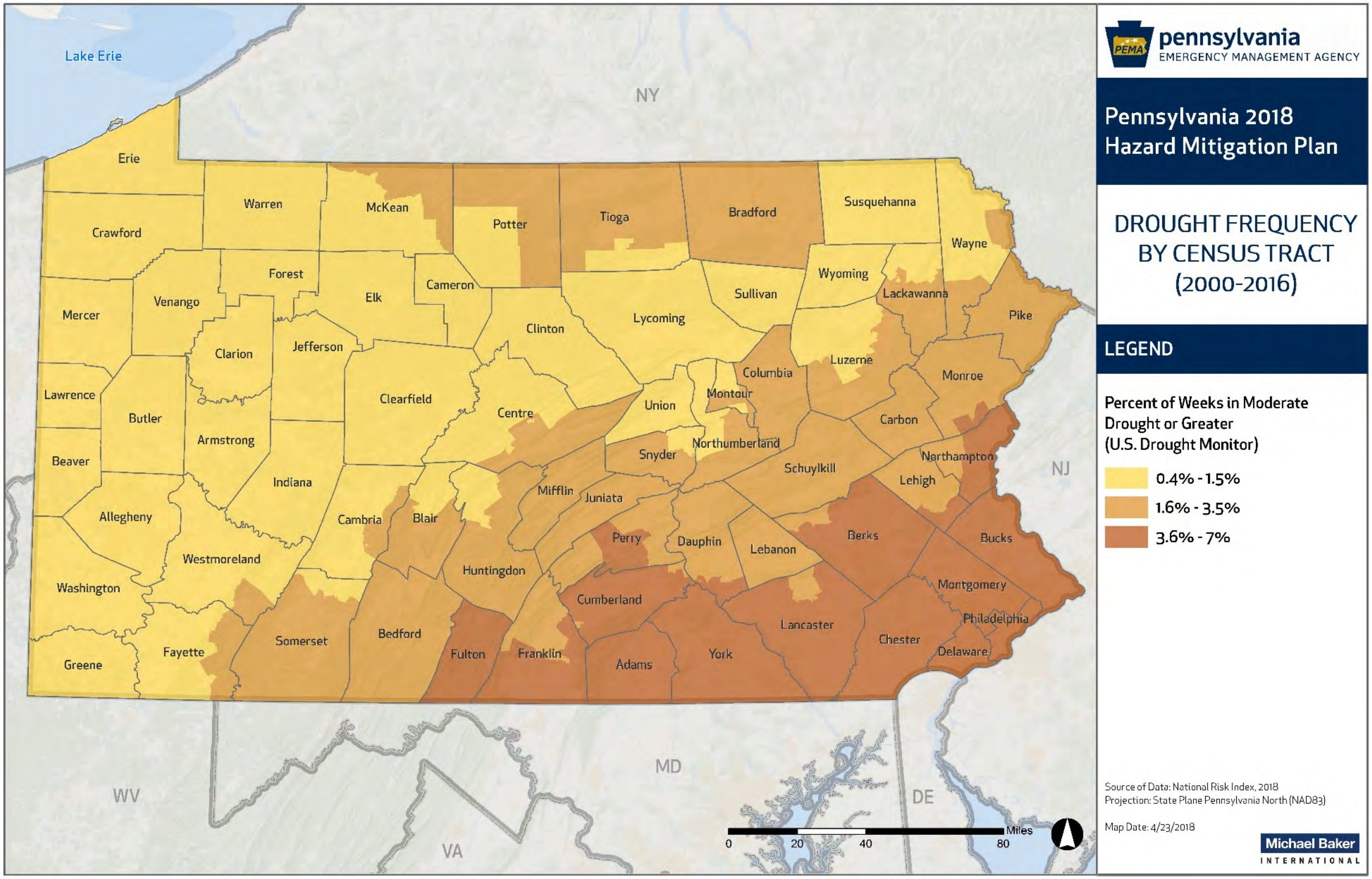
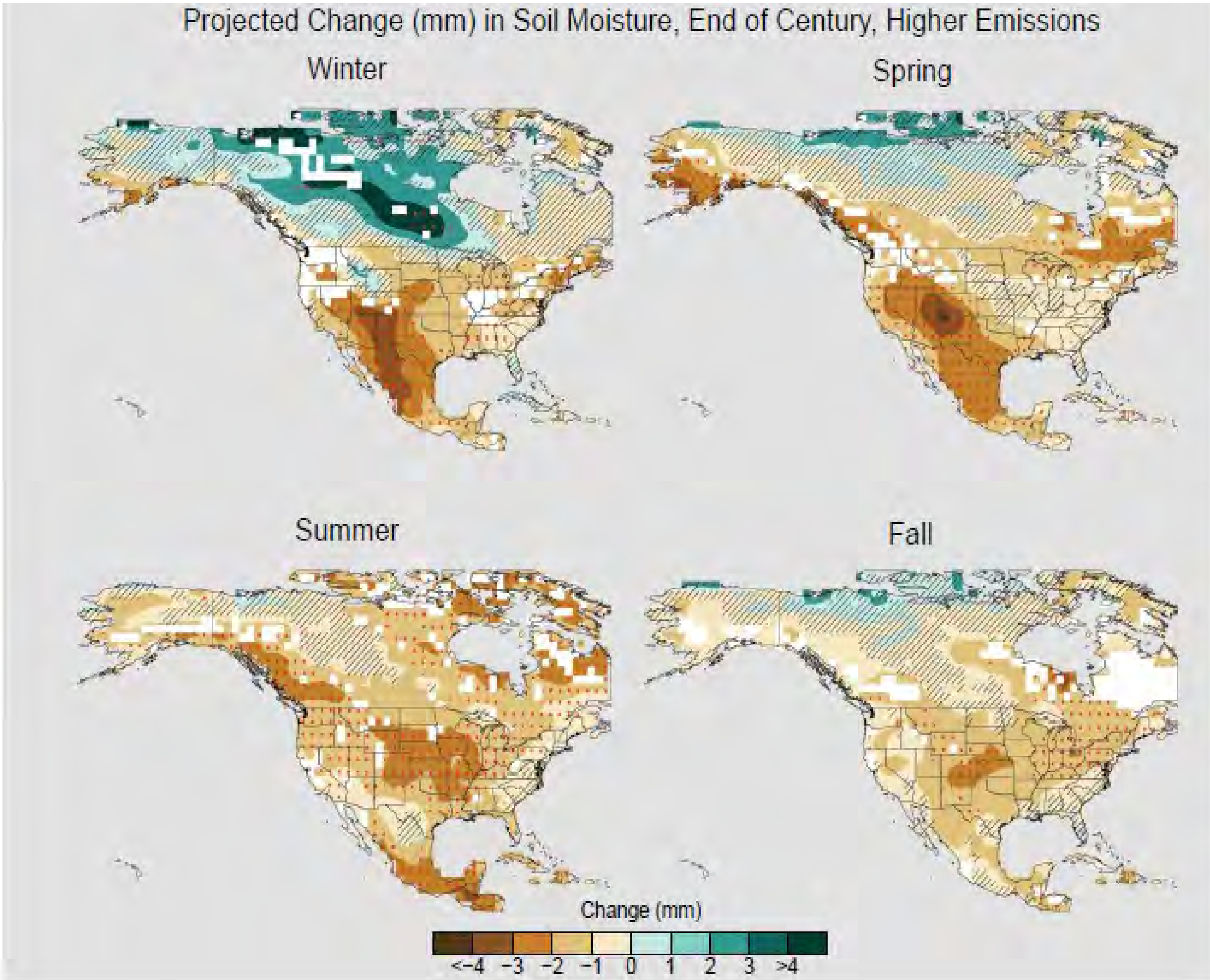


Figure 4.3.2-4 Average percent changes in surface soil moisture by the end of the century using CMIP5 model under RCP8.5 scenario. Hashes indicate changes are small compared to natural while stippling show changes that are larger than natural variation.



4.3.2.5. *Environmental Impacts*

According to the National Drought Mitigation Center at the University of Nebraska-Lincoln (2013), environmental impacts of drought include:

- Damage to animal species in the form of reduced water and feed availability, degradation of fish and wildlife habitat, migration and concentration issues (too many or too few animals in a given area), stress to endangered species, and loss of biodiversity
- Lower water levels in reservoirs, lakes, and ponds
- Reduced stream flow
- Loss of wetlands
- Increased groundwater depletion, land subsidence, and reduced groundwater recharge
- Water quality impacts like salinity, water temperature increases, pH changes, dissolved oxygen, or turbidity
- Loss of biodiversity

- Loss of trees
- Increased number and severity of fires
- Reduced soil quality and erosion issues
- Increased dust or pollutants.

4.3.2.6. State Facility Vulnerability Assessment and Loss Estimation

Drought does not pose a direct threat to state critical facility buildings – it affects land and water supply. Therefore, type, rather than location, was used to determine the vulnerability of state facilities to drought.

All critical facilities with type “agriculture” were determined to be vulnerable to drought, but no other types. There are 275 food and agriculture-related critical facilities, including seed producers, dairies, and other food producers; it can be expected that droughts will have either a direct effect on all critical facilities in this category by hindering production or an indirect effect by increasing the cost of food production inputs. The value for all these critical facilities, so a loss estimation could not be determined.

For state-owned or leased facilities, vulnerable structures were identified if the building use was “agricultural - animal facility”, “agricultural - nursery/greenhouse”, “agricultural – storage”, and/or “land”. There are 30 state facilities that are vulnerable to drought. This includes 38 percent of the structures owned or leased by the PA Department of Agriculture, and 9 structures of the Fish and Boat Commission. These facilities have a combined replacement value of over $10 million, which is less than 1 percent of the value of all state facilities. The vulnerable state-owned or lease buildings are broken down by department in Table 4.3.2-3.

Table 4.3.2-3 Vulnerability of state facilities to drought.

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	0	0%
Department of Agriculture	6	38%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	12	2%
Department of Education	0	0%
Department of Environmental Protection	0	0%
Department of General Services	200	2%
Department of Health	0	0%
Department of Labor and Industry	0	0%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	1	1%
Department of Revenue	0	0%
Department of Transportation	0	0%

Table 4.3.2-3 Vulnerability of state facilities to drought.		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	9	6%
Governor's Office	0	0%
Historical and Museum Commission	0	0%
Insurance Department	0	0%
Liquor Control Board	0	0%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	0	0%
State Police	0	0%
State System of Higher Education	0	0%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	**30**	**1%**

4.3.2.7. Jurisdictional Vulnerability Assessment and Loss Estimation

As a hazard, droughts primarily impact water supply and agricultural land. Areas of the Commonwealth that rely on private wells are more impacted by water supply reductions than areas of the Commonwealth that rely on public water supply; frequently, these areas reliant on groundwater wells are more rural in nature. Table 4.3.2-3 shows the number of groundwater wells per county in Pennsylvania as reported to the Pennsylvania Groundwater Information System. PaGWIS relies on voluntary submissions of well record data by well drillers; as a result, it is the best available data but is not completely comprehensive.

Table 4.3.2-4 Domestic water wells by county (PA DCNR, 2018).			
COUNTY	TOTAL DOMESTIC WATER WELLS	COUNTY	TOTAL DOMESTIC WATER WELLS
Adams	8,872	Lackawanna	6,816
Allegheny	5,378	Lancaster	31,979
Armstrong	1,687	Lawrence	4,824
Beaver	4,447	Lebanon	7,313
Bedford	6,024	Lehigh	10,964
Berks	19,318	Luzerne	8,129
Blair	4,471	Lycoming	6,308
Bradford	6,936	McKean	1,092
Bucks	20,430	Mercer	6,523
Butler	8,931	Mifflin	1,650
Cambria	5,932	Monroe	28,514
Cameron	621	Montgomery	19,248
Carbon	9,068	Montour	1,681
Centre	4,606	Northampton	9,804
Chester	40,362	Northumberland	3,149
Clarion	2,443	Perry	5,103
Clearfield	3,169	Philadelphia	5,668
Clinton	2,715	Pike	7,860
Columbia	2,520	Potter	3,091
Crawford	8,262	Schuylkill	6,499
Cumberland	12,351	Snyder	3,090
Dauphin	9,832	Somerset	3,445
Delaware	5,587	Sullivan	1,116
Elk	1,459	Susquehanna	5,362
Erie	7,799	Tioga	3,961
Fayette	1,463	Union	3,262
Forest	1,577	Venango	3,814
Franklin	12,060	Warren	3,016
Fulton	2,904	Washington	4,217
Greene	1,876	Wayne	5,029
Huntingdon	3,563	Westmoreland	7,377
Indiana	6,768	Wyoming	2,843
Jefferson	3,879	York	29,485
Juniata	1,472		
GRAND TOTAL – REPORTED DOMESTIC WATER WELLS			***491,014***

For vulnerable populations, census tracts that were in moderate drought or greater for at least 3.5% of weeks between 2000 and 2016 were counted as areas at high risk to drought. The populations of those entire census blocks are considered the vulnerable population. As shown in Table 4.3.2-5, nearly half of the state's population is vulnerable to drought, including 100% of counties in the Philadelphia Metropolitan Area (Philadelphia, Bucks, Chester, Delaware, and Montgomery).

Table 4.3.2-5 Estimated populations vulnerable to drought in each county.

COUNTY	VULNERABLE POPULATION	% OF TOTAL POPULATION
Adams	101,759	100%
Allegheny	0	0%
Armstrong	0	0%
Beaver	0	0%
Bedford	0	0%
Berks	407,936	99%
Blair	0	0%
Bradford	0	0%
Bucks	626,220	100%
Butler	0	0%
Cambria	0	0%
Cameron	0	0%
Carbon	0	0%
Centre	0	0%
Chester	512,028	100%
Clarion	0	0%
Clearfield	0	0%
Clinton	0	0%
Columbia	0	0%
Crawford	0	0%
Cumberland	210,188	86%
Dauphin	39,268	14%
Delaware	562,316	100%
Elk	0	0%
Erie	0	0%
Fayette	0	0%
Forest	0	0%
Franklin	101,243	66%
Fulton	14,653	100%
Greene	0	0%
Huntingdon	0	0%
Indiana		0%

Table 4.3.2-5 Estimated populations vulnerable to drought in each county.

COUNTY	VULNERABLE POPULATION	% OF TOTAL POPULATION
Jefferson	0	0%
Juniata	0	0%
Lackawanna	0	0%
Lancaster	488,020	92%
Lawrence	0	0%
Lebanon	0	0%
Lehigh	38,743	11%
Luzerne	0	0%
Lycoming	0	0%
McKean	0	0%
Mercer	0	0%
Mifflin	0	0%
Monroe	8,850	5%
Montgomery	815,876	100%
Montour	0	0%
Northampton	242,304	81%
Northumberland	0	0%
Perry	16,088	35%
Philadelphia	1,559,938	100%
Pike	0	0%
Potter	0	0%
Schuylkill	0	0%
Snyder	0	0%
Somerset	0	0%
Sullivan	0	0%
Susquehanna	0	0%
Tioga	0	0%
Union	0	0%
Venango	0	0%
Warren	0	0%
Washington	0	0%
Wayne	0	0%
Westmoreland	0	0%
Wyoming	0	0%
York	440,604	100%
Total	**6,186,034**	**48%**

Everyone is impacted by the effects of water supply reductions, but jurisdictions with large amounts of farmland and high agricultural yields are more likely to be affected by drought hazards. According to the 2012 US Department of Agriculture Agricultural Census, Pennsylvania sold over $7.4 billion worth of agricultural products. This census is released every five years, and the 2017 data is expected to be released in 2019. The top ten counties for agricultural production in the state are as follows:

1. Lancaster County (19.9% of state total sales)
2. Chester County (8.9% of state total sales)
3. Berks County (7.1% of state total sales)
4. Franklin County (5.6% of state total sales)
5. Lebanon County (4.7% of state total sales)
6. York County (3.2% of state total sales)
7. Adams County (2.7 % of state total sales)
8. Cumberland County (2.6% of state total sales)
9. Schuylkill County (2.2% of state total sales)
10. Snyder County (2.2% of state total sales)

Normal precipitation estimates for the period 1981-2010 are available for National Weather Service offices and principal climatological stations through the NOAA. In addition, precipitation normals for select cities throughout the Commonwealth for the period 1981-2010 are available (Table 4.3.2-4). Of the eight areas listed, Pittsburgh and Avoca, PA typically experience the lowest levels of precipitation annually.

Table 4.3.2-6 Monthly and annual precipitation normals for select cities in Pennsylvania, 1981 - 2010 (NOAA, 2010)

CITY	PRECIPITIATION DEPTH (inches)												
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	ANNUAL
Allentown, PA	3.03	2.7	3.39	3.56	4.14	4.31	4.95	3.69	4.62	3.88	3.5	3.58	45.35
Erie, PA	2.95	2.39	2.95	3.33	3.44	3.76	3.54	3.47	4.61	4.05	3.93	3.74	42.16
Harrisburg, PA	2.93	3.06	3.54	3.49	4.15	4.04	4.26	3.61	4.36	3.4	3.45	3.34	43.63
Philadelphia, PA	3.03	2.65	3.79	3.56	3.71	3.43	4.35	3.5	3.78	3.18	2.99	3.56	41.53
Pittsburgh, PA	2.7	2.39	2.95	3.11	3.95	4.3	3.83	3.48	3.11	2.29	3.23	2.85	38.19
Reading	2.92	2.84	3.56	3.69	4.03	4.5	4.67	3.8	4.42	3.78	3.44	3.58	45.23

Table 4.3.2-6 Monthly and annual precipitation normals for select cities in Pennsylvania, 1981 - 2010 (NOAA, 2010)

CITY	PRECIPITIATION DEPTH (inches)												
	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER	OCTOBER	NOVEMBER	DECEMBER	ANNUAL
Wilkes-Barre Scranton International Airport (Avaco, PA)	2.37	2.03	2.55	3.33	3.52	4.03	3.79	3.41	4.07	3.34	3.14	2.68	38.26
Williamsport, PA	2.8	2.5	3.1	3.38	3.89	4.02	3.83	3.68	4.33	3.37	3.53	2.96	41.39

Jurisdictional loss estimation stems from lost agricultural revenues statewide. Since droughts are large-scale, regional events that are likely to impact an entire county at a time, all agricultural yields in each county are potentially threatened by drought hazards. Table 4.3.2-7 enumerates each county's acreage of land contained in farms as well as the annual market value of all agricultural products sold, from 2012.

Table 4.3.2-7 Estimated jurisdictional losses relating to agricultural production (USDA, Census of Agriculture, 2012).

COUNTY	TOTAL ACRES OF LAND IN FARMS	MARKET VALUE OF ALL AGRICULTURAL PRODUCTS ($)
Adams	171,305	$201,742,000
Allegheny	34,837	$10,397,000
Armstrong	129,090	$35,861,000
Beaver	55,795	$20,913,000
Bedford	209,795	$122,820,000
Berks	233,744	$528,711,000
Blair	90,117	$107,701,000
Bradford	307,990	$128,794,000
Bucks	64,024	$62,418,000
Butler	136,237	$52,905,000
Cambria	76,889	$32,641,000
Cameron	6,215	$692,000
Carbon	21,162	$9,339,000
Centre	162,041	$91,581,000
Chester	164,495	$660,744,000
Clarion	115,976	$36,136,000
Clearfield	69,250	$13,691,000
Clinton	52,715	$60,558,000
Columbia	122,743	$74,351,000

Table 4.3.2-7 Estimated jurisdictional losses relating to agricultural production (USDA, Census of Agriculture, 2012).

COUNTY	TOTAL ACRES OF LAND IN FARMS	MARKET VALUE OF ALL AGRICULTURAL PRODUCTS ($)
Crawford	227,731	$116,075,000
Cumberland	154,879	$195,356,000
Dauphin	129,378	$122,589,000
Delaware	4,725	$9,781,000
Elk	23,488	$4,229,000
Erie	168,634	$91,675,000
Fayette	112,871	$27,023,000
Forest	8,283	$1,820,000
Franklin	264,521	$413,806,000
Fulton	112,210	$52,975,000
Greene	112,358	$14,574,000
Huntingdon	158,300	$93,503,000
Indiana	153,752	$67,307,000
Jefferson	91,288	$27,729,000
Juniata	91,032	$101,440,000
Lackawanna	32,750	$13,237,000
Lancaster	439,481	$1,474,954,000
Lawrence	80,468	$38,519,000
Lebanon	121,413	$348,933,000
Lehigh	76,331	$90,833,000
Luzerne	66,577	$20,993,000
Lycoming	158,462	$72,202,000
McKean	36,297	$4,952,000
Mercer	163,148	$82,650,000
Mifflin	90,554	$94,023,000
Monroe	26,483	$10,974,000
Montgomery	30,780	$25,594,000
Montour	43,493	$47,425,000
Northampton	65,744	$43,496,000
Northumberland	129,501	$154,339,000
Perry	135,075	$140,401,000
Philadelphia	285	$768,000
Pike	28,260	$2,965,000
Potter	96,689	$35,450,000
Schuylkill	105,749	$165,853,000
Snyder	91,179	$165,493,000
Somerset	214,581	$104,209,000
Sullivan	37,481	$9,517,000

Table 4.3.2-7 Estimated jurisdictional losses relating to agricultural production (USDA, Census of Agriculture, 2012).

COUNTY	TOTAL ACRES OF LAND IN FARMS	MARKET VALUE OF ALL AGRICULTURAL PRODUCTS ($)
Susquehanna	166,399	$43,321,000
Tioga	205,158	$80,258,000
Union	93,241	$135,970,000
Venango	61,531	$20,747,000
Warren	82,419	$20,747,000
Washington	205,821	$35,412,000
Wayne	112,998	$32,352,000
Westmoreland	143,062	$48,610,000
Wyoming	68,749	$14,616,000
York	262,062	$234,064,000
TOTAL	***7,710,091***	***$7,405,754,000***

4.3.3. Earthquake

4.3.3.1. Location and Extent

An earthquake is the motion or trembling of the ground produced by sudden displacement of massive rocks called plates, usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. The impact of earthquakes can extend up to hundreds of thousands of square miles. Earthquakes are also known to cause fatal loss and injury, including substantial property damages of tens of billions of dollars, while disrupting 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 the ground shaking, which is dependent upon amplitude and duration of the earthquake. Most earthquakes originate at faults, but not all faults are visible at the surface. Accordingly, the best guide to the distribution of earthquake hazard is often the distribution of past earthquakes.

Earthquake events in Pennsylvania typically do not impact areas greater than 100 km from the epicenter. Pennsylvania's strongest earthquakes with in-state epicenters have persistently occurred in an area near Lancaster (Armbruster and Scharnberger, 1986; Armbruster and Seeber, 1987). Earthquakes originating from outside Pennsylvania can also impact the Commonwealth, as was the case with a magnitude 5.8 earthquake in Virginia in August 2011 (see Section 4.3.3.3). Figure 4.3.3-1 shows relative seismic hazard zones in Pennsylvania as determined by the USGS National Seismic Hazard Mapping Project. Earthquake hazards are highest in the southeastern and far northwestern regions of the Commonwealth.

Figure 4.3.3-1 Relative earthquake hazard zones of Pennsylvania (USGS, 2014).

Data on the focal depths of Pennsylvania earthquakes are limited. The only reliable instrumental data comes from close-in studies of aftershocks in Lancaster County, and indicate an average focal depth of about 3 miles. In addition, some of the shocks that had relatively high epicentral intensities were felt over anomalously small areas, suggesting that these events were relatively shallow.

4.3.3.2. Range of Magnitude

Earthquake magnitude is often measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake. Table 4.3.3-1 summarizes Richter Scale magnitudes as they relate to the spatial extent of impacted areas. Based on historical events, earthquakes with epicenters in Pennsylvania have not exceeded a magnitude of 6.0.

Table 4.3.3-1 Richter scale magnitudes and associated earthquake size effects.

RICHTER MAGNITUDES	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 up to about 100 kilometers from epicenter.
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.

The impact an earthquake event has on an area is typically measured in terms of earthquake intensity. Intensity is most commonly measured using the Modified Mercalli Intensity (MMI) Scale based on direct and indirect measurements of seismic effects. A detailed description of the Modified Mercalli Intensity Scale is provided in Table 4.3.3-2. The earthquakes that occur in Pennsylvania tend to be relatively mild and cause minimal damage.

Table 4.3.3-2 Modified Mercalli Intensity Scale with associated impacts.

SCALE	INTENSITY	DESCRIPTION OF EFFECTS	CORRESPONDING RICHTER SCALE MAGNITUDE
I	Instrumental	Usually detected only on seismographs.	<4.2
II	Feeble	Felt only by a few persons at rest, especially on upper floors of buildings.	
III	Slight	Felt quite noticeably indoors, especially on upper floors. Most people don't recognize it as an earthquake (i.e. a truck rumbling).	
IV	Moderate	Can be felt by people walking; dishes, windows, and doors are disturbed.	
V	Slightly Strong	Sleepers are awoken; unstable objects are overturned.	<4.8
VI	Strong	Trees sway; suspended objects swing; objects fall off shelves; damage is slight.	<5.4
VII	Very Strong	Damage is negligible in buildings of good design and construction, slight to moderate in well-built ordinary structures, and considerable in poorly built or badly designed structures; some chimneys are broken.	<6.1
VIII	Destructive	Damage is slight in specially designed structures; considerable in ordinary, substantial buildings. Moving cars become uncontrollable; masonry fractures, poorly constructed buildings damaged.	<6.9
IX	Ruinous	Some houses collapse, ground cracks, pipes break open; damage is considerable in specially designed structures; buildings are shifted off foundations.	
X	Disastrous	Some well-built wooden structures are destroyed; most masonry and frame structures are destroyed along with foundations. Ground cracks profusely; liquefaction and landslides widespread.	<7.3
XI	Very Disastrous	Most buildings and bridges collapse, roads, railways, pipes and cables destroyed.	<8.1
XII	Catastrophic	Total destruction; trees fall; lines of sight and level are distorted; ground rises and falls in waves; objects are thrown upward into the air.	>8.1

The worst-case earthquake event to have occurred in Pennsylvania was the Pymatuning Earthquake in 1998 (see Section 4.3.3.3 for event summary). However, a potential worst-case scenario would be if a magnitude 6.1 or stronger earthquake occurred near one of Pennsylvania's nuclear facilities, as was the case in the Fukushima Earthquake in Japan in April 2011. This earthquake triggered a tsunami and multiple fires, and it also triggered a major nuclear disaster at the Fukushima Daiichi Nuclear Facility. The nuclear disaster caused permanent damage to some of the facility's reactors and disabled the reactor cooling system, which led to releases of radioactivity and triggered a 30-km evacuation zone displacing 100,000 people (World Nuclear Association, 2011).

4.3.3.3. Past Occurrence

About 35 earthquakes have caused light damage in Pennsylvania since the beginning of the Colonial period. Occasional broken windows, cracked plaster, and glassware toppled from shelves have characterized this damage. Nearly one half of these damaging events had out-of-state epicenters. Foremost among the class of distant shocks that were felt strongly in Pennsylvania were a trio of major earthquakes near New Madrid, Missouri, in 1811-12, and the Charleston, South Carolina, earthquake of 1886. More recently, a magnitude 5.8 earthquake with an epicenter in rural Louisa County, Virginia was felt throughout Pennsylvania, triggering evacuations, emergency bridge and tunnel inspections, and minor damage to buildings. This shallow earthquake occurring along the Spotsylvania Fault was felt as far north as Ontario, Canada and as far south as Alabama.

Figure 4.3.3-2 displays the location and magnitude of all earthquakes with epicenters in Pennsylvania recorded in the USGS Earthquake Catalog. This catalog includes all detectable earthquakes recorded in the Commonwealth from 1973 to the present. While 121 ground-shaking events were documented in this timeframe, only 17 had a magnitude of 3.0 or more. Most of these events occurred in the southeastern or far northwestern regions of the Commonwealth. The largest earthquake ever recorded, the Pymatuning Earthquake of September 25, 1998, was centered in the northwestern part of the state. The epicenter of this earthquake was near Jamestown, in Mercer County, and measured 5.2 on the Richter Scale. Damage reports suggested a maximum intensity of VI.

Table 4.3.3-3 shows a list of historical earthquakes by county compiled by the DCNR Bureau of Topographic and Geological Survey. This list was compiled from many earthquake catalogs, periodicals, and publications, and includes 161 documented seismic events whose epicenters lie within Pennsylvania. Since the timespan of seismic events is from 1724 to 2003, this list provides a longer-term perspective on seismic hazard throughout the Commonwealth. The spatial distribution of events in the DCNR record is consistent with the distribution in the shorter-term USGS record, and shows that southeastern Pennsylvania is the state's most seismically-active region. Although the region is not known to have experienced an earthquake exceeding magnitude 4.7, DCNR found that "no obvious reason exists to conclude that an earthquake of magnitude between 5 and 6 could not occur there also" (PA DCNR, 2003).

Figure 4.3.3-2 Map of earthquake epicenters in Pennsylvania (USGS, 2018).

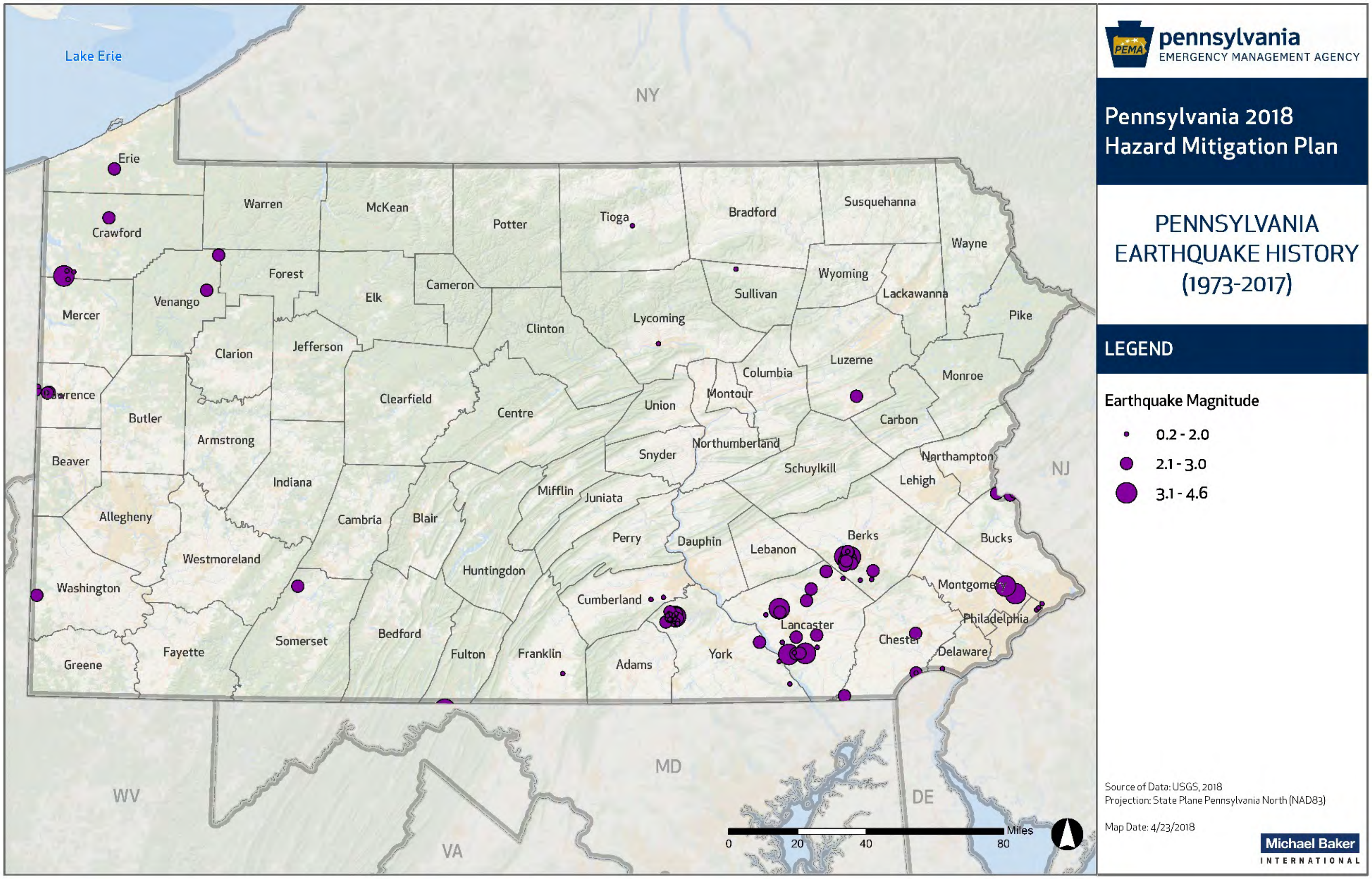


Table 4.3.3-3	Catalog of earthquakes with epicenters in Pennsylvania (DCNR, 2004).			
COUNTY	**DATE**	**LOCATION NEAREST EPICENTER**	**MAGNITUDE**	**INTENSITY**
Adams	1994/05/26	Biglerville	2.8	unknown
Berks	1906/05/28	Geigertown	unknown	III
	1937/06/09	Reading	unknown	II
	1954/01/07	Mount Pleasant	3.2	VI
	1954/08/11	Mohnton	3.3	IV
	1972/06/25	Reading	unknown	unknown
	1973/08/12	Reading	unknown	unknown
	1993/05/10	Sinking Spring	2.8	IV
	1994/01/16	Sinking Spring	4.6	V
	1994/04/16	Reading	2.3	unknown
	1995/01/08	Mohnton	2.5	unknown
	1995/04/08	Robesonia	2.6	unknown
	1995/06/04	Reading	2.7	unknown
	1996/02/03	Sinking Spring	2.3	unknown
	1996/07/07	Angelica	2.3	unknown
	1999/04/18	Reading	1.9	unknown
	1999/10/22	Reading	1.9	unknown
Blair	1938/07/15	Entriken	3.3	VI
Bucks	1961/12/27	Croyden Heights	3.3	V
	1982/05/12	Penndel	2.4	II
	1984/05/10	Hatfield	2.2	unknown
	1989/02/02	Perkasie	unknown	unknown
	1992/05/15	Milford	1.6	unknown
	1997/03/11	Pineville	1.6	unknown
Centre	1937/03/25	Philipsburg	unknown	unknown
	1991/08/15	Centre Hall	3	V
Chester	1752/12/17	Sadsburyville area	3.6	IV
	1990/03/30	Downingtown	1.8	unknown
	1996/10/17	Nottingham	2.2	unknown
	1999/07/27	Warwick	unknown	unknown
Crawford	1852/09/15	Meadville	3.7	unknown
	1985/04/14	Shermansville	3.2	unknown
	1998/11/07	Atlantic	2.3	unknown
Delaware	1737/12/08	Media area	unknown	IV
	1763/03/22	Darby area	unknown	III
	1996/07/05	Glen Mills	2.6	unknown
Erie	1921/09/27	Erie	2.9	III
	1934/10/29	Lake Erie	3.2	V
	1990/12/17	Erie	2.5	III
	1998/08/30	Lake Erie	2.1	unknown
	1999/10/30	Lake Erie	2.5	unknown
Fayette	1965/10/08	Perryopolis	3.3	unknown
Lackawanna	1940/09/27	Fleetville	unknown	II
	1960/01/22	Archbald	3.4	unknown

Table 4.3.3-3 Catalog of earthquakes with epicenters in Pennsylvania (DCNR, 2004).

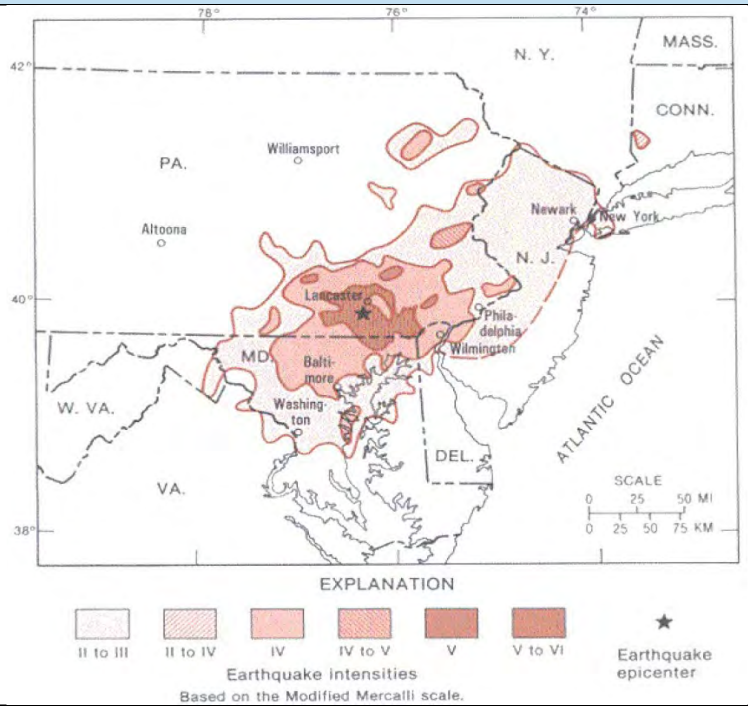
COUNTY	DATE	LOCATION NEAREST EPICENTER	MAGNITUDE	INTENSITY
Lancaster	1798/01/11	Lancaster area	unknown	IV
	1800/11/20	Landisville	4.1	V
	1801/01/27	Lancaster area	unknown	IV
	1818/03/19	Lancaster area	unknown	III
	1820/08/21	Columbia	3.4	V
	1822/05/04	Lancaster area	unknown	unknown
	1829/09/06	Lancaster area	unknown	III
	1834/02/05	Quarryville	4	V
	1865/09/17	Martic Forge	unknown	unknown
	1866/11/07	Lancaster area	unknown	unknown
	1885/03/09	Lancaster area	unknown	IV
	1886/09/27	Washington Boro	unknown	IV
	1972/12/08	Akron	3.5	V
	1978/07/16	Martic Forge	3.1	V
	1978/10/06	East Petersburg	3	VI
	1984/04/23	Marticville	4.2	VI
	1984/09/19	Lancaster	unknown	III
	1986/05/02	Marticville	2.5	IV
	1990/07/03	Reinholds	1.7	unknown
	1994/01/18	Ephrata	2.6	unknown
	1994/05/18	Strasburg	2.4	unknown
	1995/03/11	Landisville	2.7	IV
	1996/10/28	Blainsport	2.5	unknown
	1997/11/14	Lititz	3	IV
	2000/03/22	Lancaster	1.8	unknown
	2000/10/05	Martic Forge	2.1	unknown
	2001/07/17	Conestoga	1.8	unknown
Lebanon	1885/01/15	Schaefferstown	unknown	unknown
	1964/05/12	Cornwall	3.2	VI
Lehigh	1884/05/31	Allentown	unknown	V
	1908/05/31	Allentown	3.1	VI
	1928/06/22	Allentown	unknown	III
	1951/11/23	Allentown	3.3	IV
	1961/09/15	Bethlehem	4.3	V
Luzerne	2000/02/24	Penn Lake Park	2.3	unknown
Lycoming	1907/01/10	SW of Williamsport	unknown	unknown
Mercer	1873/08/17	Sharon area	unknown	III
	1890/12/15	Greenville	2.9	II
	1936/08/26	Greenville	2.9	IV
	1998/09/25	Greenville (Osgood)	5.1	unknown
Monroe	1942/10/24	Bartonsville	3.4	unknown
Montgomery	1980/03/05	Abington (Horsham)	3.5	IV
Philadelphia	1724/08/16	Philadelphia area	unknown	IV
	1755/11/27	Philadelphia area	unknown	III

Table 4.3.3-3	Catalog of earthquakes with epicenters in Pennsylvania (DCNR, 2004).			
COUNTY	**DATE**	**LOCATION NEAREST EPICENTER**	**MAGNITUDE**	**INTENSITY**
	1758/03/23	Philadelphia area	unknown	III
	1763/10/30	Philadelphia area	unknown	V
	1772/04/25	Philadelphia area	unknown	II
	1777/11/22	Philadelphia area	unknown	III
	1780/11/29	Philadelphia area	unknown	III
	1800/03/17	Philadelphia area	unknown	V
	1800/11/29	Philadelphia area	unknown	IV
	1801/11/12	Philadelphia area	unknown	III
	1811/12/09	Philadelphia area	unknown	III
	1840/11/11	Philadelphia area	unknown	V
Schuylkill	1944/02/05	Shenandoah	3.7	unknown
	1995/08/17	Schuylkill Haven	1.8	unknown
Somerset	1982/02/03	Jennerstown	2.6	III
Sullivan	1946/10/28	Forksville	3.6	unknown
Susquehanna	1982/08/14	Hop Bottom	1.8	unknown
Tioga	1990/12/14	Wellsboro	3	unknown
Warren	1995/07/08	Scandia	2.4	unknown
Wyoming	1950/03/20	Mill City	3.3	unknown
York	1889/03/08	Wrightsville	4.3	VI
	1997/06/16	Dillsburg	2.4	IV
	2000/08/24	York Haven	1.9	unknown

Very few earthquakes having a maximum intensity of IV or higher have been centered in areas outside the southeastern part of the Commonwealth. An earthquake shock on March 8, 1889 shook southeastern Pennsylvania, northern Maryland, and the northern tip of Delaware. Chimneys fell in Harrisburg and York, where the 1889 tremor was severe. Stover and others (1981) listed 10 historic earthquakes having maximum intensities of III or more and epicenters in the immediate vicinity of Philadelphia. The largest of these, a shock with a maximum intensity of approximately V, occurred on November 11, 1840. Small tremors in the Philadelphia area, such as the shocks on March 5 and March 11 in 1980, are often both felt and heard (Bischke, 1980). Witnesses usually describe the accompanying noise as a sonic boom or furnace explosion.

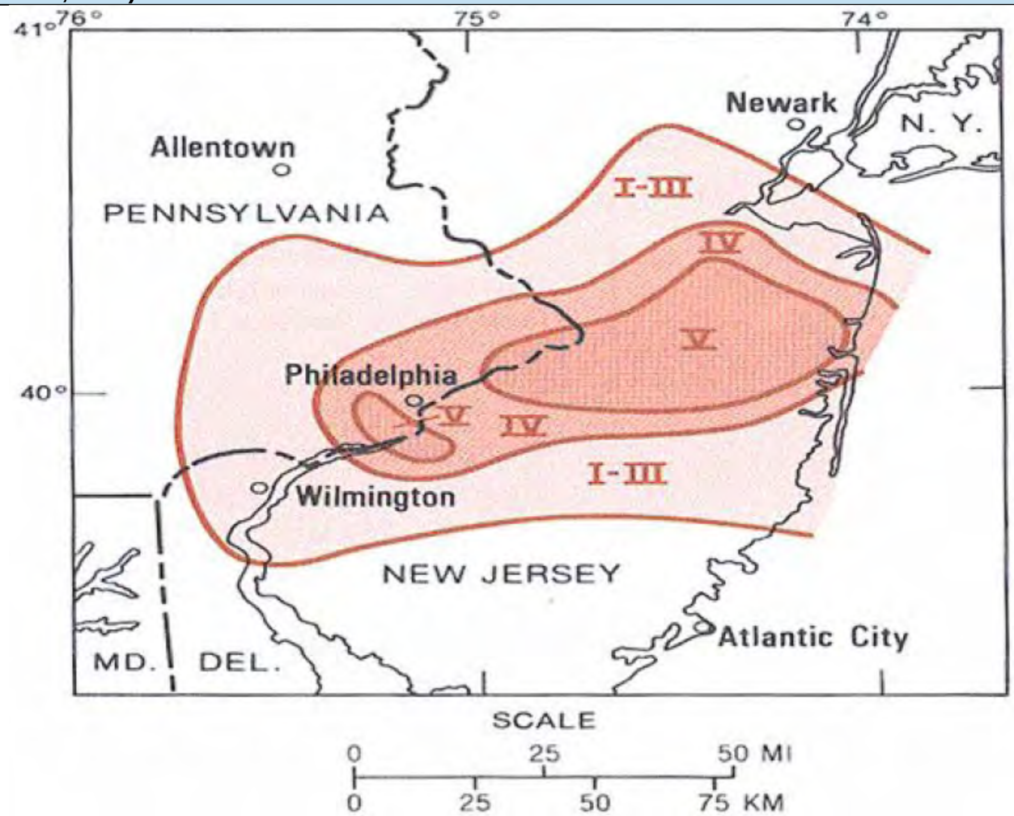
The most widely felt earthquake known to be centered in Pennsylvania occurred in the Lancaster area on April 23, 1984 (Armbruster and Seeber, 1987; Scharnberger and Howell, 1985). An isoseismal map for this event is included in Figure 4.3.3-3. More recently, an earthquake on January 16, 1994 measured 4.6 on the Richter Scale and caused damage exceeding two million dollars in the Reading area.

Figure 4.3.3-3 Isoseismal lines of the Lancaster, PA earthquake on April 23, 1984 (modified from Stover, 1988).



Earthquakes whose epicenters fall outside of Pennsylvania can impact the Commonwealth as well. A cluster of historical epicenters in southeastern Pennsylvania is spatially associated with a seismic trend along the lower Delaware River, which continues in a northeasterly direction through New Jersey. One of the strongest shocks in this northeast-trending zone occurred on August 23, 1938 (see Figure 4.3.3-4). This tremor, which was centered in New Jersey about 31 miles northeast of Philadelphia, was the principal shock of a swarm of about a dozen tremors in the area that were felt in Philadelphia. The main shock of the swarm alarmed many people and broke a few windows in the Philadelphia area.

Figure 4.3.3-4 Isoseismal lines of the New Jersey earthquake on August 23, 1938 (modified from Neumann, 1940).



The strongest, most widely felt shock known to have originated in the region covered by Figure 4.3.3-5 was the earthquake of August 10, 1884, which was centered in New Jersey about 50 miles northeast of Philadelphia. Contemporary newspapers contained reports that this earthquake caused a few chimneys to fall and glassware and other small objects to be upset in greater Philadelphia. Waves on the Delaware River were reported to have swamped small boats. Figure 4.3.3-5 is an adaptation of Rockwood's (1885) isoseismal map; the original map is the oldest known published isoseismal plot of a North American earthquake. The isoseismal lines in the figure exhibit southwest-northeast elongation that is characteristic of shocks in the region.

Figure 4.3.3-5 Isoseismal lines of the New Jersey earthquake on August 10, 1884 (modified from a publication by C.G. Rockwood, Jr., 1885).

On October 9, 1871, an earthquake having a maximum intensity of VII struck Wilmington, Delaware, located about 25 miles southwest of Philadelphia. This shock, Wilmington's most famous earthquake, was felt in a northeast-trending, elliptically shaped area about 40 miles wide and 68 miles long; chimneys were thrown down in Oxford, Pennsylvania and doors and windows were rattled in Philadelphia. Another relatively strong earthquake centered near Wilmington occurred on February 28, 1973. The area characterized by intensity V, the highest intensity associated with this shock, extended northeasterly along both sides of the Delaware River to the vicinity of Philadelphia, where the shock cracked plaster and toppled glassware.

4.3.3.4. Future Occurrence

The best available guides to the magnitude and frequency of seismic hazards in Pennsylvania are the probabilistic ground motion maps produced by the USGS. These maps display the intensity of ground motions for various probability levels, and are applied in seismic provisions of building codes, insurance rate structures, risk assessments, and other public policy. The latest available maps are the 2014 USGS National Seismic Hazard Maps. These maps include the peak ground acceleration (PGA) likely to occur at two probability levels: the 500-year event (10% probability of exceedance in 50 years) and the 2,500-year event (2% probability of exceedance in 50 years). The USGS selected these frequencies to reflect the average design life of a building (50 years) and the different levels of risk tolerance for different applications.

Figure 4.3.3-6 shows the PGA in Pennsylvania with a recurrence interval of 2,500 years (2% probability of exceedance in 50 years). PGA is expressed as a percentage of the force of gravity, or %g. Damage to buildings of poor construction generally begins at a PGA of 10% g. PGA values ranging from 8 to 12 percent are shown in southeastern Pennsylvania. These values correspond to intensities of VII. On the whole, the future probability of earthquakes in Pennsylvania can be considered *possible.*

Figure 4.3.3-6 Seismic hazard map (USGS, 2014).

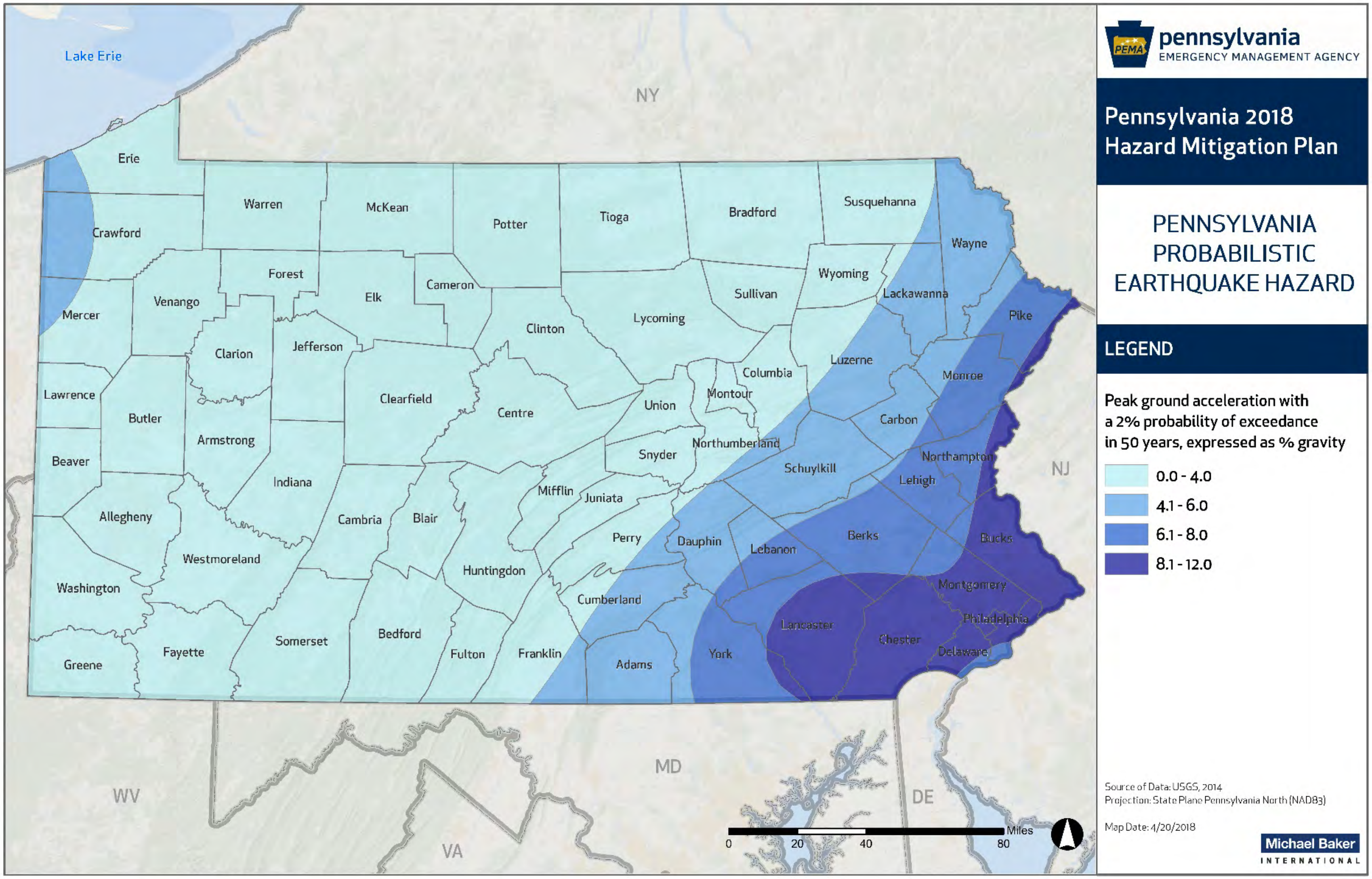
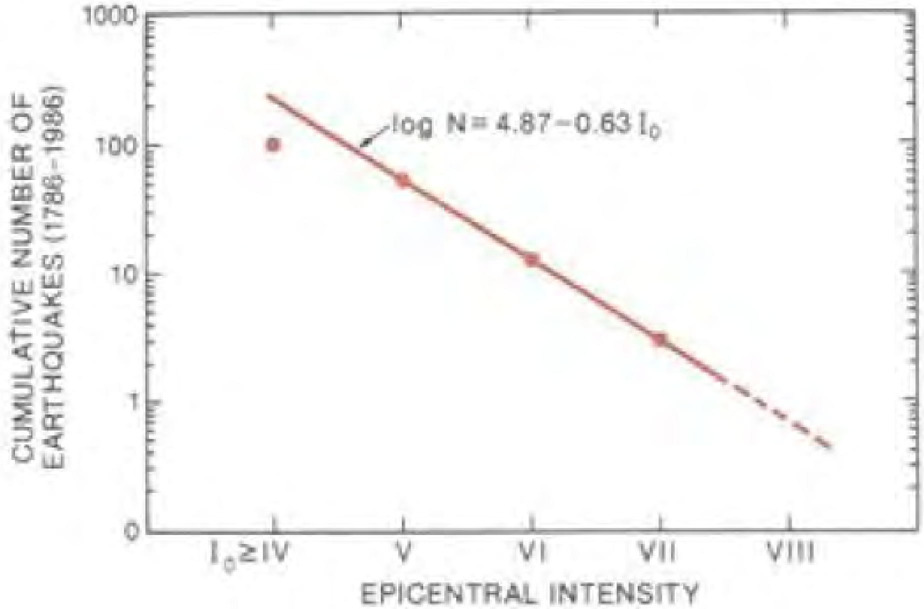


Figure 4.3.3-7 is a plot of the cumulative number (N) of earthquakes versus epicentral intensity (I_0) for the period 1786-1986 in the study region. The straight line (log N=4.87-0.63 I_0) has been fitted to the observed frequencies at the V, VI, and VII intensity levels. In regions where earthquake records have been kept for a long time, log N versus I_0 relationships are nearly linear over the range of higher intensities. In regions that have short-term histories, a linear log N relation is commonly assumed to extrapolate the frequencies of shocks larger than those observed to date. The calculated frequency derived from the linear expression shown in the figure is more than twice the observed frequency at the intensity IV level. The fact that the observed frequency falls below the calculated frequency is probably due to the incomplete cataloging of intensity IV events in the eighteenth and nineteenth centuries.

Figure 4.3.3-7 Cumulative number (N) of earthquakes versus epicentral intensity (I_0) for the period 1786 – 1986 in Pennsylvania and adjacent areas.



Pennsylvania has not experienced an earthquake of intensity VIII, the threshold of serious damage to ordinary structures, or greater in recorded history. Assuming that the expression for log N that has been derived may be extrapolated to higher intensities, it is estimated that, on average, three to four such events ($I_0 \geq$ VIII) will take place over 1,000 years. This result is similar to Algermissen's (1969) estimate of seismicity rates for the entire East Coast region (2.3 shocks per 100,000 km^2 [38,600 mi^2] with $I_0 \geq$ VIII over a 1,000-year period). In 1979, Benjamin Howell, Jr. of Pennsylvania State University used extreme-value theory and certain assumptions about the maximum size of earthquakes in the region to estimate an average return period of between 100 and 300 years for earthquakes in Pennsylvania having a maximum intensity of VIII.

Extrapolation from the available earthquake record will be improved by a better understanding of seismogenic faults in the Commonwealth and by a more complete cataloging of the historical shocks. Felt-area estimates, magnitudes, and approximate focal depths can probably be developed for more of the pre-instrumental earthquakes. A thorough search of original sources for the eighteenth and nineteenth centuries would likely result in the discovery of many additional, previously unlisted earthquakes.

4.3.3.5. Environmental Impacts

Environmental impacts of earthquakes can be numerous, widespread and devastating, particularly if indirect impacts are considered. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure. These secondary events could also result in disruptions to natural ecosystems, poor water quality, damage to vegetation, and the release of toxic materials and sewage. Impacts to infrastructure could include train derailments, pipeline failures, and utility interruptions.

4.3.3.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to earthquakes, all structures located in areas characterized by high seismic hazard were identified. Relative earthquake hazard was derived from the 2014 USGS National Seismic Hazard Map for the shaking event with a recurrence interval of 2,500 years (see Figure 4.3.3-6). As described above, the intensity of ground-shaking is measured in terms of peak ground acceleration (PGA), and PGA is expressed as a percentage of the force of gravity (%g). For this analysis, vulnerable assets were defined as those located in areas with a PGA greater than or equal to 8% g. Note that the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 683, or 15 percent, are located in areas characterized by relatively high seismic hazard (Table 4.3.3-4). These facilities have a combined replacement value of more than $225 million, or approximately 6 percent of the known value of geolocated state facilities.

Table 4.3.3-4 Vulnerability of state-owned facilities to earthquake events.

STATE CRITICAL FACILITY TYPE	NUMBER OF IMPACTED FACILITIES	% OF STRUCTURES FOR FACILITY TYPE
Attorney General	2	22%
Department of Agriculture	1	6%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	8	1%
Department of Education	1	100%

Table 4.3.3-4 Vulnerability of state-owned facilities to earthquake events.		
STATE CRITICAL FACILITY TYPE	NUMBER OF IMPACTED FACILITIES	% OF STRUCTURES FOR FACILITY TYPE
Department of Environmental Protection	1	8%
Department of General Services	44	34%
Department of Health	2	4%
Department of Labor and Industry	13	19%
Department of Military and Veterans Affairs	1	100%
Department of Public Welfare	22	22%
Department of Revenue	3	30%
Department of Transportation	171	10%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	2	1%
Governor's Office	0	0%
Historical and Museum Commission	8	27%
Insurance Department	0	0%
Liquor Control Board	152	28%
Public School Employees' Retirement System	1	17%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	1	25%
State Police	5	14%
State System of Higher Education	225	26%
Thaddeus Stevens College of Technology	20	100%
Treasury Department	0	0%
Total	**683**	**15%**

Of the 14,011 geolocated critical facilities, 2,716 or 19 percent, are located in areas characterized by relatively high earthquake hazard (Table 4.3.3-5). These facilities have a combined replacement value of approximately $36.5 billion, or 19 percent of the known value of geolocated critical facilities.

Table 4.3.3-5 Vulnerability of state critical facilities to earthquake events.		
STATE CRITICAL FACILITY TYPE	**NUMBER OF IMPACTED FACILITIES**	**% OF STRUCTURES FOR FACILITY TYPE**
Agriculture	69	25%
Banking	1	33%
Commercial	15	56%
Communication	79	13%
Dam	636	19%
Education (colleges and universities)	56	35%
Education (public schools)	869	27%
Emergency Operation Centers	7	10%
Energy	9	16%
Fire Station	413	15%
Government	1	4%
Hospitals	89	26%
National Monument or Icon	1	17%
Nuclear	2	40%
Police Station	217	17%
Transportation	8	11%
Water	244	14%
Total	**2,716**	**19%**

4.3.3.7. Jurisdictional Vulnerability Assessment and Loss Estimation

FEMA's Hazus software version 4.0 was used to estimate the relative vulnerability to earthquakes across the state. The methodology uses Hazus default data on seismic hazards and building stock data, user-defined essential facilities data, and the software's standard algorithms. The calculation algorithms quantify the potential losses associated with seismic hazards using information about shake probabilities, soil characteristics, and other parameters. As discussed in Section 4.1.4, Hazus was used to calculate two kinds of economic losses: 1) direct building losses, and 2) business interruption losses. Direct building losses consist of the damage to structures and their contents, while business interruption losses consist of the relocation expenses, employee wage loss, business income loss, and rental income loss that accrue during the time that businesses remain inoperable. For more information on the data and methodology used in this analysis, see Section 4.1.4.

The tables below show the average annualized earthquake losses for Pennsylvania aggregated to the county scale. While Table 4.3.3-6 shows potential direct building losses, Table 4.3.3-7 shows potential business interruption losses. According to the Hazus analysis, most of the potential loss is attributable to direct building losses, and most of the potential direct building loss is attributable to building damage. Figure 4.3.3-8 shows the spatial distribution of the total average annualized losses (the sum of direct building losses and business interruption losses). Note that losses are shown at the census tract level. While the county-level tables show the highest annualized losses in the most populous counties (i.e., Philadelphia, Allegheny, Montgomery, and Bucks Counties), the census-tract level map shows the highest annualized losses in census tracts located in Chester and Allegheny Counties.

Table 4.3.3-6 Potential direct building losses from earthquake hazards (Average Annualized Loss).

COUNTY	BUILDING LOSS (Million $)	CONTENTS LOSS (Million $)	INVENTORY LOSS (Million $)	TOTAL DIRECT BUILDING LOSSES (Million $)
Adams	$104.9	$25.0	$0.8	$130.6
Allegheny	$1,621.6	$421.3	$8.2	$2,051.1
Armstrong	$65.8	$16.1	$0.4	$82.4
Beaver	$192.0	$48.8	$1.2	$242.0
Bedford	$45.4	$11.3	$0.3	$56.9
Berks	$449.8	$115.2	$3.7	$568.7
Blair	$130.4	$33.4	$1.0	$164.8
Bradford	$56.8	$14.5	$0.4	$71.6
Bucks	$819.1	$203.7	$5.3	$1,028.1
Butler	$214.2	$56.0	$1.7	$272.0
Cambria	$158.9	$42.5	$1.2	$202.5
Cameron	$8.9	$2.4	$0.1	$11.4
Carbon	$73.3	$17.0	$0.3	$90.5
Centre	$159.0	$38.3	$0.6	$198.0
Chester	$684.6	$169.8	$4.0	$858.4
Clarion	$41.4	$10.6	$0.4	$52.4
Clearfield	$77.2	$19.5	$0.6	$97.3
Clinton	$37.8	$9.2	$0.2	$47.2
Columbia	$71.1	$18.5	$0.6	$90.2
Crawford	$95.5	$25.3	$1.0	$121.8
Cumberland	$282.1	$69.2	$1.6	$352.8
Dauphin	$324.9	$81.7	$1.5	$408.1
Delaware	$684.2	$168.4	$2.5	$855.0
Elk	$41.6	$11.7	$0.5	$53.9
Erie	$304.6	$81.6	$2.8	$389.0
Fayette	$124.6	$31.7	$0.7	$156.9
Forest	$13.1	$2.7	$0.0	$15.9
Franklin	$143.9	$35.1	$1.2	$180.2
Fulton	$13.6	$3.2	$0.1	$16.9
Greene	$34.1	$8.7	$0.2	$43.0
Huntingdon	$41.8	$9.4	$0.1	$51.3

Table 4.3.3-6 Potential direct building losses from earthquake hazards (Average Annualized Loss).				
COUNTY	BUILDING LOSS (Million $)	CONTENTS LOSS (Million $)	INVENTORY LOSS (Million $)	TOTAL DIRECT BUILDING LOSSES (Million $)
Indiana	$82.6	$21.0	$0.6	$104.2
Jefferson	$45.6	$11.9	$0.5	$57.9
Juniata	$21.2	$4.8	$0.1	$26.0
Lackawanna	$255.8	$68.9	$2.0	$326.7
Lancaster	$546.2	$138.1	$4.7	$689.0
Lawrence	$91.8	$23.8	$0.8	$116.3
Lebanon	$142.9	$35.3	$1.2	$179.5
Lehigh	$400.4	$101.0	$2.3	$503.7
Luzerne	$352.7	$89.8	$2.8	$445.3
Lycoming	$118.8	$30.6	$1.2	$150.6
McKean	$46.7	$12.5	$0.5	$59.7
Mercer	$130.9	$35.7	$1.5	$168.1
Mifflin	$43.7	$11.2	$0.3	$55.2
Monroe	$190.3	$42.8	$0.6	$233.8
Montgomery	$1,142.4	$293.8	$6.6	$1,442.8
Montour	$18.5	$4.6	$0.1	$23.2
Northampton	$331.0	$80.4	$2.0	$413.4
Northumberland	$95.8	$23.9	$0.8	$120.6
Perry	$41.5	$9.1	$0.1	$50.7
Philadelphia	$1,659.7	$430.9	$7.1	$2,097.7
Pike	$84.6	$17.3	$0.1	$102.0
Potter	$24.3	$6.0	$0.1	$30.4
Schuylkill	$155.6	$39.6	$1.3	$196.5
Snyder	$37.0	$9.5	$0.5	$47.0
Somerset	$78.2	$20.2	$0.7	$99.1
Sullivan	$10.1	$2.1	$0.0	$12.3
Susquehanna	$41.6	$9.5	$0.2	$51.3
Tioga	$40.3	$9.7	$0.2	$50.2
Union	$41.0	$10.0	$0.2	$51.2
Venango	$57.4	$14.5	$0.3	$72.2
Warren	$47.7	$12.0	$0.4	$60.1
Washington	$236.1	$59.7	$1.6	$297.4
Wayne	$61.5	$13.8	$0.2	$75.5
Westmoreland	$411.9	$104.9	$3.0	$519.8
Wyoming	$26.5	$6.3	$0.1	$33.0
York	$479.0	$119.0	$4.4	$602.4
Total	**$14,707**	**$3,726**	**$93**	**$18,526**

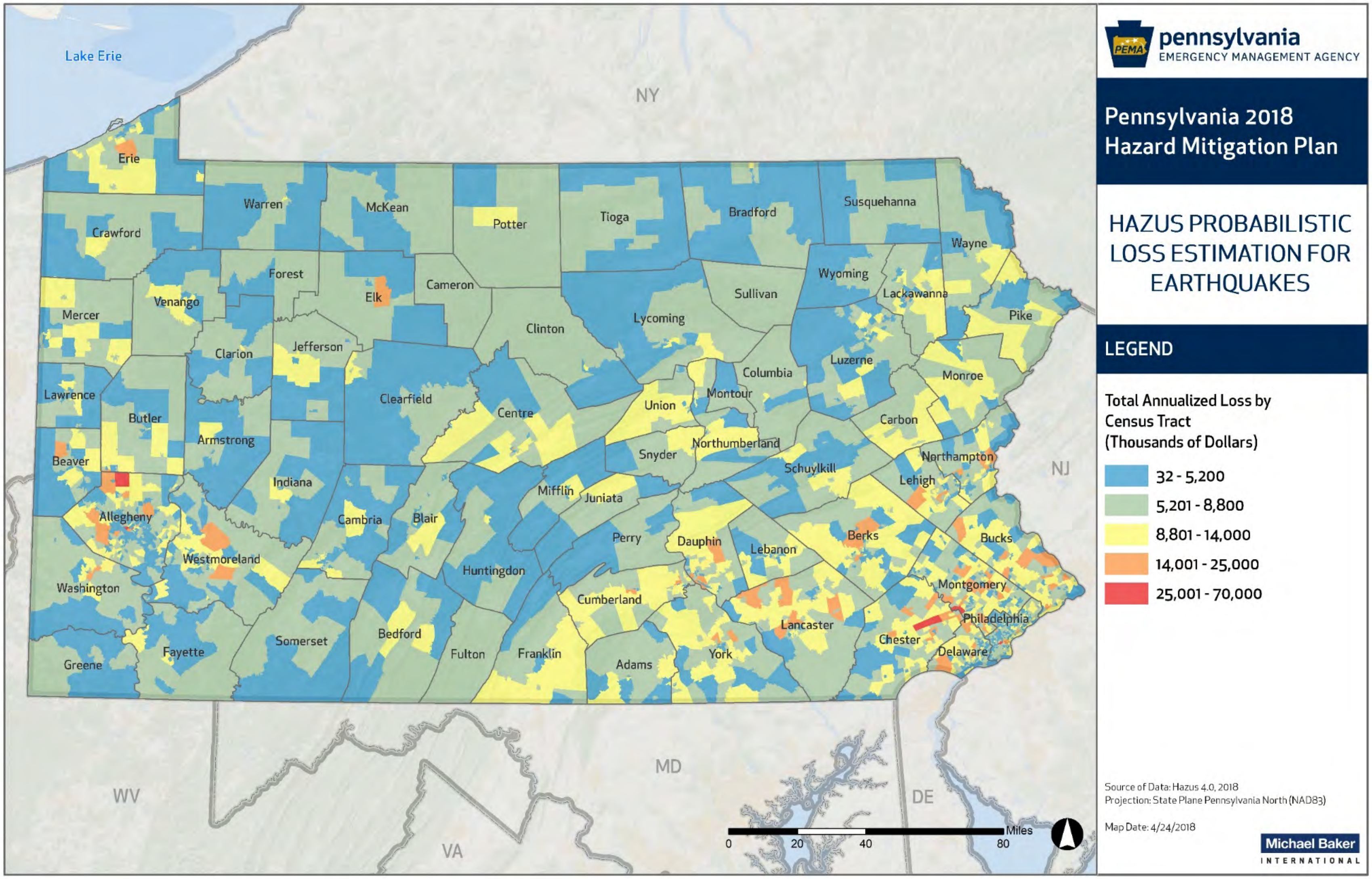
Table 4.3.3-7 Potential business interruption losses from earthquake hazards (Average Annualized Loss).

COUNTY	INCOME LOSS (Million $)	RELOCATION LOSS (Million $)	RENTAL INCOME LOSS (Million $)	WAGE LOSS (Million $)	TOTAL BUSINESS INTERRUPTION LOSSES (Million $)
Adams	$2.2	$10.6	$4.4	$3.0	$20.2
Allegheny	$46.9	$154.2	$73.9	$61.1	$336.1
Armstrong	$1.3	$7.5	$2.9	$2.0	$13.7
Beaver	$4.6	$19.9	$8.5	$5.9	$38.9
Bedford	$1.0	$5.4	$2.1	$1.4	$9.9
Berks	$9.5	$43.1	$18.8	$13.1	$84.4
Blair	$3.6	$13.8	$6.4	$5.5	$29.3
Bradford	$1.2	$6.5	$2.6	$2.1	$12.4
Bucks	$18.4	$71.1	$31.2	$25.1	$145.8
Butler	$5.6	$20.8	$8.6	$9.0	$44.0
Cambria	$4.1	$16.8	$7.3	$5.6	$33.7
Cameron	$0.2	$1.0	$0.4	$0.3	$1.8
Carbon	$1.4	$8.4	$3.3	$2.1	$15.2
Centre	$3.6	$15.2	$7.7	$4.8	$31.3
Chester	$13.5	$57.6	$24.5	$16.5	$112.1
Clarion	$1.0	$4.5	$1.9	$1.5	$8.9
Clearfield	$1.8	$8.8	$3.7	$2.8	$17.0
Clinton	$0.8	$4.3	$1.8	$1.2	$8.2
Columbia	$2.0	$7.3	$3.3	$2.5	$15.0
Crawford	$2.3	$10.7	$4.3	$3.3	$20.6
Cumberland	$6.6	$26.6	$12.0	$9.9	$55.0
Dauphin	$8.4	$32.3	$15.1	$11.1	$66.9
Delaware	$13.5	$60.7	$27.2	$18.0	$119.5
Elk	$0.9	$4.3	$1.7	$1.2	$8.1
Erie	$8.7	$30.1	$14.2	$11.3	$64.3
Fayette	$3.1	$14.1	$5.9	$4.7	$27.8
Forest	$0.2	$1.7	$0.6	$0.3	$2.8
Franklin	$3.2	$15.3	$6.5	$4.7	$29.7
Fulton	$0.2	$1.6	$0.6	$0.2	$2.6
Greene	$0.7	$3.7	$1.5	$1.1	$7.0
Huntingdon	$0.5	$4.9	$1.9	$0.9	$8.3
Indiana	$2.0	$8.7	$3.8	$3.0	$17.4
Jefferson	$1.1	$5.1	$2.1	$1.7	$10.1
Juniata	$0.4	$2.5	$0.9	$0.7	$4.5
Lackawanna	$7.6	$24.4	$12.5	$11.0	$55.5
Lancaster	$13.5	$53.7	$24.4	$18.5	$110.1

Table 4.3.3-7 Potential business interruption losses from earthquake hazards (Average Annualized Loss).

COUNTY	INCOME LOSS (Million $)	RELOCATION LOSS (Million $)	RENTAL INCOME LOSS (Million $)	WAGE LOSS (Million $)	TOTAL BUSINESS INTERRUPTION LOSSES (Million $)
Lawrence	$2.2	$10.4	$4.1	$3.1	$19.9
Lebanon	$2.8	$14.1	$6.3	$4.1	$27.3
Lehigh	$10.1	$37.2	$18.0	$13.7	$79.0
Luzerne	$9.5	$36.5	$16.8	$13.2	$76.1
Lycoming	$3.0	$12.8	$5.8	$4.2	$25.8
McKean	$1.1	$5.1	$2.1	$1.8	$10.1
Mercer	$3.8	$13.2	$5.8	$5.5	$28.3
Mifflin	$1.0	$5.1	$2.1	$1.7	$9.8
Monroe	$3.3	$20.5	$8.2	$4.0	$35.9
Montgomery	$26.5	$96.6	$44.0	$34.2	$201.2
Montour	$0.5	$2.0	$0.9	$0.8	$4.2
Northampton	$6.2	$31.6	$13.6	$8.4	$59.9
Northumberland	$1.9	$10.6	$4.5	$2.8	$19.7
Perry	$0.5	$4.7	$1.7	$0.7	$7.6
Philadelphia	$40.6	$155.9	$79.9	$52.0	$328.3
Pike	$1.1	$9.4	$3.8	$1.7	$15.9
Potter	$0.6	$3.0	$1.1	$0.9	$5.5
Schuylkill	$3.1	$17.1	$6.9	$4.7	$31.7
Snyder	$0.8	$3.9	$1.6	$1.1	$7.4
Somerset	$1.9	$8.8	$3.7	$2.8	$17.2
Sullivan	$0.1	$1.3	$0.5	$0.1	$2.0
Susquehanna	$0.6	$5.0	$1.9	$0.9	$8.4
Tioga	$0.9	$4.7	$2.0	$1.3	$8.9
Union	$1.0	$4.1	$1.9	$1.4	$8.4
Venango	$1.4	$6.6	$2.7	$2.2	$12.9
Warren	$0.9	$5.4	$2.1	$1.4	$9.8
Washington	$5.6	$23.9	$10.1	$7.6	$47.1
Wayne	$1.3	$7.2	$3.0	$1.9	$13.3
Westmoreland	$9.8	$42.5	$17.6	$13.9	$83.8
Wyoming	$0.6	$3.0	$1.2	$0.8	$5.6
York	$9.5	$47.0	$19.4	$12.6	$88.5
Total	**$347**	**$1,426**	**$642**	**$472**	**$2,888**

Figure 4.3.3-8 Map of average annualized losses for earthquake hazard (Hazus, 2018).



4.3.4. Extreme Temperature

4.3.4.1. Location and Extent

Pennsylvania can experience many different temperature extremes. Temperatures across the Commonwealth normally remain between 0°F and 100°F and average from 43°F in the north-central mountains to 55°F in the southeast. High temperatures of 90°F or above occur about ten days per year at any one location, but southeastern localities may experience more than twice this number. Ranges of daily temperature from maximum to minimum are commonly around 20°F during the summer and are a few degrees less during the winter. Freezing temperatures occur on an average of 100 or more days per year, and the greatest number of occurrences is in the Appalachian Plateaus province in north-central Pennsylvania. The southeast (near sea level) and northwest (adjacent to Lake Erie) portions of the Commonwealth have the longest freeze-free period. Extreme temperature hazards are not tied to a specific temperature threshold; instead, these hazards occur when the temperature is extremely high or extremely low (PSC 2018).

Figure 4.3.4-1 and Figure 4.3.4-2 show the excessive cold/wind chill warnings and the heatwave warnings throughout Pennsylvania between 2005 and 2017. During July, the warmest month, high temperatures normally range from the upper-70s in northern areas of the Commonwealth to the mid-80s in southern areas. Minimum temperatures for this month range from the upper-60s in the southeast to the lower 50s in the north-central mountains. During January, the coldest month, most of the Commonwealth experiences low temperatures in the teens and high temperatures in the 30s. High temperatures usually remain near or below the freezing point during this month in northern sections of the Commonwealth. In southern sections, high temperatures hover in the mid- to upper-30s.

Figure 4.3.4-1 Map showing excessive cold and wind chill warnings throughout Pennsylvania by census tract based on data collected from 2005 - 2017 (FEMA NRI, 2018)

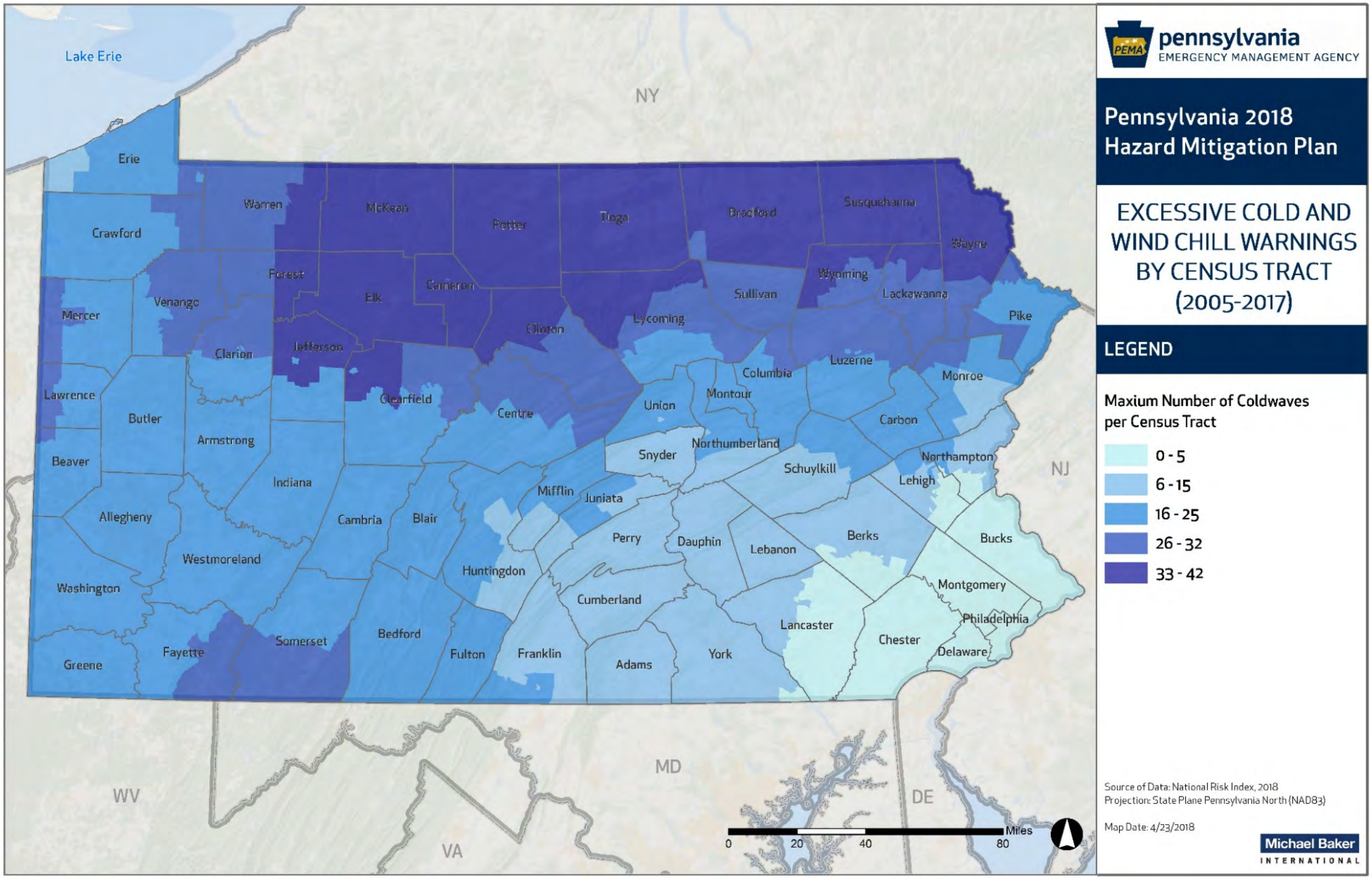
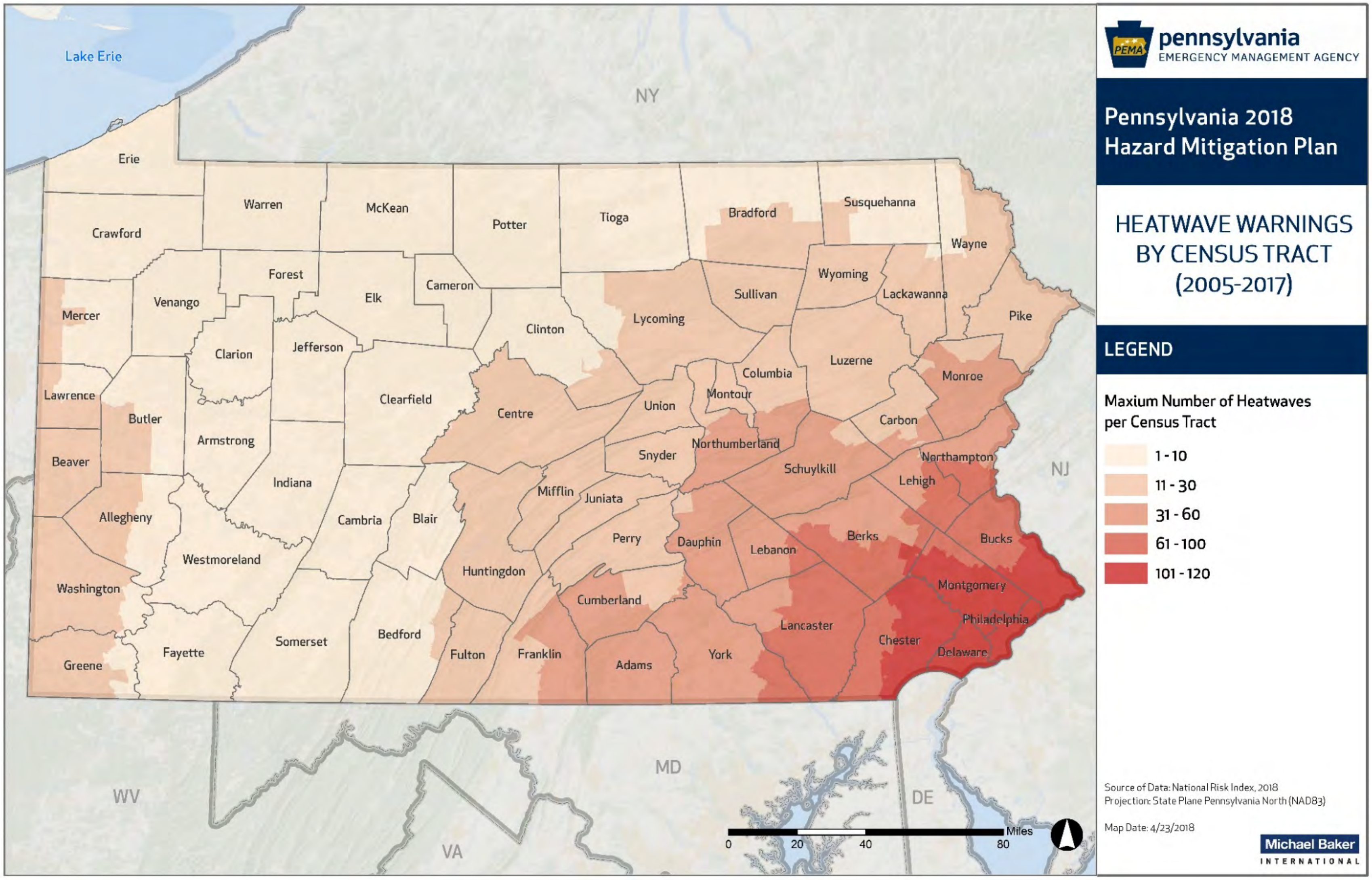


Figure 4.3.4-2 Map showing heatwave warnings throughout Pennsylvania by census tract based on data collected from 2005 - 2017 (FEMA NRI, 2018)



4.3.4.2. Range of Magnitude

Extreme temperatures can result in elevated utility costs to consumers and can cause human risks. Extremely high temperatures cause heat stress. Major human risks for these temperatures include heat cramps, heat syncope, heat exhaustion, heatstroke, and death. The impacts of high temperatures will vary from person to person based on individual age, health, and other factors. The very old and the very young are most vulnerable to health-related impacts of extreme temperatures.

Temperature advisories, watches and warnings are issued by the National Weather Service relating the above impacts to the range of temperatures typically experienced in Pennsylvania. Exact thresholds vary across the Commonwealth, but in general *Heat Advisories* are issued when the heat index will be equal to or greater than 100°F, but less than 105°F, *Excessive Heat Warning*s are issued when heat indices will attain or exceed 105°F, and *Excessive Heat Watches*, are issued when there is a possibility that excessive heat warning criteria may be experienced within twelve to forty-eight hours. The heat index is a measurement that takes into account both the temperature and relative humidity and is calculated as shown in Figure 4.3.4-3 (NOAA NWS, 2018).

Figure 4.3.4-3 National Weather Service's Heat Index matrix (NOAA NWS, 2018)

NOAA's National Weather Service

Heat Index

Temperature (°F)

Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Cold temperatures can be extremely dangerous to humans and animals exposed to the elements. Without heat and shelter, cold temperatures can cause hypothermia, frost bite, and death. Wind chill temperatures are often used in place of raw temperature values due to the effect of wind can have in drawing heat from the body under cold temperatures. These values represent what temperatures actually feel like to humans and animals under cold, windy conditions. Similar to high temperatures, the effect of cold temperatures will vary by individual.

In Pennsylvania, *Wind Chill Warnings* are issued when wind chills drop to -25°F or lower. While this threshold applies to the entire state, the threshold for advisories vary based on regions. Wind Chill Advisories are issued in the southeast and western sections of Pennsylvania when wind chill values drop to -10°F. South-central to northern sections of the Commonwealth when wind chills drop to -15°F. See Figure 4.3.4-4 for which criteria applies to which regions (NOAA NWS, 2018).

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 would overwhelm the power grid, causing widespread blackouts, essentially cutting off vital HVAC services for Pennsylvanians. This kind of event could create a public health hazard for the elderly and children and would result in heat cramps, sunstroke, heat exhaustion, and death.

4.3.4.3. Past Occurrence

The highest temperature ever recorded was 111°F in Phoenixville, Chester County on July 9 and July 10, 1936, while the lowest temperature ever recorded was -42°F in Smethport, McKean County, on January 5, 1904 (NOAA SCEC, 2018).

Data from the National Climatic Data Center reports that there have been 85 extreme temperature episodes in Pennsylvania between 2000 and 2017, resulting in a total of 94 deaths and 103 injuries.

50 of these events have been a result of extreme cold/wind chill, resulting in 4 deaths. The database reports one event in January 2000 and one in February 2007 which resulted in 2 deaths each.

There have been 35 extreme heat episodes, resulting in 90 deaths and 103 injuries across the state. The database reports an episode on June 21st, 2011 that resulted in 25 deaths and 60 injuries across 10 counties. Past events typically affected multiple counties or the entire state (NCEI, 2018).

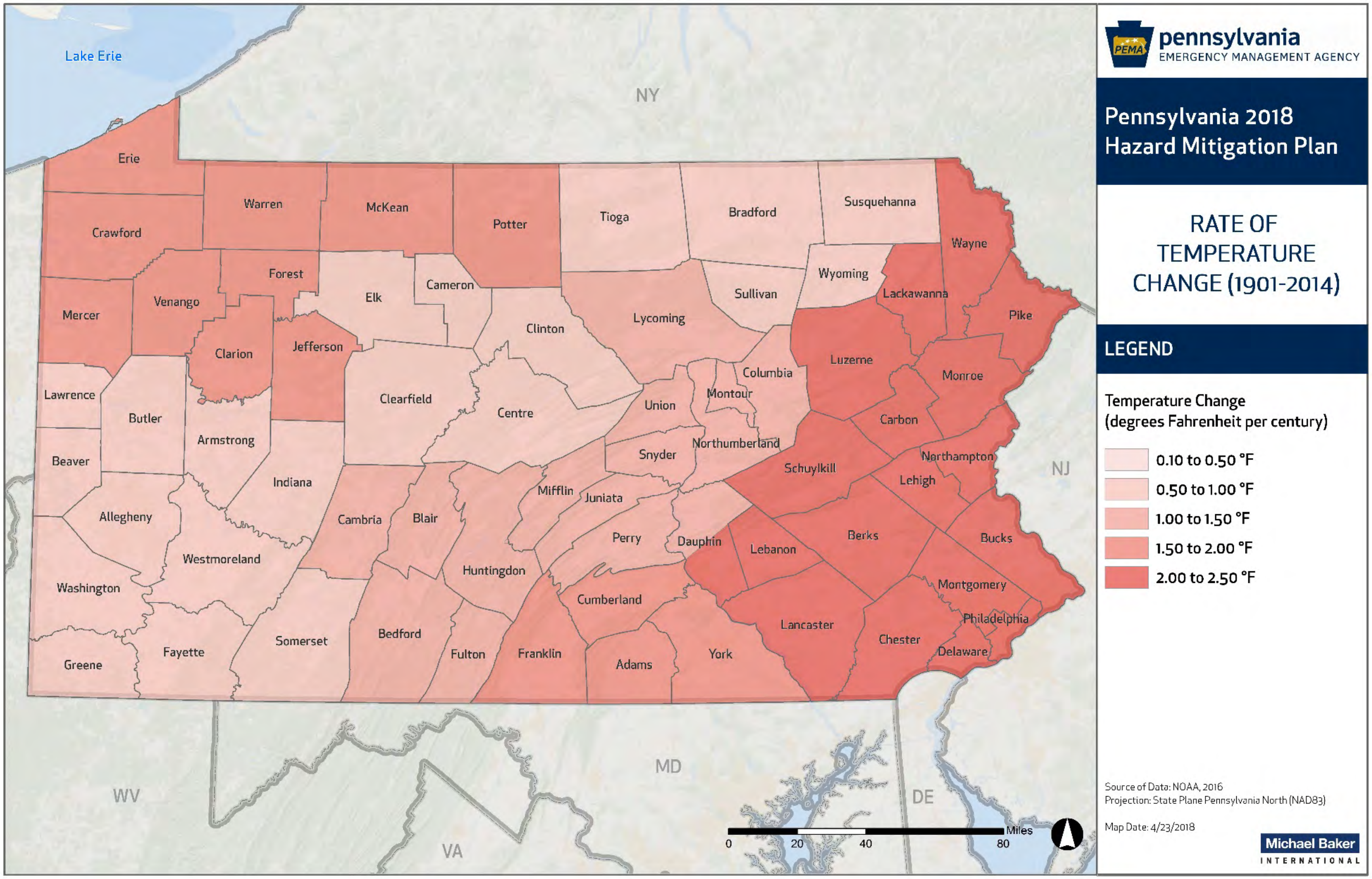
Pennsylvania was also the impetus for national action on extreme heat hazards. PEMA teamed with NOAA and the National Weather Service to develop the excessive heat descriptions and action thresholds that are now used nationwide.

4.3.4.4. Future Occurrence

Figure 4.3.4-4 shows how annual average air temperatures have changed in all Pennsylvania counties since 1901 based on data from the National Oceanic and Atmospheric Administration (NOAA, 2016). The highest rate of change is in the eastern and southeastern part of the state with a change of between 2 and 2.5°F, while counties by Lake Erie have changed 1.5-2°F. Extreme temperatures mirror this pattern with the highest number of heat waves (Figure 4.3.4-2) and lowest number of cold waves (Figure 4.3.4-1) occurring in the southeast from 2005-2017

(NOAA 2016). The northernmost counties have the highest number of cold waves in the state. These trends are predicted to continue and intensify with the changing climate. In the highly urbanized southeast, the urban heat island effect is also a factor in extreme temperatures as increases in concrete/asphalt and reductions in green canopy result in urbanized areas registering a higher temperature than surrounding, vegetated suburban and rural areas.

Figure 4.3.4-4 Rate of temperature change in Pennsylvania counties from 1901 to 2014 (NOAA, 2016)



According to the Fourth National Climate Assessment, which utilized the Intergovernmental Panel on Climate Change's Representative Concentration Pathways (RCP) 4.5 and 8.5 scenarios, the annual average temperature across the United States is projected to increase by 2.5°F (RCP 4.5) and 2.9°F (RCP 8.5) by 2021-2050, relative to 1976-2005. For the Northeast the change in annual average temperature is 3.98°F (RCP 4.5) and 5.09°F (RCP 8.5) by 2036-2065 and 5.27°F (RCP 4.5) and 9.11°F (RCP 8.5) by 2071-2100 (Vose et al. 2017).

However extreme temperatures are projected to increase more than average and the number of days above 90°F will rise while heat waves will intensify. There is *very high confidence* in this projection. Specifically, for the Northeast, the coldest day is projected to change by 9.51°F, the warmest day by 6.51°F, with extreme cold waves (a 5-day 1 in 10-year event) increasing by 15.93°F and extreme heat waves (a 5-day 1 in 10-year event) increasing by 12.88°F (Vose et al. 2017). These changes are the difference between the average for 2036-2065 and the average for 1976-2005 under the RCP 8.5 scenario. Very rare extreme events (1 in 20-year) are projected to occur annually for maximum temperatures while minimums will not occur. These changes translate to about 20-30 more days above 90°F and 20-30 fewer days below freezing in the northeastern parts of the United States by mid-century (RCP 8.5) (Vose et al. 2017).

Focusing on Pennsylvania, Figure 4.3.4-5 shows the observed (around 2°F since the beginning of the 20th century) and projected temperature change for a low and high emissions scenario. Much of the warming has been in the winter and spring, along with an increase in the number of warm nights (minimum temperature above 70°F) and decrease in number of cold nights (minimum temperature below 0°F) (Frankson et al. 2017). The annual mean temperature change across the state is projected to be 5.9 to 6.3°F (3.3 to 3.5°C) temperature by 2041-2070 relative to 1971-2000 as modeled by the CMIP5, statistically downscaled (see Figure 4.3.4-6). With these changes, Philadelphia will have temperatures similar to historical Richmond, VA, while Pittsburgh will resemble Washington, DC (Shortle et al. 2015). There is not significant variation with season. It is *highly likely* that extreme temperatures will occur in the future.

Figure 4.3.4-5 Observed and projected temperature change for Pennsylvania (Frankson et al. 2017).

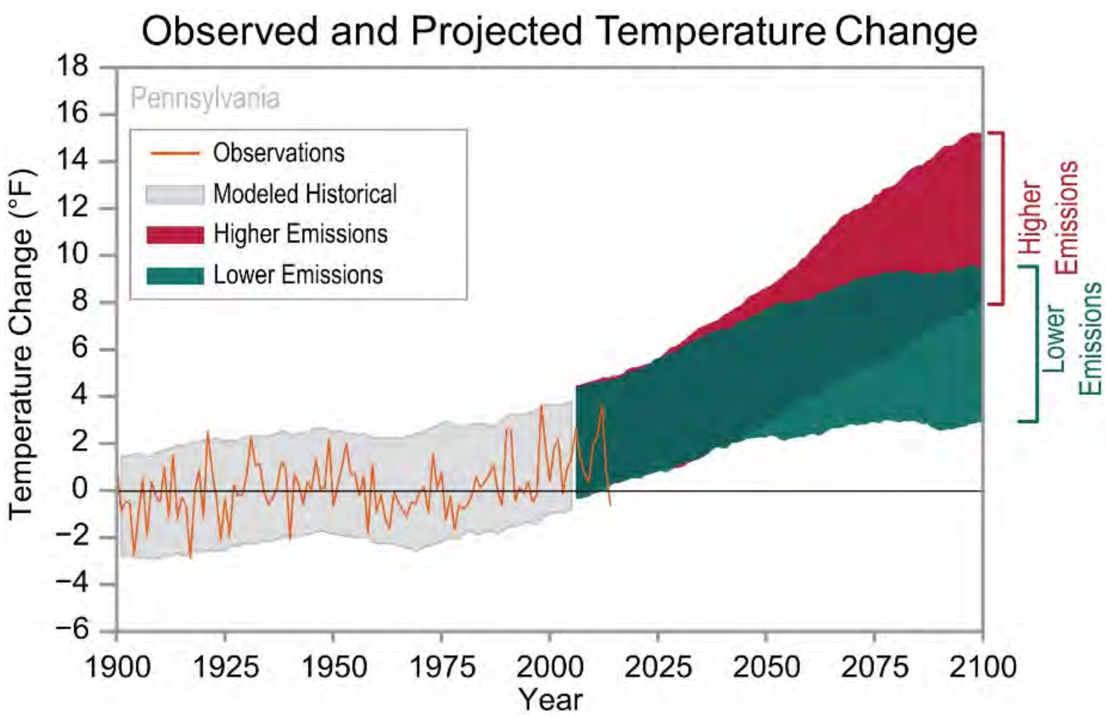
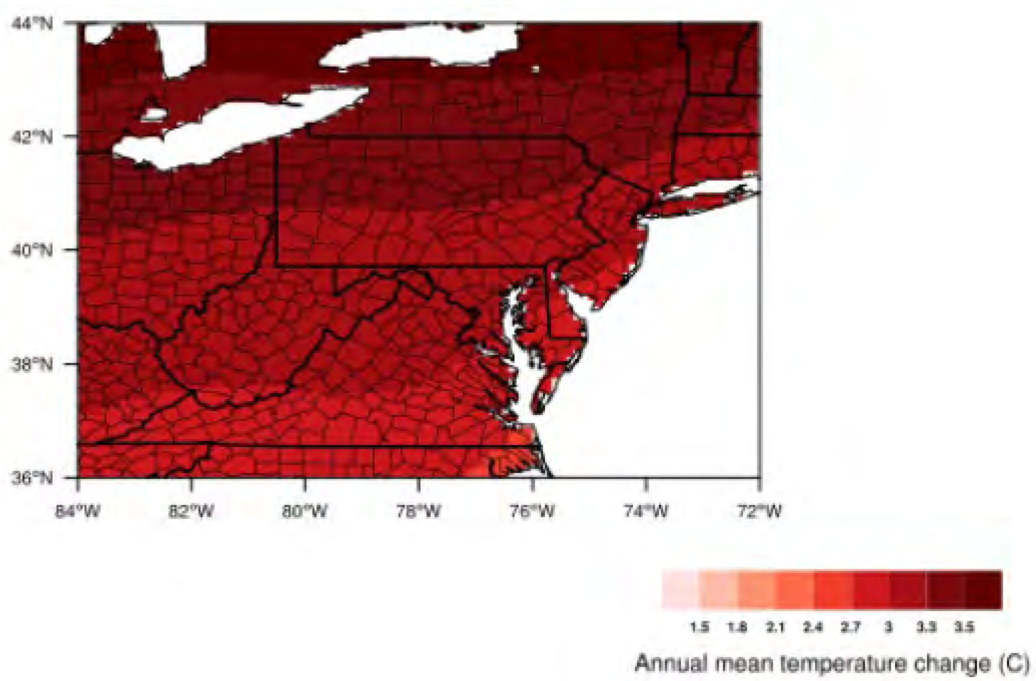


Figure 4.3.4-6 Projections of annual mean temperature by 2041-2070 relative to 1971-2000 for the northeast. Emissions scenario is the IPCC RCP8.5 (Shortle et al., 2015)



4.3.4.5. Environmental Impacts

Temporary periods of extreme hot or cold temperatures typically do not have significant environmental impacts but have serious health impacts, especially in urban areas experiencing the heat island effect. However, prolonged periods of hot temperatures may be associated with drought conditions and can damage or destroy vegetation, dry up rivers and streams, and reduce water quality. Prolonged exposure to extremely cold temperatures can kill wildlife and vegetation.

Extreme temperature events are also known to have an impact on utilities. In times of extreme heat, increased use of air conditioners can cause overload existing utility grids and spur localized or regionalized brownouts. Extreme cold events, especially when coupled with severe winter weather, can cause utility pipes to burst and interrupt the distribution of utilities. Prolonged extreme temperature events can also spur fuel shortages. The impact of extreme temperatures on utilities will depend on the overall use and duration of the event.

4.3.4.6. State Facility Vulnerability Assessment and Loss Estimations

As described in Section 4.1, state and jurisdictional vulnerability assessments were completed by spatially overlaying hazards with census tracts and state critical facility layers in GIS. When spatial analysis determined that the hazard would impact a census tract within a county or the location of state critical facilities these locations where deemed vulnerable to the hazard. Loss estimates were prepared based on the value of the facilities impacted by census tract and by state critical facility. Each hazard uses a methodology that is specific to the type of risk it may cause; Table 4.2.2-2 includes a complete methodology description for vulnerability assessments and loss estimates for each hazard.

Extreme Heat

The vulnerability of state critical facilities was evaluated as facilities located within a census tract that experienced more than 100 heatwave warnings between 2005 and 2017. Using this criterion, a total of 2,208 vulnerable critical facilities have been identified as vulnerable. Due to the large number of schools, fire departments, and dams in the Commonwealth, it is unsurprising that those categories of facilities have the highest totals. Table 4.3.4-1 shows the vulnerability of state critical facilities by facility type. The estimated replacement cost of all state critical facilities at risk from extreme heat hazards is $29,294,255,958, which represents 15 percent of the value of all the state's critical facilities.

Table 4.3.4-1 State Critical Facilities vulnerable to Extreme Heat by Critical Facility Type

STATE CRITICAL FACILITY TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	58	21%
Banking	1	33%
Commercial	16	59%
Communication	64	10%
Dam	438	13%
Education (colleges and universities)	53	33%
Education (public schools)	786	25%

Emergency Operation Center	5	7%
Energy	12	22%
Fire Station	326	12%
Government	2	8%
Hospital	86	25%
National Monument or Icon	4	67%
Nuclear	1	20%
Police Station	179	14%
Transportation	14	19%
Water	163	9%
TOTAL VULNERABLE CRITICAL FACILITIES	***2208***	***16%***

Table 4.3.4-2 shows the state-owned or leased buildings that are vulnerable to extreme heat broken down by department. Of the 4,460 geolocated state facilities, 494, or 11 percent, are located within census tracts that experienced over 100 heatwave warnings between 2005 and 2017. The departments with the most affected structures are the Liquor Control Board, the PA State System of Higher Education, and the Department of Transportation. The estimated replacement cost of all state owned and leased structures at risk from extreme heat hazards is $214,177,622, which represents five percent of the value of all the state's structures.

Table 4.3.4-2 Estimated state-owned or leased buildings vulnerable to extreme heat for each department.

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	3	33%
Department of Agriculture	1	6%
Department of Banking and Securities	1	50%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	18	3%
Department of Education	1	100%
Department of Environmental Protection	1	8%
Department of General Services	24	18%
Department of Health	3	6%
Department of Labor and Industry	12	17%
Department of Military and Veterans Affairs	1	100%
Department of Public Welfare	22	22%
Department of Revenue	3	30%
Department of Transportation	108	6%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	2	1%
Governor's Office	0	0%
Historical and Museum Commission	8	27%

Table 4.3.4-2 Estimated state-owned or leased buildings vulnerable to extreme heat for each department.		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Insurance Department	0	0%
Liquor Control Board	143	26%
Public School Employees' Retirement System	1	17%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	1	25%
State Police	6	17%
State System of Higher Education	135	16%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	**494**	**11%**

Extreme Cold

The vulnerability of state critical facilities was evaluated as facilities that are located within census tracts that experienced more than 32 excessive cold or wind chill warnings between 2005 and 2017. Using this criterion, a total of 1,107 vulnerable critical facilities have been identified as vulnerable, which is about 8 percent of the critical facilities. The most affected critical facilities are dams, fire stations, and water-related facilities. Table 4.3.4-3 shows the vulnerability to extreme cold of state critical facilities by facility type. The estimated replacement cost of all 1107 state critical facilities vulnerable to extreme cold/wind chills is $11,981,078,560, or about 6 percent of the total value of all state critical facilities.

Table 4.3.4-3 State Critical Facilities vulnerable to Extreme Cold by Critical Facility Type		
STATE CRITICAL FACILITY TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Agricultural	8	3%
Banking	0	0%
Commercial	0	0%
Communication	65	11%
Dam	448	13%
Education (colleges and universities)	3	2%
Education (public schools)	120	4%
Emergency Operation Center	8	12%
Energy	0	0%
Fire Station	186	7%
Government	0	0%
Hospital	21	6%
National Monument or Icon	0	0%
Nuclear	0	0%

Table 4.3.4-3 State Critical Facilities vulnerable to Extreme Cold by Critical Facility Type		
STATE CRITICAL FACILITY TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Police Station	72	6%
Transportation	1	1%
Water	175	10%
Total	**1,107**	**8%**

Table 4.3.4-2 shows the state-owned or leased buildings that are vulnerable to extreme heat broken down by department. Of the 4,460 geolocated state facilities, 304, or 7 percent, are located within census tracts that experienced over 100 heatwave warnings between 2005 and 2017. The departments with the most affected structures are the Liquor Control Board, the PA State System of Higher Education, and the Department of Transportation. The estimated replacement cost of all state owned and leased structures at risk from extreme heat hazards is $214,177,622, which represents 5% of the value of all the state's structures.

Table 4.3.4-4 shows the state-owned or leased buildings that are vulnerable to extreme heat broken down by department. Of the 4,460 geolocated state facilities, 304, or 7 percent, are located within census tracts that experienced over 100 heatwave warnings between 2005 and 2017.

The estimated replacement cost of all 1107 state critical facilities located in extreme cold hazard zones is approximately $12.0 million.

Table 4.3.4-4 State-owned or leased buildings vulnerable to Extreme Cold by Department Type		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Attorney General	0	0%
Department of Agriculture	3	19%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	1	50%
Department of Corrections	38	5%
Department of Education	0	0%
Department of Environmental Protection	1	8%
Department of General Services	0	0%
Department of Health	6	13%
Department of Labor and Industry	0	0%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	5	5%

Table 4.3.4-4 State-owned or leased buildings vulnerable to Extreme Cold by Department Type		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Department of Revenue	0	0%
Department of Transportation	167	10%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	22	14%
Governor's Office	0	0%
Historical and Museum Commission	0	0%
Insurance Department	0	0%
Liquor Control Board	21	4%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	0	0%
State Police	2	6%
State System of Higher Education	38	4%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	*304*	***7%***

The estimated replacement cost of all 304 state-owned and leased structures at risk from extreme cold hazards is approximately $86.6 million, which represents 2% of the value of all the state's structures.

4.3.4.7. Jurisdictional Vulnerability Assessment and Loss Estimation

The vulnerability of jurisdictions to extreme temperature differs based on the type of temperature being examined. Extreme heat and extreme cold are the two temperature types being studied

Extreme temperatures do not generally impact buildings; instead, they primarily impact people. In particular, the very old and the very young are vulnerable to temperature extremes. The total number of children and elderly residents in each county can be found in Table 2.3-3. Some hazards, including extreme heat and extreme cold, do not lend themselves to quantifying vulnerable structures and loss estimates. However, an effort was made to identify the locations, structures, and critical facilities that fall in areas expected to experience the highest and lowest temperatures statewide. Future SHMPs will work to better define vulnerability and losses for hazards expected to mainly impact health and social welfare.

Extreme Heat

For this analysis, areas vulnerable to extreme heat have been identified as census tracts that experienced more than 100 heatwave warnings between 2005 and 2017.

As stated in Section 4.3.4.3, during the years 2000-2017, the NCEI reported 35 extreme heat events in Pennsylvania resulting in 90 deaths and 103 injuries. It is evident from past events that extreme heat is dangerous and can cause human related illnesses and death. As temperature goes up so do the number of people hospitalized for heat related illnesses. Therefore, it is important to understand how many people are exposed to such conditions, and how many buildings exist, where potential problems could arise should power be lost. Additionally, extreme heat can cause damage to buildings or contents by overheating HVAC or air-conditioning systems, contributing to jurisdictional losses. It is unlikely that an entire building would be impacted in an extreme heat event, though. Only six counties are vulnerable to extreme heat: Berks, Bucks, Chester, Delaware, Montgomery, and Philadelphia. Table 4.3.4-5 shows potential jurisdictional losses in each of these vulnerable counties. Jurisdictional loss estimates were identified at the tract level and aggregated at the county level to show the possible losses per county. The County most prone to extreme heat is Philadelphia, with the highest populations, buildings and building costs.

Table 4.3.4-5 Vulnerability of people and buildings to extreme heat

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Berks	11,798	5,151	$1,328,939	3%
Bucks	451,190	161,802	$58,739,739	72%
Chester	383,297	134,178	$55,182,123	81%
Delaware	562,316	196,456	$68,420,231	100%
Montgomery	758,534	267,646	$107,400,427	94%
Philadelphia	1,559,938	534,077	$165,970,513	100%
Total	**3,727,073**	**1,299,310**	**$457,041,972**	**31%**

Outside of GIS analysis, the EPA recognizes the urban heat island effect as a contributing factor to extreme heat events. This phenomenon is when areas that have significant amounts of dark or black surfaces, like blacktop and tar roofs, have cumulatively higher temperatures than surrounding communities with open and green space. Philadelphia is recognized as having a heat island and has worked with the EPA on mitigation programs for the heat island such as implementing white/reflective roofs and establishing cooling stations citywide during extreme heat events.

Extreme Cold

Vulnerability for extreme cold was classified being located in a census tract that had more than 32 excessive cold and wind chill warnings between 2005 and 2017. Even though brick-and-mortar structures are not usually impacted by extreme cold, facilities need to be maintained to ensure that they operate in appropriate conditions for people. Nonetheless, facilities need to be maintained to ensure that they operate in appropriate conditions for people.

It is evident from this that extreme cold is dangerous and can cause death. Therefore, it's important to understand how many people are exposed to such conditions, and how many buildings exist, where potential problems could arise should power be lost. Additionally, extreme cold can cause damage to structures; for example, burst pipes will damage buildings and will necessitate repairs. It is unlikely that an entire building would be impacted in an extreme cold event. Jurisdictional loss estimates were identified at the tract level and aggregated at the county level to show the possible losses per county. Table 4.3.4-6 shows potential jurisdictional losses in extreme cold areas Counties most prone to excessive cold and wind chills are Bradford, McKean, Susquehanna, and Tioga, having high populations, buildings and costs associated to building exposure.

Table 4.3.4-6 Vulnerability of people and buildings to excessive cold and wind chills

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSANDS $)	% OF TOTAL BUILDING VALUE
Adams	0	0	0	0%
Allegheny	0	0	0	0%
Armstrong	0	0	0	0%
Beaver	0	0	0	0%
Bedford	0	0	0	0%
Berks	0	0	0	0%
Blair	0	0	0	0%
Bradford	57,936	27,121	$5,338,071	94%
Bucks	0	0	0	0%
Butler	0	0	0	0%
Cambria	0	0	0	0%
Cameron	2,797	3,412	$538,030	60%
Carbon	0	0	0	0%
Centre	0	0	0	0%
Chester	0	0	0	0%
Clarion	0	0	0	0%
Clearfield	14,138	7,088	$1,265,438	16%
Clinton	3,031	3,151	$494,685	13%
Columbia	0	0	0	0%
Crawford	0	0	0	0%
Cumberland	0	0	0	0%
Dauphin	0	0	0	0%
Delaware	0	0	0	0%
Elk	31,111	17,549	$4,163,676	100%
Erie	0	0	0	0%
Fayette	0	0	0	0%
Forest	5,584	3,112	$530,537	40%
Franklin	0	0	0	0%

Table 4.3.4-6	Vulnerability of people and buildings to excessive cold and wind chills			
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSANDS $)	% OF TOTAL BUILDING VALUE
Fulton	0	0	0	0%
Greene	0	0	0	0%
Huntingdon	0	0	0	0%
Indiana	0	0	0	0%
Jefferson	16,179	9,216	$1,732,815	38%
Juniata	0	0	0	0%
Lackawanna	23,470	10,687	$2,503,516	10%
Lancaster	0	0	0	0%
Lawrence	0	0	0	0%
Lebanon	0	0	0	0%
Lehigh	0	0	0	0%
Luzerne	0	0	0	0%
Lycoming	3,419	3,270	$502,693	4%
McKean	42,609	21,145	$4,665,899	100%
Mercer	0	0	0	0%
Mifflin	0	0	0	0%
Monroe	0	0	0	0%
Montgomery	0	0	0	0%
Montour	0	0	0	0%
Northampton	0	0	0	0%
Northumberland	0	0	0	0%
Perry	0	0	0	0%
Philadelphia	0	0	0	0%
Pike	0	0	0	0%
Potter	17,239	13,236	$2,428,053	100%
Schuylkill	0	0	0	0%
Snyder	0	0	0	0%
Somerset	0	0	0	0%
Sullivan	0	0	0	0%
Susquehanna	41,832	22,448	$4,158,351	100%
Tioga	42,031	21,005	$4,033,074	100%
Union	0	0	0	0%
Venango	0	0	0	0%
Warren	7,132	4,286	$763,813	16%
Washington	0	0	0	0%
Wayne	33,534	17,401	$3,685,080	60%
Westmoreland	0	0	0	0%
Wyoming	11,821	5,651	$1,092,920	41%
York	0	0	0	0%

Table 4.3.4-6	Vulnerability of people and buildings to excessive cold and wind chills			
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSANDS $)	% OF TOTAL BUILDING VALUE
Total	353,863	189,778	$37,896,651	3%

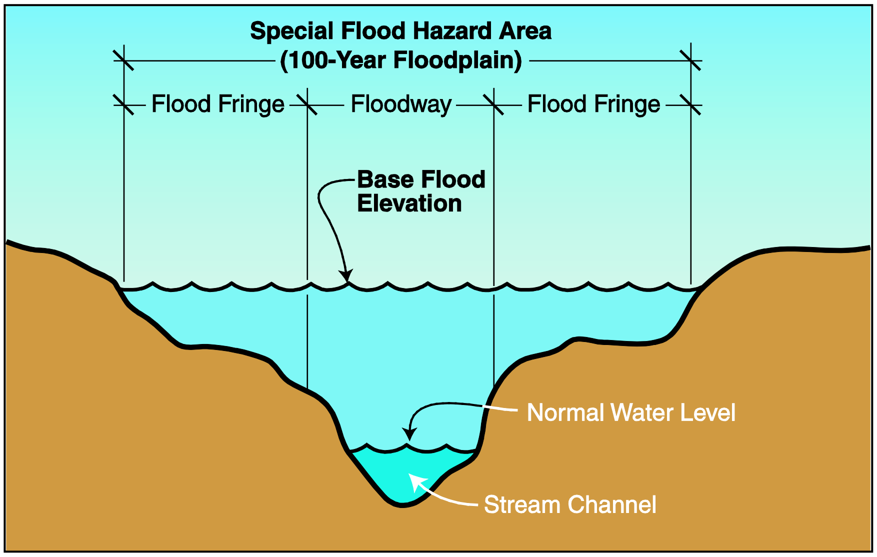
4.3.5. Flood, Flash Flood, Ice Jam

4.3.5.1. Location and Extent

Flooding in Pennsylvania is usually associated with abnormally high and intense rainfall amounts. However, flooding can also be caused by sudden snowmelt, landslides (see Section 4.3.9), dam failures, lock failures, or levee failures. Heavy rainfall events have the potential to produce localized or widespread flooding. Events such as a one-inch cloudburst lasting 30 minutes may affect only a small watershed and be considered insignificant regionally. Large events such as a broad-scale tropical storm lasting more than 24 hours may affect drainage basins several thousand square miles in size. In either case, flood sources in Pennsylvania include rivers, creeks, streams, and lakes. Riverine, as opposed to coastal, flood mechanisms cause most flooding in the Commonwealth. However, portions of southeastern Pennsylvania along the Delaware River are subject to tidal or storm surge flooding. This section focuses on riverine and storm-based flooding, but floods of record caused by hurricanes and dam failures are also mentioned and cross-referenced to the appropriate hazard profile. Also, the role of dams and levees as flood protection methods is mentioned in this section. Please see Sections 4.3.7, 4.3.20, and 4.3.26 to get a full picture of flood impacts as hurricanes, dam failure, and levee failure all impact flooding.

Floodplains found in lowlands, adjacent to rivers, streams, creeks, lakes, or other large water bodies are subject to recurring floods. The size of the floodplain is described by the recurrence interval of a given flood. In assessing the potential spatial extent of flooding, it is important to know that a floodplain associated with a flood that has a 10% annual 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), for which Flood Insurance Rate Maps (FIRM) are published, identifies the 1%-annual-chance flood, which is used to delineate the Special Flood Hazard Area and identify Base Flood Elevations. Figure 4.3.5-1 illustrates these terms.

Figure 4.3.5-1 Diagram Identifying Special Flood Hazard Area, 1%-Annual-Chance (100-Year) Floodplain, Floodway, and Flood Fringe



The Special Flood Hazard Area serves as the primary regulatory boundary used by FEMA and the Commonwealth of Pennsylvania. 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). These maps can be used to identify the expected spatial extent of flooding from a 1%- and 0.2%-annual-chance event. Figure 4.3.5-2 shows the location of Special Flood Hazard Areas throughout Pennsylvania. In Pennsylvania, the 1%-annual-chance zones include A, AE, AH, and AO. Note that there is typically higher uncertainty in the delineation of flood hazard areas in broad, flat floodplains in comparison to areas of steeper topography.

Figure 4.3.5-2 Special Flood Hazard Areas throughout Pennsylvania (FEMA, 2018).

4.3.5.2. Range of Magnitude

Both localized and widespread floods are considered hazards when people and property are affected. Injuries and deaths can occur when people are swept away by flood currents or bacteria and disease are spread by moving or stagnant floodwaters. Most property damage results from inundation by sediment-filled water. 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.

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. Many areas of the Commonwealth have relatively steep topography, which promotes quick and flash surface water runoff. Most storms track from west to east, but some originate in the Great Lakes or Atlantic Ocean. Rapidly changing weather patterns and temperatures may cause large-scale snow-melting events in which ice jams in the receiving streams may aggravate the already serious problem of large water volumes contributed by thousands of small tributaries.

Rainfall in Pennsylvania is about average for the eastern United States. When classified according to amount of precipitation, rainfall can be divided into several categories:

- Very light rain – when precipitation rate is <0.01 inches/hour
- Light rain – when precipitation rate is between 0.01 to 0.04 inches/hour
- Moderate rain – when the precipitation rate is between 0.04 to 0.16 inches/hour
- Heavy rain – when the precipitation rate is between 0.16 to 0.63 inches/hour
- Very heavy rain – when the precipitation rate is between 0.63 to 2 inches/hour
- Extreme rain – when the precipitation rate is >2 inches/hour

While significant flood events are typically associated with very heavy and extreme rain, rainfall events of lesser intensity may also cause flooding given sufficient duration.

Flood effects can be volume- or force-related. Major floods along larger streams having wide floodplains tend to result in large-scale inundations. This causes widespread damage through soaking and silt deposits in homes, businesses, and industrial plants. In hilly regions where runoff paths are steep, flash floods may be prevalent. Flash floods are short in duration and usually occur in a somewhat localized area. In these floods, the velocity rather than the volume of water causes flood damages. Torrents of water can rush down minor hillside gullies at 30 to 50 miles per hour, carrying trees, debris, and rocks. These floods are often unpredictable and, particularly if they occur at night, can cause major panic and loss of life. Frozen surfaces can more than double normal runoff velocities, particularly in small drainage areas. This causes flash floods, which can be compounded by ice and debris jams in channels and culverts. Also, obstructions within the floodplain such as bridges and undersized culverts can also increase flooding.

The worst flooding events experienced in Pennsylvania were the Johnstown Flood of 1889, Tropical Storm Agnes in 1972, and Tropical Storm Lee in 2011. Each of these events are discussed in Section 4.3.5.3 and Tropical Storms Agnes and Lee are also addressed in Section 4.3.7.

4.3.5.3. Past Occurrence

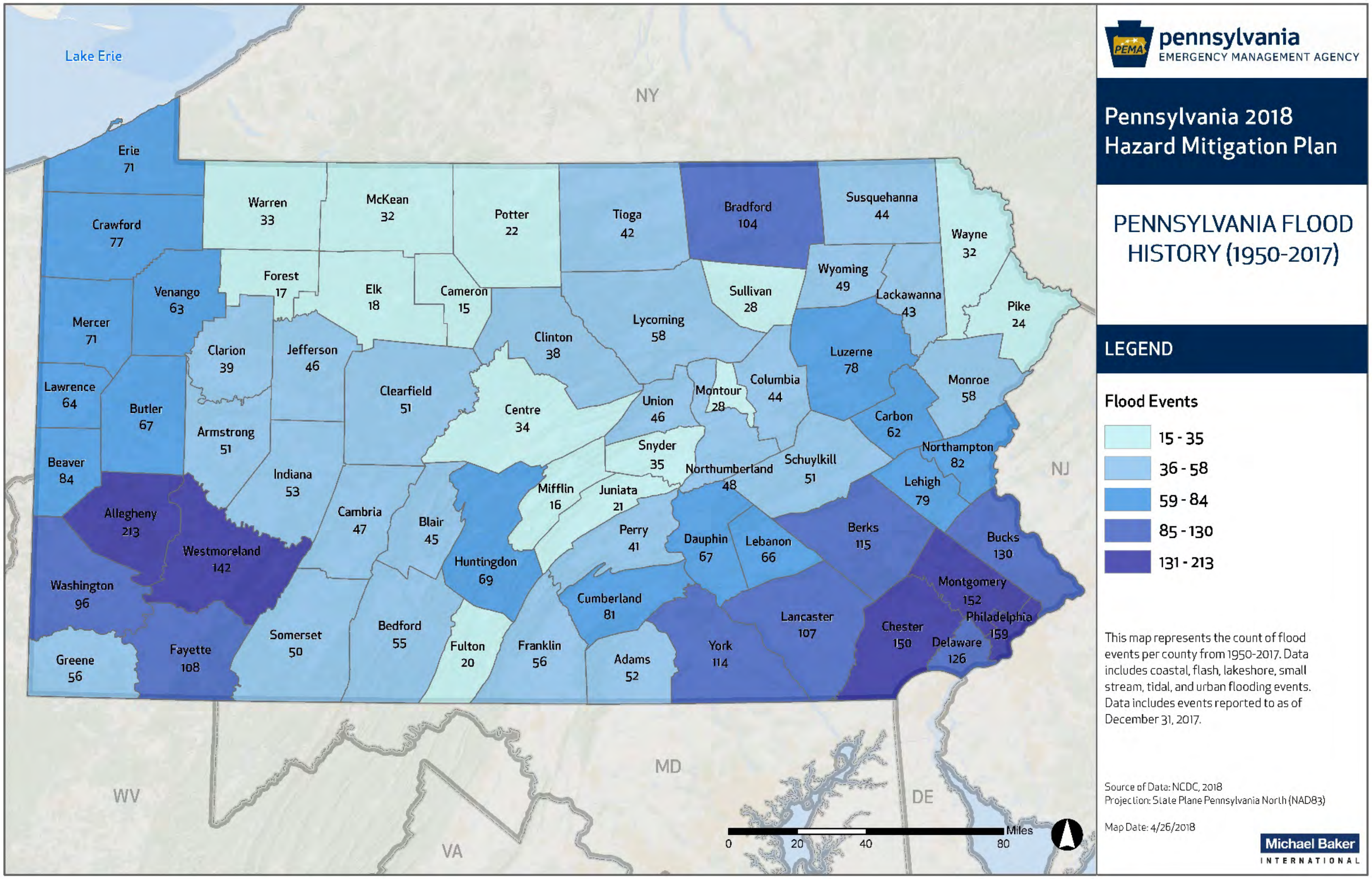
Pennsylvania has a long and continuous history of floods. A significant number of the Presidential Disaster and Emergency Declarations in Pennsylvania have been in response to hazard events related to flooding (see Table 4.2.1-1). Additional declarations issued for hurricane, tropical storm, or severe storm events were likely issued at least in part to flood impacts as well. Together, these events would account for the majority of Disaster and Emergency Declarations in the Commonwealth. Table 4.3.5-1 provides a tabulation of the number of flood events recorded for each county in the Commonwealth between 1950 and 2017. Figure 4.3.5-3 provides this information in map form. Allegheny, Chester, Montgomery, Philadelphia, and Westmoreland Counties have experienced the highest number of events over this 67-year period. A total of 24 counties have 67 events or more, or an average of one flood event per year.

Table 4.3.5-1 Number of Flood Events by County between 1950 and 2017 (NCEI, 2018)

COUNTY	NUMBER OF EVENTS	COUNTY	NUMBER OF EVENTS
Adams	52	Lackawanna	43
Allegheny	213	Lancaster	107
Armstrong	51	Lawrence	64
Beaver	84	Lebanon	66
Bedford	55	Lehigh	79
Berks	115	Luzerne	78
Blair	45	Lycoming	58
Bradford	104	McKean	32
Bucks	130	Mercer	71
Butler	67	Mifflin	16
Cambria	47	Monroe	58
Cameron	15	Montgomery	152
Carbon	62	Montour	28
Centre	34	Northampton	82
Chester	150	Northumberland	48
Clarion	39	Perry	41
Clearfield	51	Philadelphia	159
Clinton	38	Pike	24
Columbia	44	Potter	22
Crawford	77	Schuylkill	51
Cumberland	81	Snyder	35
Dauphin	67	Somerset	50
Delaware	126	Sullivan	28
Elk	18	Susquehanna	44
Erie	71	Tioga	42
Fayette	108	Union	46

Table 4.3.5-1 Number of Flood Events by County between 1950 and 2017 (NCEI, 2018)			
COUNTY	**NUMBER OF EVENTS**	**COUNTY**	**NUMBER OF EVENTS**
Forest	17	Venango	63
Franklin	56	Warren	33
Fulton	20	Washington	96
Greene	56	Wayne	32
Huntingdon	69	Westmoreland	142
Indiana	53	Wyoming	49
Jefferson	46	York	114
Juniata	21	**TOTAL**	**4,335**

Figure 4.3.5-3 Pennsylvania Flood History, 1950 to 2017 (NCEI, 2018).



Previous versions of the SHMP found that approximately 57% flood events occur during the months of June, July, and August. Although most of the major historic Pennsylvania floods have occurred in the summer, occasionally flooding has been caused by a moderate warm winter rain following a deep snow pack. This type of flooding occurred in March 1936 and again in January 1996.

Pennsylvania has one of the most intense recorded rainfall event in the history of the U.S. In August 1942, more than 30 inches fell within a span of five hours near Smethport, a small town near the New York state border in McKean County (Eisenlohr, 1952). Whereas Smethport received the largest rainfall, it was estimated that more than 20 inches fell over a 200 square-mile area between Emporium and Austin. A peak flow rate of 80,000 cubic feet per second was estimated in Sinnemahoning Creek from high-water marks; almost ten times as large as any other flood recorded in that stream. The storm and resulting floods undoubtedly caused a large amount of destruction, but possibly owing to more pressing World War II problems, the event never received a great amount of publicity.

Floods in March 1936 were caused by a large accumulation of snow during a cold January, followed by a steady warming trend in February and rainfall. There was rapid snow and ice melting in almost all major watersheds in Pennsylvania. Ice jams caused enormous back-up effects on bridges, and many cities experienced the highest flood levels ever recorded. In reaction to the severe damages suffered in the 1936 flood, major flood-control structures were built throughout much of Pennsylvania. A more recent flood occurred in January 1996 where water levels in many rivers and municipalities exceeded the March 1936 level and, in some cases, was the second highest flood of record.

In June 1972, Tropical Storm Agnes caused widespread flooding that resulted in the largest total flood damage event in Pennsylvania. The storm lasted between two and three days, during which rainfall varied from four inches in western Pennsylvania up to 20 inches in some regions north of Harrisburg. Most major streams rose to record stages, causing hundreds of millions of dollars in damages in cities such as Wilkes-Barre, Lock Haven, and Harrisburg. In Pittsburgh, the Allegheny and Monongahela Rivers rose to within a few inches of the top of their banks. Pittsburgh avoided major flood damage due to the large capacities of several flood-control reservoirs, notably the Allegheny and Conemaugh. It is estimated that these structures held back a combined volume of over one million acre-feet. In the Susquehanna River watershed, the recently completed Curwensville (Clearfield County), Foster Joseph Sayers (Centre County), and Alvin R. Bush (Clinton County) Dams, together with some older dams, held back a total volume of roughly 250,000 acre-feet. This reduced potential Susquehanna River stages by several feet, but storage volumes were not nearly large enough to prevent flooding in the downstream reaches of the river. Agnes caused 122 deaths, 50 of which were in Pennsylvania. More information regarding Tropical Storm Agnes can be found in Section 4.3.7.

Parts of Crawford, Venango, Clarion, Jefferson, and Forest Counties were devastated during a summer storm on June 9, 1981. Flash flooding occurred with recorded local rainfall totals of 4.5 inches in the City of Franklin and 6.4 inches in Cooperstown. One death and at least $65 million in damages were reported. Two Mile Run and Sage Run in Cranberry Township, Venango

County, were especially hard hit. Flash floods of this kind are not uncommon across the Allegheny Plateau in western Pennsylvania. Similar floods caused by intense rainfall over a limited area occurred include:

- Johnstown Flood of May 1889;
- Johnstown in July 1977 (78 deaths);
- Eastern Pennsylvania in August 1955 (101 deaths);
- East Brady, Armstrong County, in August 1980;
- Hyndman, Bedford County, in August 1984; and
- Northern suburbs of Pittsburgh in May 1986 (eight deaths) and 1987.

Tropical Storm Lee caused catastrophic flooding in eastern and central Pennsylvania in 2011. Hurricane Irene made landfall in the U.S. on August 27, 2011 and again on August 28, dumping between two and eight inches of rain in eastern Pennsylvania, with the worst rain occurring in the Delaware River basin. One and a half weeks later, beginning on September 5, Tropical Storm Lee and its associated heavy rainfall moved through Pennsylvania and New York. With large portions of the Susquehanna River Basin already saturated by Hurricane Irene, Lee's rain caused flash flooding and riverine flooding in and east of the Susquehanna River Valley. The heavy rain broke previous precipitation records set by the former worst-case, Tropical Storm Agnes, and caused multiple new floods of record throughout the state.

Lee/Irene left significant amounts of water over nearly all of central and eastern Pennsylvania with the worst occurring in Northeastern Pennsylvania communities of Towanda, Wilkes-Barre, Bloomsburg, Danville, and Sunbury. According to the NWS, over 2,000 people were evacuated and 3,000 homes and businesses flooded in Bradford County alone. Bradford County's agricultural community was severely damaged with about $7 million in crop damage. In Luzerne County, 60,000 people were evaluated and while the Wyoming Valley levee system held, unprotected communities saw flood depths worse than in Hurricane Agnes. Lee/Irene forced the first ever closure of the Bloomsburg Fair, since fairgrounds were covered in 10-12 feet of water. There were ten fatalities statewide due to the storm: one in Bradford County, four in Dauphin, three in Lancaster, one in Lebanon, and one in Philadelphia. Of these fatalities, half occurred as a result of cars being washed away. The NWS reported at least 23,780 structures as being affected by the event, with over 1,000 completely destroyed and nearly 8,000 substantially damaged. With the event occurring in the active growing season, there was widespread crop damage reported to the Department of Agriculture. The Commonwealth and many county EOCs were activated for extended periods, and the event received both a Presidential Emergency Declaration and a Declaration of Major Disaster. As of May 2012, damages (including debris removal, emergency protective measures, road repair, bridge repair, buildings, utilities, and parks) topped $200 million for this event (NWS, 2012).

Oil City, located in western Pennsylvania, has historically been plagued with ice jams and ice-related flooding more than most other communities throughout the Commonwealth. Records show that events have occurred from as far back as the mid-1800s. These floods have caused extreme hardships for the community and heavy economic and personal losses as well. A floating ice control structure on the Allegheny River and a fixed concrete weir on Oil Creek are designed to eliminate flood-causing ice jams on the Allegheny River at the mouth of Oil Creek. The floating structure on the Allegheny River was installed in 1982 and modified in 1983 at a federal cost of $1,110,000. It has effectively reduced ice formation on the river. The ice control structure on Oil Creek cost approximately $2.3 million and was completed in December 1989. A HMGP award was provided though DR 1898 in 2011 to upgrade the Oil City Ice Boom.

Pennsylvania has not since experienced a large-scale catastrophic flooding event to the scale of damage caused by Tropical Storm Lee in 2011. However, more recent flood events have resulted in significant property damage and deaths. In April 2014, flooding in the greater Philadelphia region caused approximately $4.5 million in property damage. Precipitation totals averaged from 3 to 6 inches, with the highest amounts in the Philadelphia suburbs causing poor drainage and creek and river flooding. Over 1,000 people had to be evacuated from flooded homes and apartments and numerous water rescues and road closures occurred. The Schuylkill River had its highest crest since Tropical Storm Floyd in September of 1999. Other creeks and rivers had their highest crest since Tropical Storm Irene in August of 2011 (NCEI, 2018). In November 2017, a flash flood in Erie County resulted in two fatalities. Thunderstorm formed across the Ohio Valley and southern Great Lakes that moved rapidly east at speeds of 60 to 80 miles per house and produced a measured 3.85 inches of rainfall in the Erie County area. The intensity of the rainfall ultimately overwhelmed storm drainage systems causing significant overland flooding. In Erie, a basement wall collapsed from the water pooling on the outside, trapping and ultimately drowning two residents. The flooding was likely exasperated by the poor drainage, but ultimately it was the torrential nature of the rainfall that caused the damages (NCEI, 2018).

In the last 20 years, flooding impacted Pennsylvania with state-wide declarations in January 1996, Hurricane Floyd in September 1999, Hurricane Isabel/Henri in September 2003, Lee/Irene in 2011, and Sandy in 2012/2013. Flooding impacting another Region of the country resulted in a Proclamation of Emergency for Hurricane Katrina in September 2005 for Pennsylvania to assist with mutual aid and housing evacuees. Since 2007, there have been a total of ten flood-related Disaster and Emergency Declarations, including hurricanes and severe storms, impacting Pennsylvania. In addition, since 1978, there have been 70,129 total claims resulting in nearly $1.2 billion of total losses paid, as shown in Table 4.3.5-2. Based on the total number of claims, the average claims payment over this period is just under $17,000. Figures 4.3.5-4 and 4.3.5-5 show total claims and total claims per 1,000 persons by county, respectively. In both maps, Lycoming County has among the highest number of claims.

Table 4.3.5-2 Historic Flood Insurance Claims and Loss Payments (FEMA, 2018)

COUNTY	TOTAL CLAIMS SINCE 1978	TOTAL LOSSES PAID SINCE 1978
Adams	408	$6,309,785
Allegheny	4,190	$61,964,775
Armstrong	494	$5,503,540
Beaver	768	$11,543,816
Bedford	1,434	$12,752,691

Table 4.3.5-2 Historic Flood Insurance Claims and Loss Payments (FEMA, 2018)		
COUNTY	**TOTAL CLAIMS SINCE 1978**	**TOTAL LOSSES PAID SINCE 1978**
Berks	1,069	$15,127,770
Blair	1,030	$6,978,150
Bradford	860	$22,264,652
Bucks	4,698	$128,997,252
Butler	831	$12,371,288
Cambria	764	$3,104,945
Cameron	79	$561,490
Carbon	92	$395,222
Centre	343	$3,001,709
Chester	1,586	$20,418,569
Clarion	168	$2,540,724
Clearfield	524	$5,145,518
Clinton	910	$7,895,746
Columbia	2,108	$59,913,373
Crawford	406	$1,626,490
Cumberland	1,535	$15,990,358
Dauphin	5,299	$86,584,774
Delaware	2,486	$40,013,226
Elk	291	$7,042,146
Erie	509	$4,834,763
Fayette	714	$8,213,309
Forest	22	$189,836
Franklin	176	$1,015,873
Fulton	14	$282,492
Greene	234	$2,843,930
Huntingdon	542	$9,472,429
Indiana	366	$1,784,709
Jefferson	391	$7,808,008
Juniata	206	$1,080,283
Lackawanna	1,277	$19,277,592
Lancaster	1,955	$27,668,509
Lawrence	139	$1,052,635
Lebanon	971	$15,166,304
Lehigh	949	$9,966,884
Luzerne	3,993	$90,577,407
Lycoming	3,943	$57,528,226
McKean	178	$993,568
Mercer	123	$896,470

Table 4.3.5-2 Historic Flood Insurance Claims and Loss Payments (FEMA, 2018)		
COUNTY	**TOTAL CLAIMS SINCE 1978**	**TOTAL LOSSES PAID SINCE 1978**
Mifflin	502	$4,245,626
Monroe	361	$12,081,725
Montgomery	5,041	$117,662,901
Montour	136	$2,901,513
Northampton	1,294	$43,459,217
Northumberland	1,704	$24,244,653
Perry	757	$7,615,183
Philadelphia	1,087	$19,820,155
Pike	206	$2,860,338
Potter	70	$461,486
Schuylkill	867	$21,627,549
Snyder	944	$12,606,473
Somerset	335	$1,919,971
Sullivan	135	$3,387,799
Susquehanna	416	$10,625,836
Tioga	178	$1,203,424
Union	1,028	$12,594,427
Venango	449	$6,161,253
Warren	145	$1,079,807
Washington	904	$13,977,123
Wayne	212	$4,416,766
Westmoreland	1,309	$13,212,534
Wyoming	1,452	$30,675,709
York	1,522	$15,114,848
TOTAL	**70,129**	**$1,182,657,552**

Figure 4.3.5-4 Total NFIP Claims by County since 1978 (FEMA, 2018).

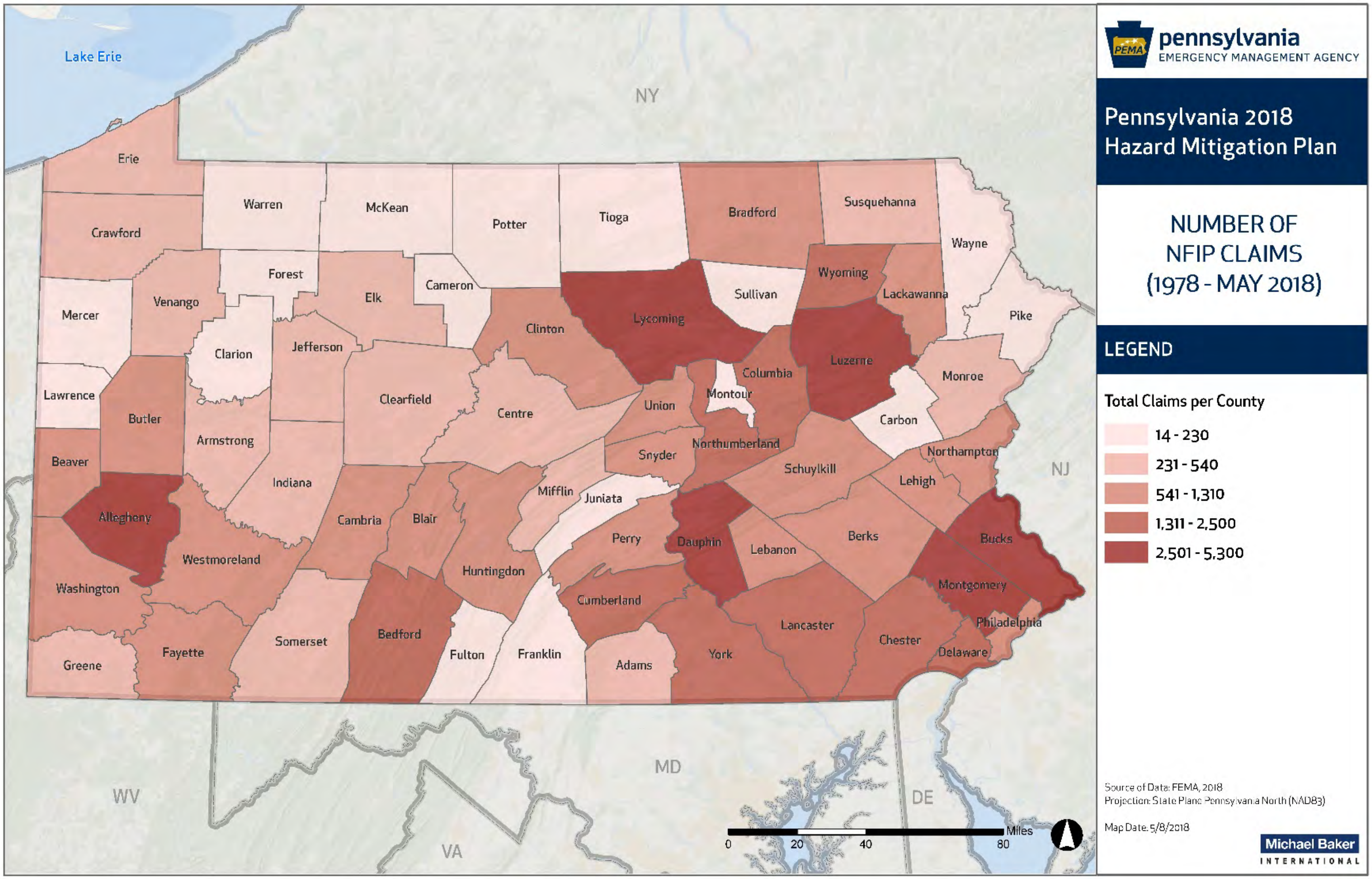
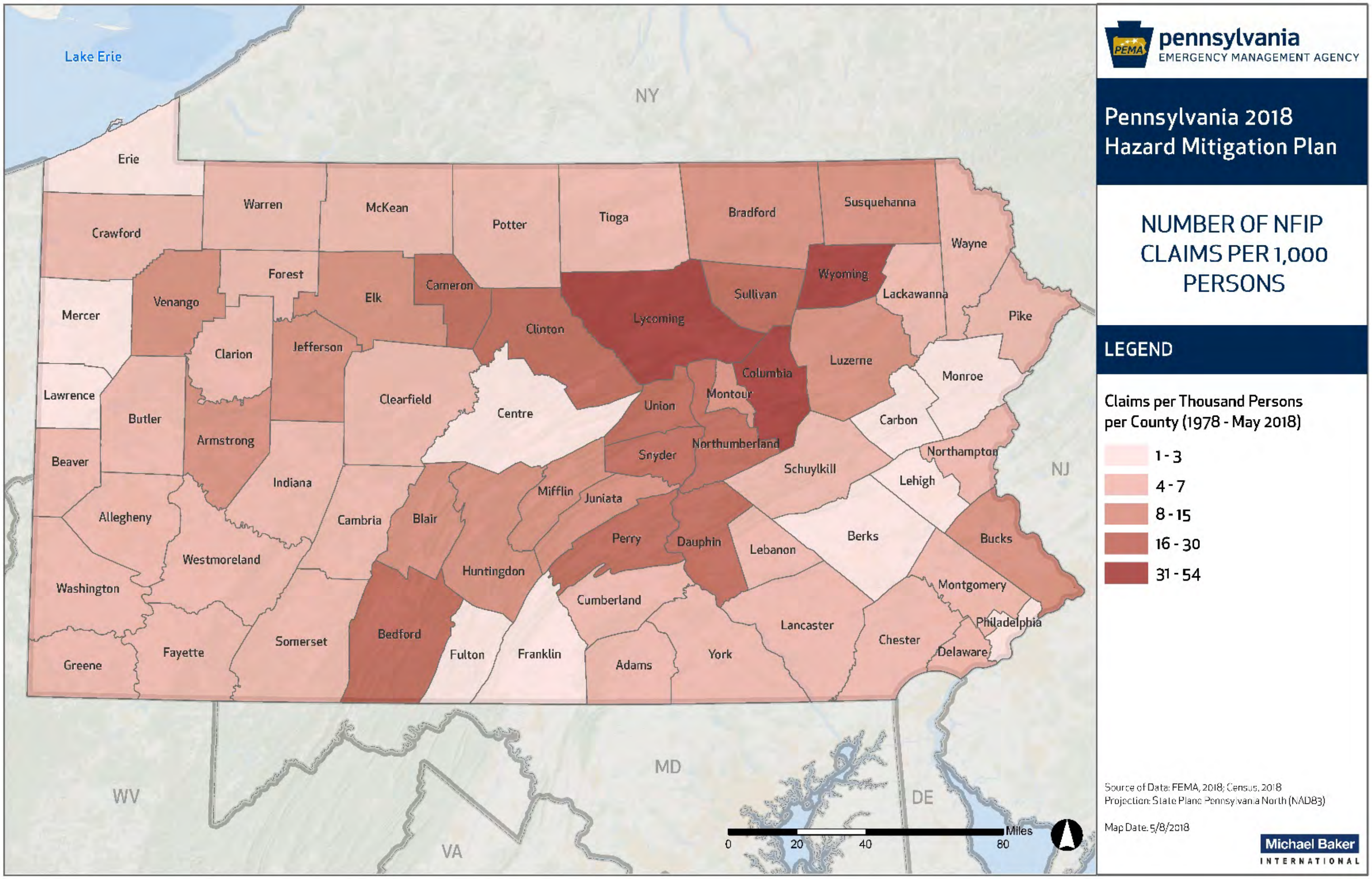


Figure 4.3.5-5 Total NFIP Claims per 1,000 Persons by County since 1978 (FEMA, 2018).

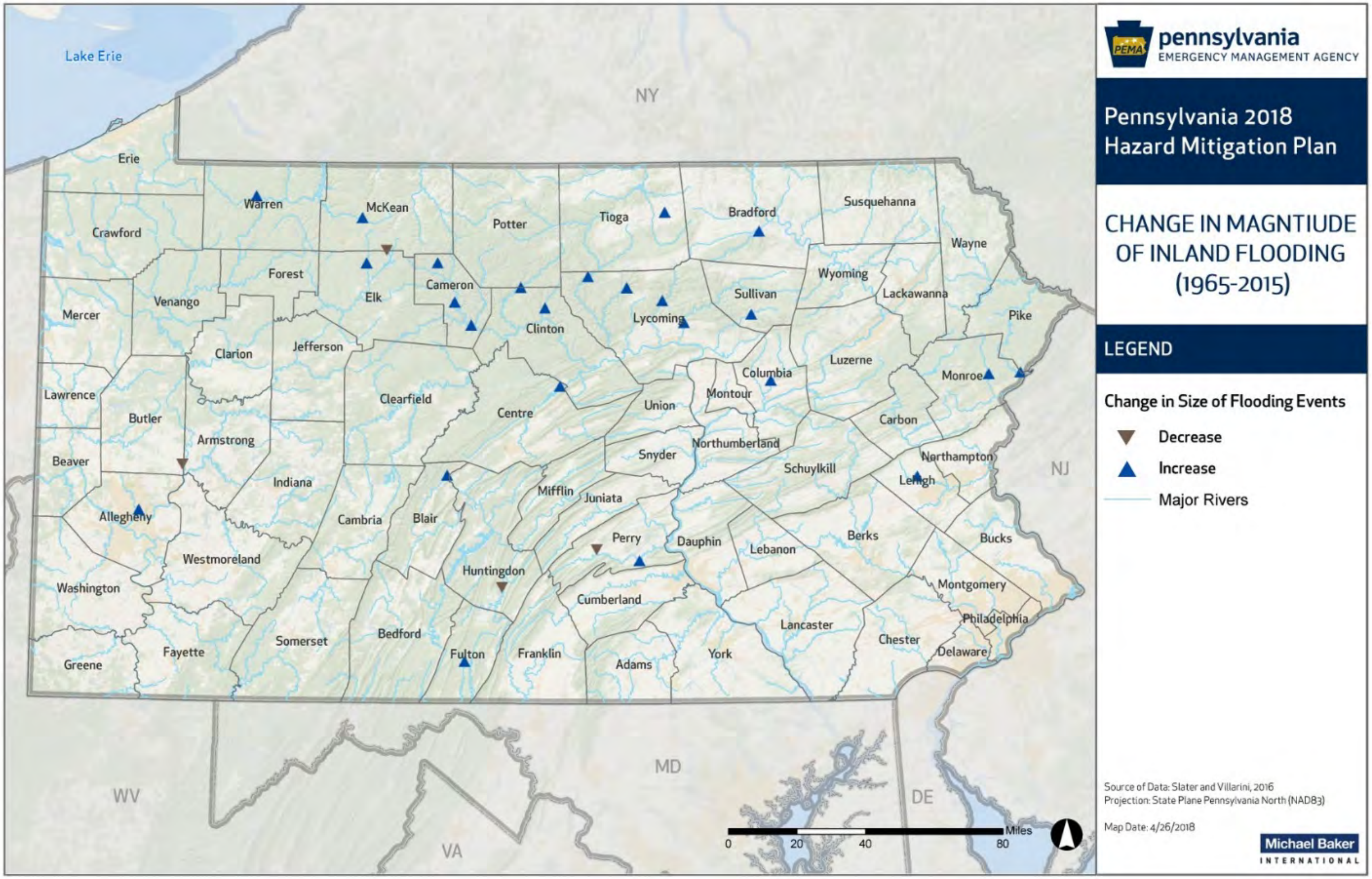


4.3.5.4. Future Occurrence

In Pennsylvania, flooding occurs commonly and can take place 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 such events to happen several years in succession. Floods are described in terms of their extent (including the horizontal area affected and the vertical depth of floodwaters) and related probability of occurrence. Historical records are used to determine the probability of occurrence (percent chance) for a flood of specific extent to occur. The change in magnitude of inland flooding from 1965 to 2015 (Figure 4.3.5-6) shows an increase in flood magnitude for most sites across Pennsylvania.

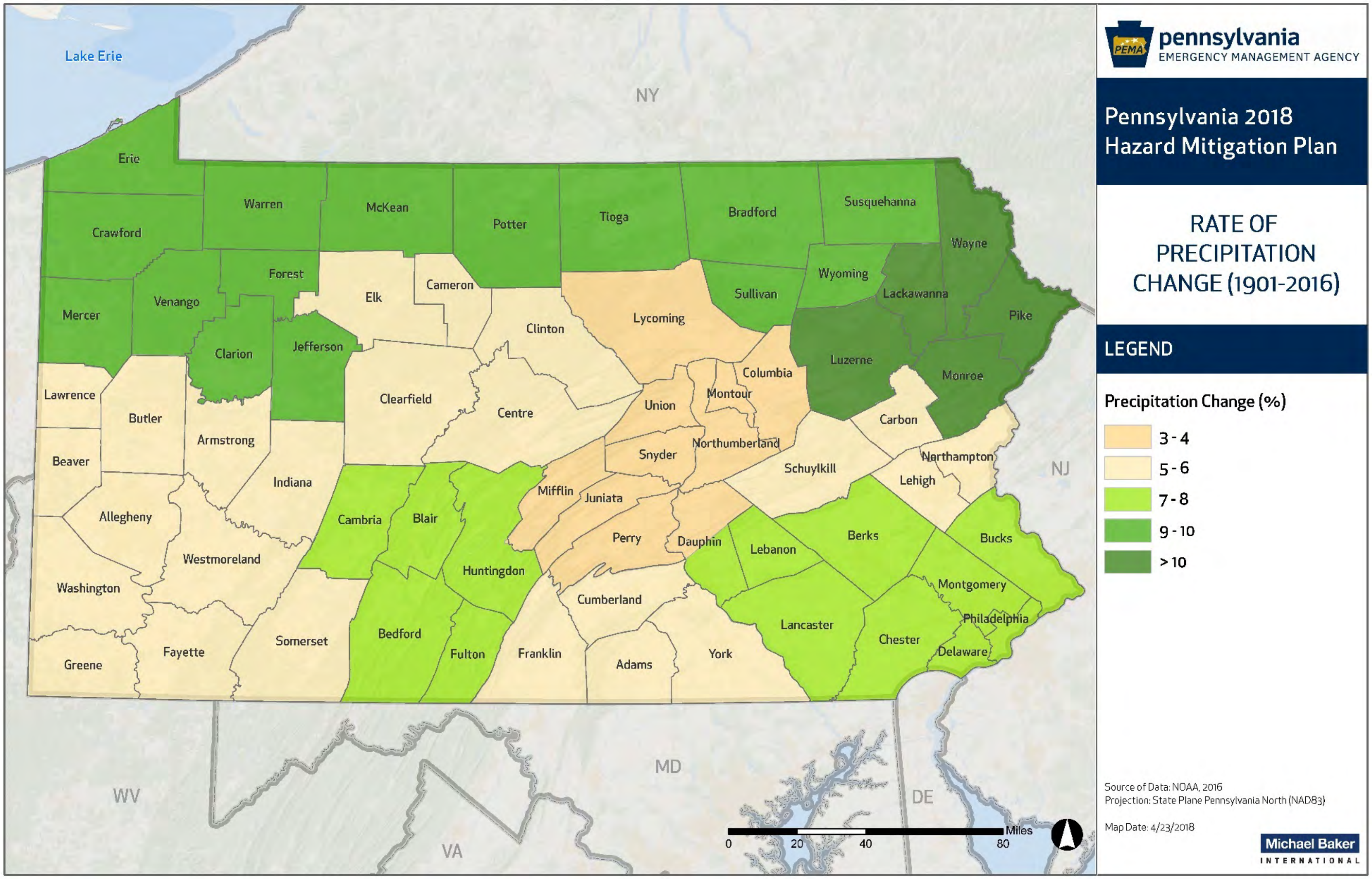
The NFIP recognizes the 1%-annual-chance flood, also known as the *base flood*, as the standard for identifying properties subject to federal flood insurance purchase requirements. A 1%-annual-chance flood is a flood which has a 1% chance of occurring over a given year. FIRMs published by FEMA can be used to identify areas subject to the 1%- and 0.2%-annual-chance flooding. Areas subject to 2%- 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 associated Flood Insurance Study Reports. The most recent Flood Insurance Study for each county in Pennsylvania is available from the FEMA Map Service Center (http://www.msc.fema.gov).

Figure 4.3.5-6 Change in Magnitude of Inland Flooding from 1965-2015 for Pennsylvania



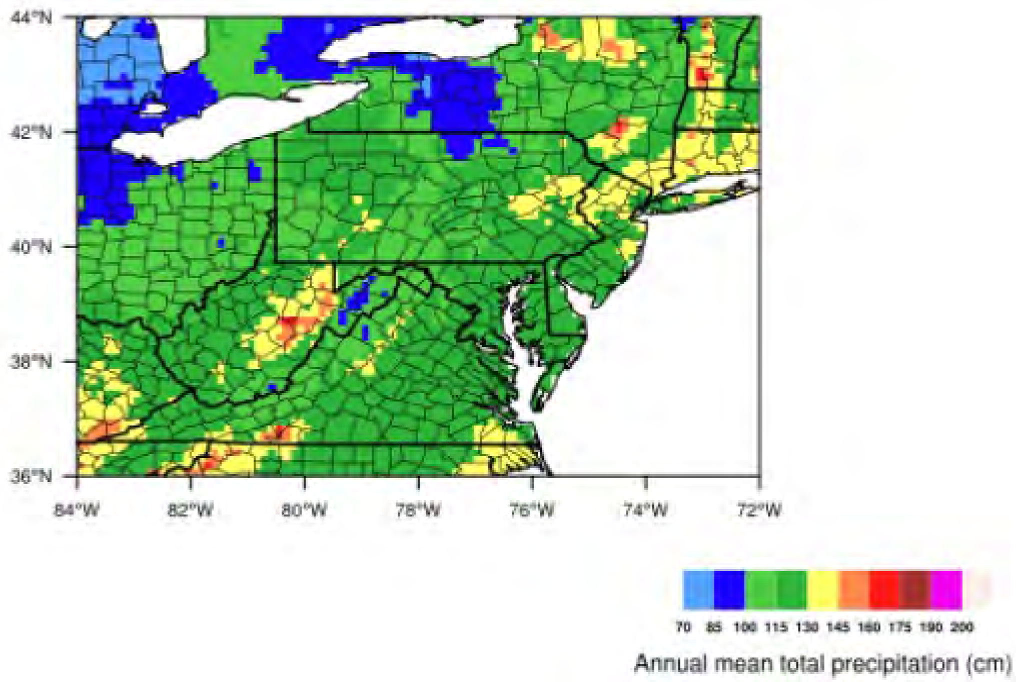
Since heavy precipitation events can be precursors to, or causes of, flooding events, changes to precipitation rates can be illustrative of future potential occurrence of flooding conditions, although this relationship is complex as additional factors including soil moisture and land cover affect flooding occurrence as well. Figure 4.3.5-7 shows the rate of precipitation change from 1901 to 2016. The northeastern counties saw the most change with over 10% precipitation change, while the northern counties had a 9-10% precipitation change, and the southeast had 7-8% change. This is supported by the general increase in precipitation (especially in the form of heavy rainfall events) seen throughout the Northeast. There are also mostly increasing trends in maximum streamflow in the Northeast consistent with the increase in observed extreme precipitation (Wehner et al. 2017). The trend of increased frequency and magnitude of heavy precipitation events is *highly likely* to continue. This is due to the increase in atmospheric water vapor from a warming climate which results in a greater amount of rainfall falling in precipitation events. Globally, annual maximum daily precipitation increased 8.5% since 110 years ago with extreme precipitation events increasing (Easterling et al. 2017).

Figure 4.3.5-7 Rate of Precipitation Change from 1901-2016 for Pennsylvania (NOAA, 2016).



The mean annual precipitation change for the eastern part of the state is projected to be between 10 and 12 percent, while the western half of the state is projected to see 8 to 10 percent increases by 2041-2070 relative to 1971-2000, as modeled with CMIP5 and statistically downscaled under the IPCC RCP8.5 emissions scenario (Shortle et al. 2015). Total annual precipitation projections for 2041-2070 are shown in Figure 4.3.5-6 with the east central areas of the state predicted to have the highest amounts of precipitation.

Figure 4.3.5-8 Projections of Annual Total Precipitation for 2041-2070 from the CMIP5 Statistically Downscaled Model under RCP8.5 Emissions Scenario (Pennsylvania Climate Impact Assessment Update, 2015)



Precipitation is expected to increase in all seasons with large increases in winter (14%) and small increases in summer and fall precipitation (Figure 4.3.5-9). It is highly likely that months of above-normal precipitation will increase (Shortle et al. 2015). Changes to runoff are more uncertain but expected to be a small to zero increase with the exception of the eastern part of the state which may have up to 15-20% increase (Figure 4.3.5-10). With highly likely increases in precipitation and potential significant increases in runoff for the eastern half of the state, it is highly *probable* there will be increased risk of flooding for many Pennsylvania counties in the future especially in the winter and spring months. Consistent with increasing precipitation, the intensity and magnitude of river flooding is also expected to increase.

Figure 4.3.5-9 Annual and Seasonal Precipitation Change by 2041-2070 Relative to Historical from CMIP5 Model Simulations (PA Climate Impacts Assessment Report Update, 2015)

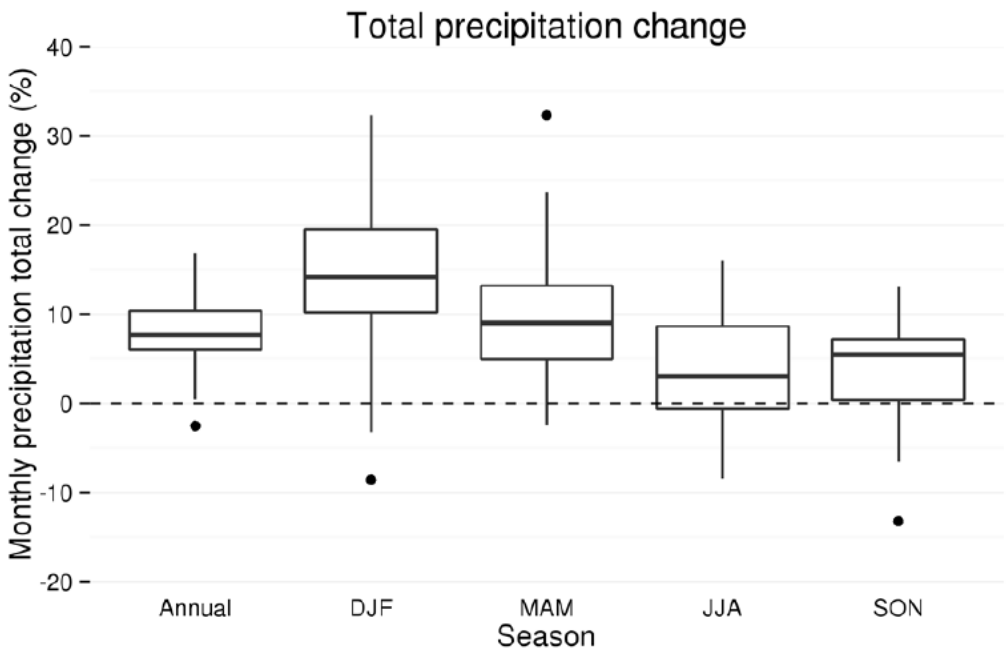
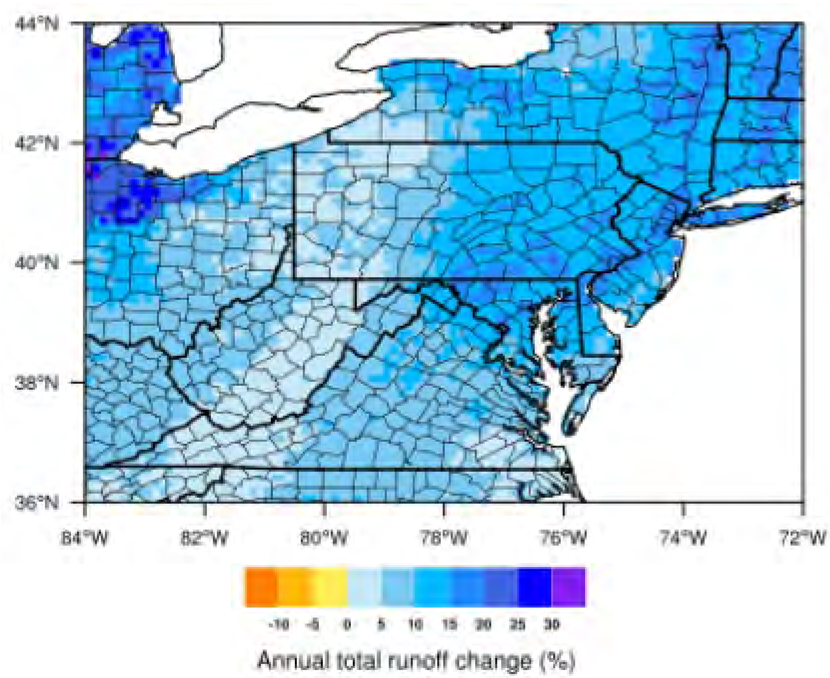


Figure 4.3.5-10 Projected Change in Annual Mean Runoff by 2041-2070 Compared to 1971-2000 from the CMIP5 Statistically Downscaled Model under the RCP8.5 Emissions Scenario (Pennsylvania Climate Impact Assessment Update, 2015)



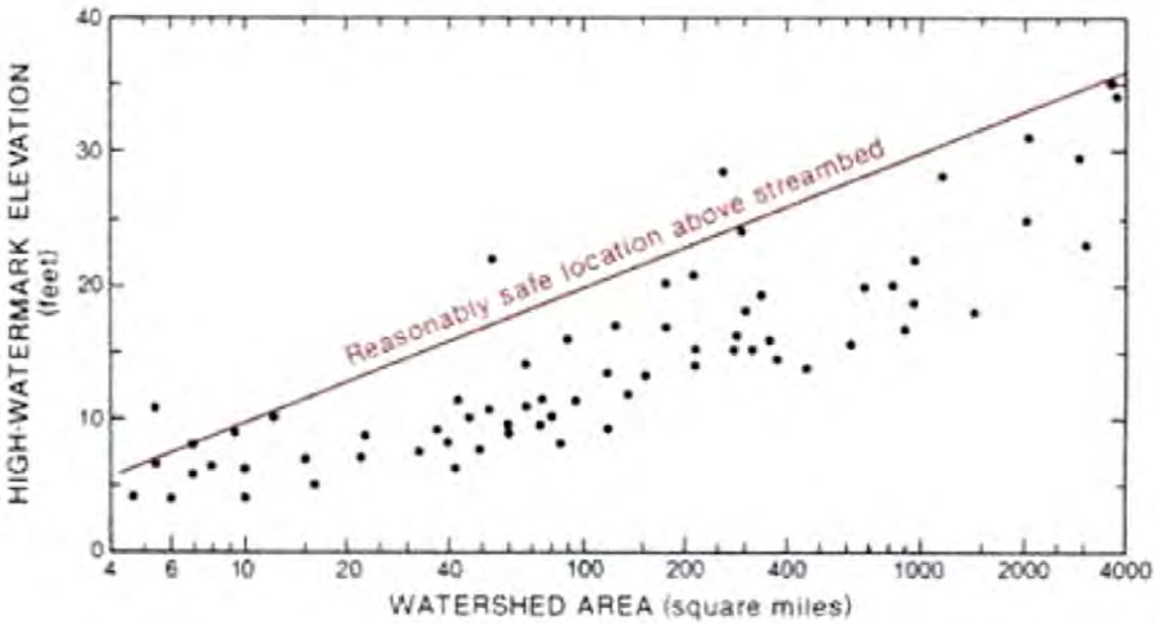
4.3.5.5. Environmental Impacts

Floods are naturally occurring events that benefit riparian systems that have not been disrupted by human actions. Such benefits include groundwater recharge and the introduction of nutrient rich sediment improving soil fertility. However, the destruction of riparian buffers, changes to land use and landcover throughout a watershed, and introduction of chemical or biological contaminants that often accompany human presence cause environmental harm when floods occur. Hazardous material facilities are potential sources of contamination during flood events (see Section 4.3.23). Other environmental impacts of flooding include: water-borne diseases, heavy siltation, erosion of streambanks and riverbeds, destruction of aquatic habitat, damage to water and sewer infrastructure located in floodplains, increased acid mine drainage, damage or loss of crops and drowning of both humans and animals.

4.3.5.6. State Facility Vulnerability Assessment and Loss Estimation

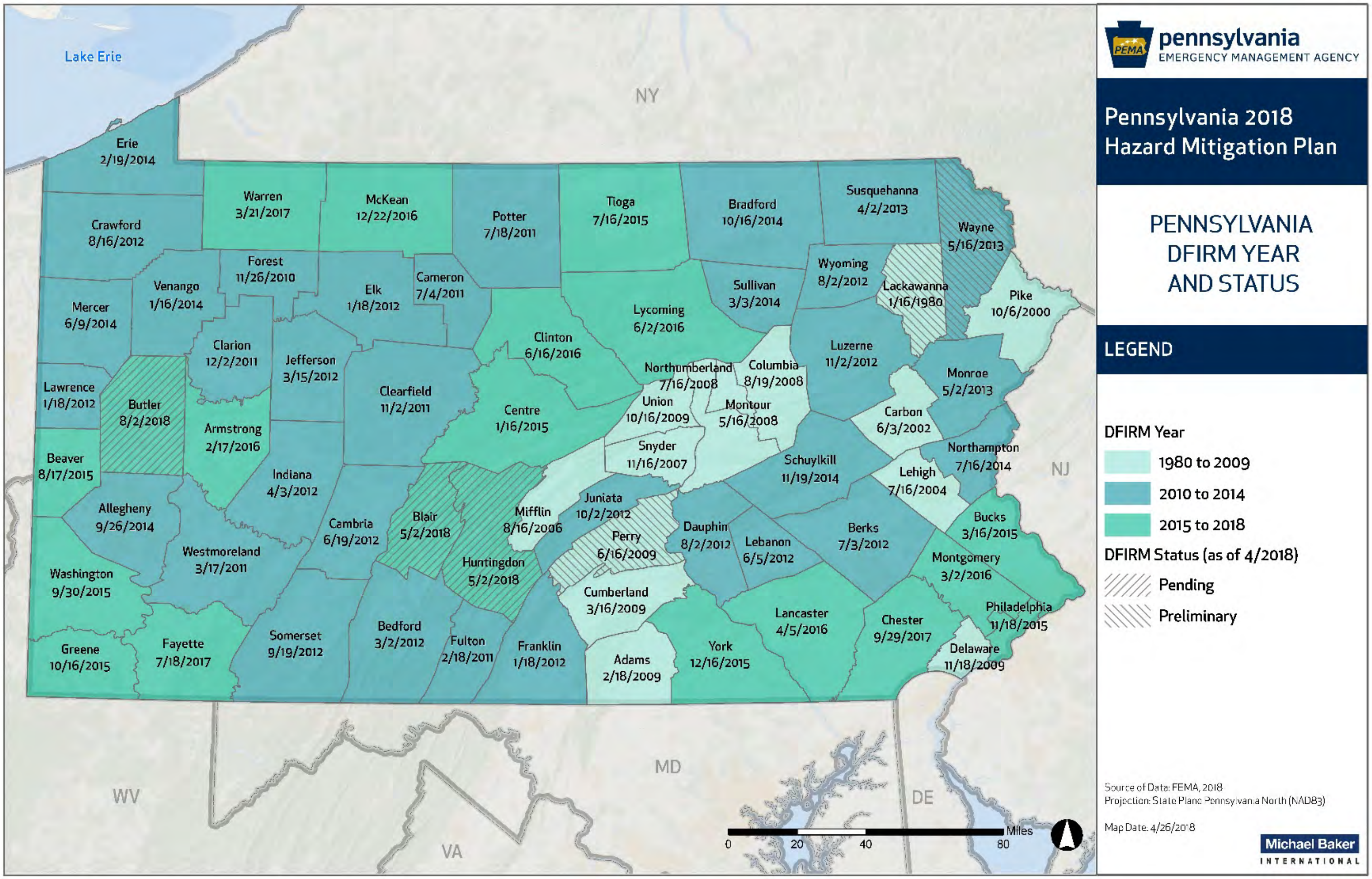
A major concern for any activity near a stream is the area's vulnerability to flooding. While maps identifying the 1%- and 0.2%-annual-chance flood hazard areas, many unmapped floodplain areas are prone to flooding. The potential flooding depth above a streambed depends mostly, but not entirely on the upstream drainage area. The drainage area includes that portion of the watershed that is located upstream from a point of interest, excluding areas subject to the influence of major flood-control dams. Figure 4.3.5-12 shows a plot of historic high watermarks for Pennsylvania floods as a function of watershed area. Using historic high watermark elevations (above streambed), a "reasonably safe" zone can be defined based on the area of a watershed in which a given property is located. For example, a resident of Millerstown in Allegheny County, which occupies about ten square miles of Bull Creek watershed, could feel relatively safe if located ten feet above the streambed, whereas a resident of Chadds Ford in Chester County, which occupies about 290 square miles of the Brandywine Creek watershed, should be located approximately twenty-five feet above the streambed. Note that this graph provides only a rough approximation of flood hazards. Detailed hydraulic and hydrologic analyses are needed to assess the impact of low-permeability soils, steep slopes, and dense urbanization on flood potential for a specific jurisdiction.

Figure 4.3.5-12 Plot of Historic High Watermarks in Pennsylvania vs. Watershed Area



The NFIP recognizes the 1%-annual-chance flood as the standard for identifying properties subject to federal flood insurance purchase requirements. Identifying these special flood hazard areas is essential when determining facilities that are vulnerable to flood. Therefore, the latest available flood information was obtained to assess vulnerability through GIS analysis. The most recent data for each county was collected and included a total of 61 effective FIRMs were used, as well as six pending and preliminary FIRMs. A map of counties and their FIRM status as of April 2018 is presented in Figure 4.3.5-13. Having new FIRM data available nearly statewide adds significant value to communities' ability to discern flood risk. The effective and preliminary FIRM data is based on strong hydrologic and hydraulic modeling and presents a better, more up-to-date reflection of actual flood risk than the original Q3 maps.

Figure 4.3.5-13 FIRM Status by County as of April 2018 (FEMA, 2018).



To assess the vulnerability of state-owned or leased facilities and critical facilities to flooding, all facilities located in areas characterized by high flood hazard were identified. High risk areas are defined as the 1%-annual-chance floodplain as depicted on effective and preliminary FIRMs. Additionally, the potential impact of climate change on the vulnerability of state assets to flood hazards was evaluated for three counties: Allegheny, Lycoming, and Delaware. These three counties were the sample counties selected for Phase 1 of the PennDOT Extreme Weather Vulnerability Study, published in March 2017. The PennDOT study developed planning-level estimates of the increase in the 1%-annual-chance floodplain based on projected climate change impacts on precipitation through 2050 and 2100. For this analysis, the projected increase in the 1%-annual-chance floodplain through 2100 was used to evaluate the potential impacts of climate change on flood vulnerability.

As shown in Table 4.3.5-3, 164 state-owned or leased facilities were identified in the current 1%-annual-chance floodplain. The highest concentration of which are facilities owned or leased by the Department of Transportation. The Liquor Control Board and the State System of Higher Education similarly have a relatively large number of facilities identified in the floodplain. However, state facilities identified as vulnerable to flooding represent only four percent of the total state-owned or leased structures. The replacement value of the 164 total vulnerable facilities is estimated to be about $54.8 million, or 1.4 percent of the value of all state-owned or leased facilities.

Table 4.3.5-3 Vulnerability of state facilities to flood hazard.

DEPARTMENT	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF DEPARTMENT STRUCTURES
Attorney General	1	11%
Department of Agriculture	3	19%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	1	50%
Department of Corrections	3	0%
Department of Education	0	0%
Department of Environmental Protection	1	8%
Department of General Services	1	1%
Department of Health	5	10%
Department of Labor and Industry	6	9%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	5	5%
Department of Revenue	0	0%
Department of Transportation	52	3%
Drug and Alcohol Programs	0	0%

Table 4.3.5-3 Vulnerability of state facilities to flood hazard.		
DEPARTMENT	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF DEPARTMENT STRUCTURES**
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	14	9%
Governor's Office	0	0%
Historical and Museum Commission	4	13%
Insurance Department	0	0%
Liquor Control Board	34	6%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	0	0%
State Police	1	3%
State System of Higher Education	32	4%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	1	50%
Total	**164**	**4%**

Table 4.3.5-4 identifies state-owned or leased facilities in both the current and the projected 1%-annual-chance floodplain in Delaware, Allegheny, and Lycoming Counties. Of the 362 state-owned or leased facilities in Delaware, Allegheny, and Lycoming Counties, 12 are identified as vulnerable to flooding based on the existing floodplain. An estimated 59 additional state facilities are identified as vulnerable to future flood risk; this is a nearly 500 percent increase in the number of vulnerable structures. A total of 46 of the 59 additional facilities identified are those owned or leased by the Department of Corrections. The replacement value of the 12 facilities currently in the floodplain is estimated to be $101,000, or less than one percent of the value of all state-owned or leased facilities in the three counties. The replacement value of the 71 facilities identified as vulnerable to future flood risk is $92,400,410, or 43 percent of the value of all state-owned or leased facilities.

Table 4.3.5-4 Vulnerability of State Facilities to Flooding (Delaware, Allegheny, Lycoming Counties Only)			
DEPARTMENT	**NUMBER OF STRUCTURES**	**NUMBER OF VULNERABLE STRUCTURES TO CURRENT FLOOD RISK**	**NUMBER OF VULNERABLE STRUCTURES TO FUTURE FLOOD RISK**
Attorney General	1	0	0
Department of Agriculture	1	0	0

Table 4.3.5-4 Vulnerability of State Facilities to Flooding (Delaware, Allegheny, Lycoming Counties Only)			
DEPARTMENT	**NUMBER OF STRUCTURES**	**NUMBER OF VULNERABLE STRUCTURES TO CURRENT FLOOD RISK**	**NUMBER OF VULNERABLE STRUCTURES TO FUTURE FLOOD RISK**
Department of Corrections	53	0	46
Department of Environmental Protection	1	0	0
Department of General Services	8	0	0
Department of Health	2	1	1
Department of Labor & Industry	7	0	1
Department of Public Welfare	8	0	2
Department of Revenue	2	0	0
Department of Transportation	169	5	13
Executive Offices	1	0	0
Historical and Museum Commission	3	0	1
Liquor Control Board	100	5	6
Public School Employees' Retirement System	1	0	0
State Employees' Retirement System	1	0	0
State Police	3	0	0
State System of Higher Education	17	1	1
Treasury Department	1	1	1
Total	**362**	**12**	**71**

With respect to critical facilities, the types of facilities most vulnerable to flooding include dams, fire departments, and water facilities (Table 4.3.5-5). Additionally, one nuclear facility was identified as at-risk, which represents 20 percent of the structures for that facility type.

Table 4.3.5-5 Vulnerability of Critical Facilities to Flooding		
TYPE	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF STRUCTURES BY TYPE**
Agricultural	15	5%
Banking	0	0%
Commercial	0	0%
Communication	16	3%
Dam	1,109	32%
Education (colleges and universities)	0	0%
Education (public schools)	40	1%
Emergency Operation Center	2	3%

Table 4.3.5-5 Vulnerability of Critical Facilities to Flooding		
TYPE	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF STRUCTURES BY TYPE
Energy	4	7%
Fire Station	163	6%
Government	0	0%
Hospital	6	2%
National Monuments or Icon	0	0%
Nuclear	1	20%
Police Station	62	5%
Transportation	11	15%
Water	575	32%
Total	**2,004**	**14%**

A total of 2,004 critical facilities were identified in the existing 1%-annual-chance floodplain. The total replacement cost of these critical facilities is estimated to be more than $41 billion, or 21 percent of the total value of all critical facilities in the Commonwealth.

Table 4.3.5-6 identifies critical facilities in both the current and the projected 1%-annual-chance floodplain in Delaware, Allegheny, and Lycoming Counties. Of the 1,471 critical facilities in Delaware, Allegheny, and Lycoming Counties, 86 are identified as vulnerable to flooding based on the existing floodplain and 111 are identified as vulnerable to future flood risk. This represents a 29 percent increase in the number of vulnerable structures. The types of facilities most vulnerable to projected future flood risk remain the dams, fire stations, and water facilities.

Table 4.3.5-6 Vulnerability of Critical Facilities to Flooding (Delaware, Allegheny, Lycoming Counties Only)			
TYPE	NUMBER OF STRUCTURES	NUMBER OF VULNERABLE STRUCTURES TO CURRENT FLOOD RISK	NUMBER OF VULNERABLE STRUCTURES TO FUTURE FLOOD RISK
Agricultural	22	3	3
Banking	1	0	0
Commercial	6	0	0
Communication	70	1	1
Dam	159	18	20
Education (colleges and universities)	25	0	0
Education (public schools)	449	2	4
Emergency Operation Center	3	0	0
Energy	3	1	1

Table 4.3.5-6 Vulnerability of Critical Facilities to Flooding (Delaware, Allegheny, Lycoming Counties Only)			
TYPE	NUMBER OF STRUCTURES	NUMBER OF VULNERABLE STRUCTURES TO CURRENT FLOOD RISK	NUMBER OF VULNERABLE STRUCTURES TO FUTURE FLOOD RISK
Fire Station	348	13	25
Government	2	0	1
Hospital	52	1	1
Police Station	178	9	11
Transportation	15	4	4
Water	138	34	40
Total	**1,471**	**86**	**111**

The replacement value of the 86 critical facilities currently at risk to flooding is estimated to be about $2.6 billion, or 13 percent of the value of all critical facilities in Delaware, Allegheny, and Lycoming Counties. With the additional 25 critical facilities identified in the projected 1%-annual-chance floodplain, the estimated replacement value of total structures exposed to future flood risk increases to approximately $3.0 billion, or 15 percent of the value of all critical facilities in the three counties.

4.3.5.7. Jurisdictional Vulnerability Assessment and Loss Estimation

The 2018 Plan incorporates a Statewide Level 2 Hazus Flood Study. A Level 2 Hazus study is defined as one in which the user supplements the Hazus default data with more recent, more local, and/or more accurate data. For this Level 2 analysis, the latest available FEMA flood maps and the best available ground elevation data were used to derive local flood depths. In addition, the default Hazus inventory for essential facilities was replaced with a more accurate inventory derived from the Department of Homeland Security's Homeland Infrastructure Foundation-Level Data (HIFLD).

As discussed in Section 4.1.4, Hazus measures social impact in terms of displaced households and shelter requirements, and economic impact in terms of 1) direct building losses and 2) business interruption losses. Direct building losses consist of the damage to structures and their contents, while business interruption losses consist of the relocation expenses, employee wage loss, business income loss, and rental income loss that accrue during the time that a business remains inoperable. For more information on the data and methodology used in this analysis, see Section 4.1.4.

Estimated total economic losses for a 1%-annual-chance flood event across the entire Commonwealth sum to $22,475,430,000, of which $22,329,310,000 are building-related losses. The 1%-annual-chance flood simulation estimated the displacement of 110,336 households and a corresponding shelter requirement of 158,820 people. Allegheny and Montgomery Counties are expected to see the highest total economic loss in a 1% annual-chance flood event, while Fulton County is expected to experience the least. This data is also mapped in Figure 4.3.5-14.

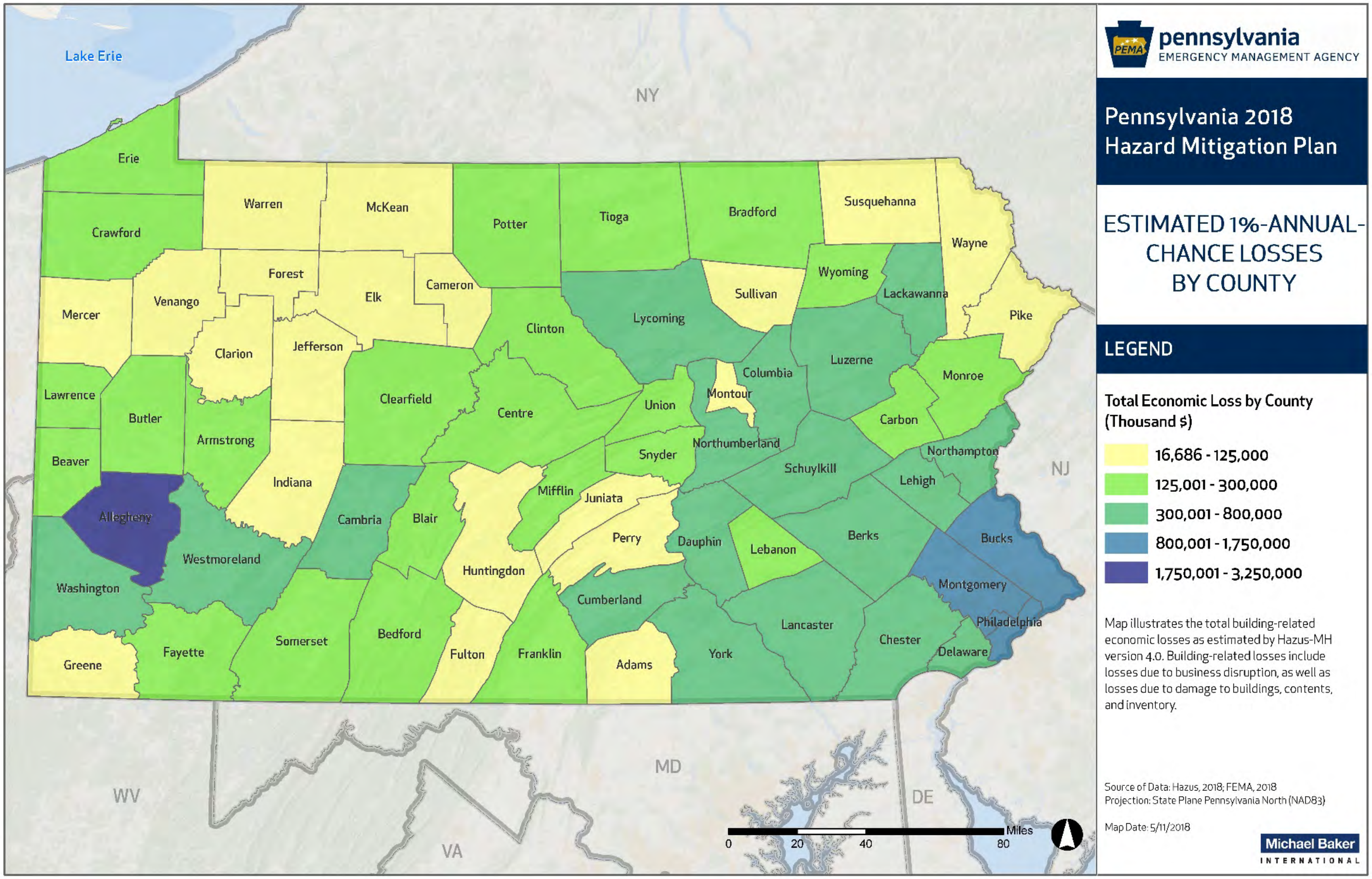
Table 4.3.5-7 Potential social and economic losses due to flood hazards (1%-annual-chance flood).					
COUNTY	**NO. OF BUILDINGS AT LEAST MODERATELY DAMAGED**	**HOUSEHOLDS DISPLACED**	**SHELTER REQUIREMENTS (PEOPLE)**	**TOTAL ECONOMIC LOSSES (MILLION $)**	**DIRECT BUILDING LOSSES (MILLION $)**
Adams	78	934	629	86.18	85.99
Allegheny	2,127	5,935	9,351	3,218.16	3,188.22
Armstrong	663	1,634	2,745	223.47	222.13
Beaver	235	1,072	1,250	218.92	217.63
Bedford	347	1,387	1,074	143.73	143.34
Berks	488	2,702	3,074	395.84	393.84
Blair	356	2,087	2,899	157.09	156.07
Bradford	412	1,715	2,266	166.28	164.57
Bucks	1,726	5,423	9,915	1,013.18	1,007.26
Butler	367	1,283	1,617	184.24	182.98
Cambria	853	2,023	3,215	770.80	763.99
Cameron	254	378	636	66.23	66.06
Carbon	219	608	938	126.90	126.50
Centre	313	1,461	1,653	198.82	198.07
Chester	531	3,566	4,172	642.04	639.84
Clarion	45	170	103	42.46	42.14
Clearfield	246	1,125	1,101	157.28	155.46
Clinton	652	1,661	2,564	299.85	297.21
Columbia	417	1,332	1,855	412.24	408.97
Crawford	723	1,598	2,115	262.35	260.81
Cumberland	570	1,955	3,006	306.26	304.74
Dauphin	975	3,300	6,095	741.72	735.92
Delaware	1,323	4,137	7,788	799.55	795.17
Elk	143	433	433	92.67	91.97
Erie	133	1,219	1,056	184.42	183.67
Fayette	280	1,403	1,444	197.97	195.69

Table 4.3.5-7 Potential social and economic losses due to flood hazards (1%-annual-chance flood).					
COUNTY	**NO. OF BUILDINGS AT LEAST MODERATELY DAMAGED**	**HOUSEHOLDS DISPLACED**	**SHELTER REQUIREMENTS (PEOPLE)**	**TOTAL ECONOMIC LOSSES (MILLION $)**	**DIRECT BUILDING LOSSES (MILLION $)**
Forest	154	91	60	37.85	37.70
Franklin	292	1,888	2,447	156.33	155.55
Fulton	22	183	54	16.69	16.65
Greene	56	638	351	84.73	84.32
Huntingdon	250	1,150	1,294	114.98	114.15
Indiana	175	1,039	1,177	115.28	113.94
Jefferson	140	585	612	88.40	88.07
Juniata	94	752	814	91.94	91.79
Lackawanna	1,012	2,642	5,188	560.24	555.17
Lancaster	661	4,064	4,740	558.06	555.85
Lawrence	139	628	710	201.48	199.92
Lebanon	275	1,119	1,487	149.31	148.89
Lehigh	582	2,005	3,262	394.60	393.46
Luzerne	1,237	3,076	5,015	577.85	574.03
Lycoming	1,326	3,324	5,548	743.63	740.38
McKean	177	972	1,276	100.48	99.75
Mercer	91	710	831	117.89	116.86
Mifflin	273	953	1,259	148.62	147.11
Monroe	281	1,092	1,295	176.96	176.22
Montgomery	2,067	5,286	8,941	1,729.79	1,722.05
Montour	21	287	175	41.96	41.65
Northampton	547	1,721	2,507	318.41	317.36
Northumberland	698	1,837	2,696	389.23	387.66
Perry	165	852	787	110.51	109.87
Philadelphia	1,591	4,171	11,343	1,214.13	1,207.26
Pike	96	238	286	47.59	47.49

Table 4.3.5-7 Potential social and economic losses due to flood hazards (1%-annual-chance flood).

COUNTY	NO. OF BUILDINGS AT LEAST MODERATELY DAMAGED	HOUSEHOLDS DISPLACED	SHELTER REQUIREMENTS (PEOPLE)	TOTAL ECONOMIC LOSSES (MILLION $)	DIRECT BUILDING LOSSES (MILLION $)
Potter	292	758	782	153.81	152.57
Schuylkill	878	2,354	3,378	390.38	387.72
Snyder	186	749	827	148.66	147.81
Somerset	232	1,149	1,056	167.64	166.56
Sullivan	59	128	59	18.14	18.06
Susquehanna	172	831	864	71.80	71.25
Tioga	274	1,192	1,391	127.03	126.65
Union	364	1,204	2,052	181.06	179.60
Venango	106	403	463	63.76	63.45
Warren	450	893	1,056	112.74	111.55
Washington	666	2,446	3,085	529.30	525.66
Wayne	41	309	82	52.32	52.19
Westmoreland	757	2,962	3,070	517.92	512.99
Wyoming	220	633	595	144.79	143.65
York	408	2481	2911	400.49	398.21
TOTAL	**32,003**	**110,336**	**158,820**	**22,475.43**	**22,329.31**

Figure 4.3.5-14 Hazus-Calculated Loss Estimates by County (Hazus, 2018).



As discussed in Section 4.1.3, the 2018 SHMP recognized the importance of protecting not just lives and property, but sense of place as well. To this end, historic buildings were also included in the assessment of jurisdictional vulnerability to flooding. The data source and definition of historic buildings is described further in Section 4.1.3. Table 4.3.5-8 shows the number and percent of historic buildings in each county located in FEMA's 1%-annual-chance floodplain. A total of 936 historic buildings are subject to high flood hazard. Chester, Lancaster, Berks, and Montgomery counties have the largest numbers of historic buildings vulnerable to flooding, with 97, 70, 59, and 51 vulnerable historic buildings, respectively. In addition, in some counties more than a quarter of all historic buildings lie in the 1-percent-annual-chance floodplain. These counties include Cambria, Franklin, and Huntington.

Table 4.3.5-8 Vulnerability of historic buildings to floods (PHMC, as of June 14, 2018).

COUNTY	AT-RISK HISTORIC BUILDINGS	% OF COUNTY HISTORIC BUILDINGS
Adams	7	13%
Allegheny	34	7%
Armstrong	6	25%
Beaver	3	6%
Bedford	13	24%
Berks	59	23%
Blair	11	22%
Bradford	5	16%
Bucks	43	14%
Butler	9	19%
Cambria	19	32%
Cameron	2	40%
Carbon	4	20%
Centre	17	21%
Chester	97	21%
Clarion	1	9%
Clearfield	5	25%
Clinton	6	35%
Columbia	5	20%
Crawford	5	14%
Cumberland	23	21%
Dauphin	21	14%
Delaware	25	13%
Elk	3	13%
Erie	1	1%
Fayette	10	8%
Forest	1	17%
Franklin	30	28%

Table 4.3.5-8 Vulnerability of historic buildings to floods (PHMC, as of June 14, 2018).		
COUNTY	AT-RISK HISTORIC BUILDINGS	% OF COUNTY HISTORIC BUILDINGS
Fulton	5	38%
Greene	11	24%
Huntingdon	13	26%
Indiana	3	7%
Jefferson	2	9%
Juniata	3	33%
Lackawanna	10	11%
Lancaster	70	21%
Lawrence	7	28%
Lebanon	15	22%
Lehigh	20	17%
Luzerne	17	18%
Lycoming	6	15%
McKean	4	19%
Mercer	1	4%
Mifflin	5	17%
Monroe	9	15%
Montgomery	51	13%
Montour	3	19%
Northampton	28	24%
Northumberland	9	17%
Perry	5	29%
Philadelphia	29	5%
Pike	8	25%
Potter	0	0%
Schuylkill	7	13%
Snyder	9	23%
Somerset	8	13%
Sullivan	2	33%
Susquehanna	2	13%
Tioga	5	16%
Union	9	33%
Venango	2	10%
Warren	1	6%
Washington	18	9%
Wayne	7	13%
Westmoreland	11	8%
Wyoming	9	24%

Table 4.3.5-8 Vulnerability of historic buildings to floods (PHMC, as of June 14, 2018).		
COUNTY	AT-RISK HISTORIC BUILDINGS	% OF COUNTY HISTORIC BUILDINGS
York	34	21%
Total	**936**	**15%**

The National Flood Insurance Program identifies repetitive loss (RL) and severe repetitive loss (SRL) properties. The following definition of RL and SRL properties from the Hazard Mitigation Assistance (HMA) Unified Guidance from February 2015 reflects changes made in the Biggert-Waters Flood Insurance Reform Act of 2012:

- A **repetitive loss** property is a structure covered by a contract for flood insurance made available under the NFIP that:

  (a) Has incurred flood-related damage on 2 occasions, in which the cost of the repair, on the average, equaled or exceeded 25 percent of the market value of the structure at the time of each such flood event; and

  (b) At the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage. (Please note: Homes are eligible for ICC coverage after first loss however cost for ICC is part of all policies.)
- A **severe repetitive loss** property is a structure that:

  (a) Is covered under a contract for flood insurance made available under the NFIP; and

  (b) Has incurred flood related damage

    (i) For which 4 or more separate claims payments (includes building and contents) have been made under flood insurance coverage with the amount of each such claim exceeding $5,000, and with the cumulative amount of such claims payments exceeding $20,000; or

    (ii) For which at least 2 separate claims payments (includes only building) have been made under such coverage, with the cumulative amount of such claims exceeding the market value of the insured structure.

Table 4.3.5-9 and Table 4.3.5-10 show the number and type of RL and SRL properties, respectively, for each county in Pennsylvania. This data was obtained from PEMA in January 2018 and joined with data on mitigated properties from the following sources:

- Commonwealth of Pennsylvania 2013 State Standard All-Hazard Mitigation Plan
- PEMA mitigated properties tracking from July 2017

Information within each of the data sources improved between 2013 and 2018. Database updates were completed as part of disaster recovery projects in the Commonwealth at the local, state and federal level. Though the databases have improved, information on mitigation does not exactly match between Bureaunet and PEMA tracking, ICC, and GSTF. The mitigation strategy reflects both the progress made and the continuing need for updates to capture all mitigation in the Commonwealth.

Table 4.3.5-9 shows the number and type of RL properties for each county in Pennsylvania. As of January 2018, Pennsylvania had 8,039 repetitive loss properties with 22,400 total losses and approximately $614.5 million in total paid claims. Of the 8,039 properties, 1,410 properties have been mitigated, which is 18 percent of the total repetitive loss properties in the Commonwealth. Completing FEMA Form AW-501 was a task promoted in grant related presentations for recent Disaster Declarations in the Commonwealth.

Based on input from the DCED, an assumption is made that *non-residential* type is anything other than "residential" including, but not necessarily limited to "commercial" building types. Also, *ASSMD Condo* type refers to a situation where an individual owns the structure, or portion of the structure, but not any of the land.

Table 4.3.5-9 Total and mitigated Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (January 2018).

COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Adams	24	7	2	0	2	0	1	0	1	0	30	7
Allegheny	270	20	29	1	3	1	6	0	98	12	406	34
Armstrong	34	1	0	0	1	0	1	0	5	0	41	1
Beaver	59	13	1	0	0	0	4	0	11	1	75	14
Bedford	112	37	0	0	6	6	2	1	1	0	121	44
Berks	59	22	4	0	2	0	4	0	17	2	86	24
Blair	99	20	0	0	2	0	5	2	7	2	113	24
Bradford	68	14	4	0	1	0	0	0	8	1	81	15
Bucks	584	90	32	2	15	2	20	0	102	8	753	102
Butler	57	8	0	0	1	0	1	0	6	0	65	8
Cambria	9	0	2	0	0	0	0	0	7	0	18	0
Cameron	9	2	0	0	0	0	0	0	1	0	10	2
Carbon	5	3	0	0	0	0	0	0	0	0	5	3
Centre	15	0	2	0	0	0	0	0	4	0	21	0
Chester	125	4	10	0	3	1	7	1	29	3	174	9
Clarion	4	0	1	0	2	0	0	0	5	1	12	1
Clearfield	36	4	4	0	1	0	4	1	11	1	56	6
Clinton	63	2	2	0	1	0	1	0	6	1	73	3
Columbia	299	105	35	5	13	4	4	1	38	4	389	119
Crawford	23	4	1	0	0	0	0	0	4	0	28	4
Cumberland	113	9	16	0	1	0	5	0	20	1	155	10
Dauphin	599	145	36	9	9	4	13	3	87	9	744	170
Delaware	178	46	7	1	5	0	3	0	72	2	265	49
Elk	21	0	0	0	0	0	0	0	7	0	28	0
Erie	35	8	1	1	2	0	0	0	9	3	47	12
Fayette	30	0	4	0	0	0	2	0	25	1	61	1

Table 4.3.5-9 Total and mitigated Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (January 2018).

COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Forest	1	0	0	0	0	0	0	0	0	0	1	0
Franklin	8	2	0	0	0	0	0	0	0	0	8	2
Fulton	0	0	0	0	0	0	0	0	1	0	1	0
Greene	24	3	1	0	1	0	0	0	8	0	34	3
Huntingdon	47	3	2	0	0	0	0	0	6	0	55	3
Indiana	27	4	3	0	0	0	0	0	1	0	31	4
Jefferson	33	8	1	0	0	0	1	0	12	2	47	10
Juniata	16	0	2	1	0	0	0	0	2	0	20	1
Lackawanna	100	7	23	1	2	0	0	0	18	1	143	9
Lancaster	82	8	4	0	7	0	2	0	42	6	137	14
Lawrence	13	0	1	0	0	0	0	0	2	0	16	0
Lebanon	67	12	3	0	1	0	1	1	6	0	78	13
Lehigh	68	10	0	0	3	1	3	0	35	2	109	13
Luzerne	325	59	67	7	7	1	2	0	66	11	467	78
Lycoming	445	79	37	5	15	3	5	1	29	5	531	93
McKean	7	1	1	0	0	0	0	0	4	1	12	2
Mercer	6	1	0	0	1	0	0	0	3	1	10	2
Mifflin	33	8	0	0	0	0	1	0	12	1	46	9
Monroe	25	6	2	0	1	0	0	0	11	0	39	6
Montgomery	391	68	20	5	15	1	23	1	119	8	568	83
Montour	6	1	0	0	1	1	0	0	3	1	10	3
Northampton	190	47	12	2	4	0	4	0	27	2	237	51
Northumberland	155	48	18	15	10	2	5	3	51	20	239	88
Perry	71	1	11	0	3	0	4	0	14	0	103	1
Philadelphia	71	1	4	0	5	1	4	0	20	0	104	2
Pike	27	2	0	0	0	0	0	0	3	0	30	2
Potter	2	0	0	0	0	0	0	0	1	0	3	0
Schuylkill	53	3	9	1	1	0	1	0	17	0	81	4
Snyder	126	33	12	2	5	1	0	0	9	5	152	41
Somerset	10	0	1	0	0	0	1	0	3	0	15	0
Sullivan	16	2	0	0	2	1	0	0	1	0	19	3
Susquehanna	65	12	2	0	1	0	0	0	6	2	74	14
Tioga	11	1	0	0	0	0	0	0	3	1	14	2
Union	95	32	15	11	2	1	3	2	16	3	131	49
Venango	18	6	1	1	7	7	0	0	27	26	53	40
Warren	10	1	0	0	0	0	0	0	1	0	11	1
Washington	41	2	4	0	1	0	2	0	26	1	74	3

Table 4.3.5-9 Total and mitigated Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (January 2018).												
COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Wayne	27	2	0	0	0	0	0	0	3	0	30	2
Westmoreland	88	13	10	1	7	3	2	0	16	5	123	22
Wyoming	152	47	7	3	9	1	1	1	15	3	184	55
York	118	18	1	0	4	0	2	0	17	2	142	20
Total	**6,000**	**1,115**	**467**	**74**	**185**	**42**	**150**	**18**	**1,237**	**161**	**8,039**	**1,410**

A sub-set of the repetitive loss properties is severe repetitive loss properties; the Commonwealth has 476 severe repetitive loss properties with 2,612 total losses and approximately $76.8 million in total paid claims. Table 4.3.5-10 illustrates the number and type of properties by county in Pennsylvania. Of the 476 SRL properties, 76 have been mitigated, or 16 percent of all SRL properties, as documented on the PEMA Mitigated Properties spreadsheet included in *Appendix G – Repetitive Loss and Severe Repetitive Loss Properties Inventory*. Like the RL property data, this data was obtained from FEMA and cross referenced with PEMA data in January 2018.

Table 4.3.5-10 Total and mitigated Severe Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (January 2018).												
COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Adams	5	1	0	0	0	0	0	0	0	0	5	1
Allegheny	2	0	0	0	0	0	0	0	0	0	2	0
Armstrong	3	1	0	0	0	0	0	0	0	0	3	1
Beaver	3	2	0	0	0	0	0	0	0	0	3	2
Bedford	10	1	0	0	0	0	1	0	0	0	11	1
Berks	1	0	0	0	0	0	0	0	0	0	1	0
Blair	2	1	0	0	0	0	0	0	0	0	2	1
Bradford	7	0	0	0	0	0	0	0	0	0	7	0
Bucks	91	13	6	1	0	0	1	0	0	0	98	14
Butler	6	1	0	0	0	0	0	0	0	0	6	1
Cambria	0	0	0	0	0	0	0	0	0	0	0	0
Cameron	0	0	0	0	0	0	0	0	0	0	0	0
Carbon	0	0	0	0	0	0	0	0	0	0	0	0
Centre	0	0	0	0	0	0	0	0	0	0	0	0
Chester	9	0	0	0	0	0	0	0	0	0	9	0
Clarion	0	0	0	0	0	0	0	0	0	0	0	0

Table 4.3.5-10 Total and mitigated Severe Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (January 2018).

COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Clearfield	1	0	0	0	0	0	0	0	0	0	1	0
Clinton	2	0	0	0	0	0	0	0	0	0	2	0
Columbia	15	8	1	0	0	0	0	0	0	0	16	8
Crawford	0	0	0	0	0	0	0	0	0	0	0	0
Cumberland	5	0	1	0	0	0	1	0	0	0	7	0
Dauphin	19	6	1	0	0	0	2	0	0	0	22	6
Delaware	24	4	6	1	0	0	1	1	0	0	31	6
Elk	0	0	0	0	0	0	0	0	0	0	0	0
Erie	1	0	0	0	0	0	0	0	0	0	1	0
Fayette	0	0	1	0	0	0	0	0	0	0	1	0
Forest	0	0	0	0	0	0	0	0	0	0	0	0
Franklin	0	0	0	0	0	0	0	0	0	0	0	0
Fulton	0	0	0	0	0	0	0	0	0	0	0	0
Greene	0	0	0	0	0	0	0	0	0	0	0	0
Huntingdon	3	0	1	0	0	0	0	0	0	0	4	0
Indiana	0	0	0	0	0	0	0	0	0	0	0	0
Jefferson	0	0	0	0	0	0	0	0	0	0	0	0
Juniata	0	0	0	0	0	0	0	0	0	0	0	0
Lackawanna	4	0	3	0	0	0	0	0	0	0	7	0
Lancaster	12	0	1	1	0	0	0	0	0	0	13	1
Lawrence	0	0	0	0	0	0	0	0	0	0	0	0
Lebanon	2	0	0	0	0	0	0	0	0	0	2	0
Lehigh	3	0	0	0	0	0	0	0	0	0	3	0
Luzerne	21	4	6	1	0	0	0	0	0	0	27	5
Lycoming	23	4	3	0	1	0	0	0	0	0	27	4
McKean	0	0	0	0	0	0	0	0	0	0	0	0
Mercer	1	0	0	0	0	0	0	0	0	0	1	0
Mifflin	1	1	0	0	0	0	0	0	0	0	1	1
Monroe	3	0	0	0	0	0	0	0	0	0	3	0
Montgomery	65	12	4	1	0	0	8	0	0	0	77	13
Montour	0	0	0	0	0	0	0	0	0	0	0	0
Northampton	26	2	2	0	0	0	1	0	0	0	29	2
Northumberland	10	2	0	0	0	0	0	0	0	0	10	2
Perry	1	0	0	0	0	0	0	0	0	0	1	0
Philadelphia	10	0	0	0	0	0	0	0	0	0	10	0
Pike	1	0	0	0	0	0	0	0	0	0	1	0

Table 4.3.5-10 Total and mitigated Severe Repetitive Loss properties in Pennsylvania. Data from PA RL & SRL Inventory (January 2018).												
COUNTY	SINGLE FMLY		2-4 FAMILY		ASSMD CONDO		OTHER RESID		NON RESIDNT		TOTAL	
	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT	TOTAL	MIT
Potter	0	0	0	0	0	0	0	0	0	0	0	0
Schuylkill	2	0	1	0	0	0	0	0	0	0	3	0
Snyder	4	1	1	0	0	0	0	0	0	0	5	1
Somerset	1	0	0	0	0	0	0	0	0	0	1	0
Sullivan	0	0	0	0	0	0	0	0	0	0	0	0
Susquehanna	2	1	0	0	0	0	0	0	0	0	2	1
Tioga	0	0	0	0	0	0	0	0	0	0	0	0
Union	3	2	4	2	0	0	0	0	0	0	7	4
Venango	0	0	0	0	0	0	0	0	0	0	0	0
Warren	0	0	0	0	0	0	0	0	0	0	0	0
Washington	0	0	0	0	0	0	0	0	0	0	0	0
Wayne	3	0	0	0	0	0	0	0	0	0	3	0
Westmoreland	1	0	0	0	0	0	0	0	0	0	1	0
Wyoming	7	1	0	0	0	0	0	0	0	0	7	1
York	3	0	0	0	0	0	0	0	0	0	3	0
Total	**418**	**68**	**42**	**7**	**1**	**0**	**15**	**1**	**0**	**0**	**476**	**76**

Figure 4.3.5-15 displays the number of RL and SRL properties by county, while Figure 4.3.5-16 displays the per capita number of RL and SRL properties by county. The number of RL and SRL properties per county serves as an indicator of the relative economic vulnerability of Pennsylvania jurisdictions to flood hazards, while the number of properties per capita serves as an indicator of the relative social vulnerability of Pennsylvania jurisdictions. In counties with more RL and SRL properties per capita, a greater share of residents is affected by repetitive flooding. Some of the more populous counties in the state's southeast rank among the highest counties in terms of economic vulnerability, but rank lower in terms of social vulnerability.

As of January 2018, Pennsylvania had 8,039 RL properties with claims totaling approximately $614.5 million. At least 1,410 (17.5 percent) of these properties have been mitigated. The Commonwealth has 476 SRL properties with claims totaling approximately $76.8 million. At least 76 (16.0 percent) of these properties have been mitigated. A majority (6 percent) of the 476 SRL properties within the Commonwealth are located in Bucks, Montgomery, Delaware Northampton, Luzerne, Lycoming, and Dauphin Counties, while most other counties have less than 20 SRL properties. Twenty three counties have no SRL properties at all. Bucks, Dauphin, Montgomery, Lycoming, Luzerne, Columbia, Allegheny, Delaware, Northampton, and Northumberland are among the counties which the Commonwealth has targeted to provide mitigation options to property owners since they have the highest numbers of RL properties.

The mitigation of RL and SRL properties is a high priority, especially since the losses experienced by these tend to be high and frequent. Losses avoided during the Severe Storms and Flooding from DR 4149 and DR 4292 for RL and SRL properties are estimated at $6.9 million. These avoided losses represent an order-of-magnitude approximation based on RL and SRL properties mitigated prior to these disasters in the disaster-declared counties, regardless of their location vis-à-vis the disaster-related flooding. This analysis provides a generalized idea of the losses that may have been prevented by mitigating RL and SRL structures and can help community members, local officials, and floodplain managers understand in conceptual terms how much less money may be paid out due to a flood because of mitigation activity. Table 4.3.5-11 shows the latest payment prior to these flood disasters for RL and SRL structures in the declared counties. A more robust loss avoidance study would incorporate the following information:

- Property location
- Pre-mitigation structure type
- Pre-mitigation square footage
- Pre-mitigation first floor elevation
- Post-mitigation first floor elevation
- Pre-mitigation number of floors
- Elevation certificates
- Detailed flood depth data for Sandy-impacted areas
- Data on structure and contents replacement value
- Defined depth-damage curves (used to define the relationship between flood depth and structure damage).

Table 4.3.5-11 Losses Avoided in Severe Storms and Flooding from DR 4149 and DR 4292. Data from PA RL & SRL Inventory.

COUNTY	Last Building Payment Prior to DR 4149 & DR 4292	Last Contents Payment Prior to DR 4149 and DR 4292	Last Total Payment Prior to DR 4149 and DR 4292
Allegheny	$408,753	$113,400	$522,153
Bradford	$612,502	$83,627	$696,129
Centre	$15,000	$0	$15,000
Clearfield	$31,556	$15,711	$47,266
Clinton	$3,682	$9,414	$13,096
Crawford	$33,870	$5,869	$39,739
Fayette	$0	$0	$0
Huntingdon	$53,908	$23,363	$77,270
Jefferson	$130,972	$75,034	$206,006
Lawrence	$0	$0	$0
Lycoming	$2,364,747	$425,571	$2,790,318
Sullivan	$46,032	$21,220	$67,253
Venango	$639,089	$1,712,954	$2,352,043

Table 4.3.5-11 Losses Avoided in Severe Storms and Flooding from DR 4149 and DR 4292. Data from PA RL & SRL Inventory.			
COUNTY	**Last Building Payment Prior to DR 4149 & DR 4292**	**Last Contents Payment Prior to DR 4149 and DR 4292**	**Last Total Payment Prior to DR 4149 and DR 4292**
Wayne	$78,016	$14,420	$92,436
Total	**$4,418,127**	**$2,500,582**	**$6,918,709**

PEMA has worked to mitigate RL and SRL properties since the inception of the SRL and Repetitive Flood Claims (RFC) grant programs. Since 2008, emphasis has been placed on mitigating SRL properties in particular. Fifty of the 76 SRL mitigated properties are identified as having been mitigated through PEMA and FEMA. Additionally, 1,295 of the mitigated RL properties have been mitigated using PEMA and FEMA grant program funding.

Figure 4.3.5-15 Repetitive Loss and Severe Repetitive Loss Properties by County (FEMA, 2018).

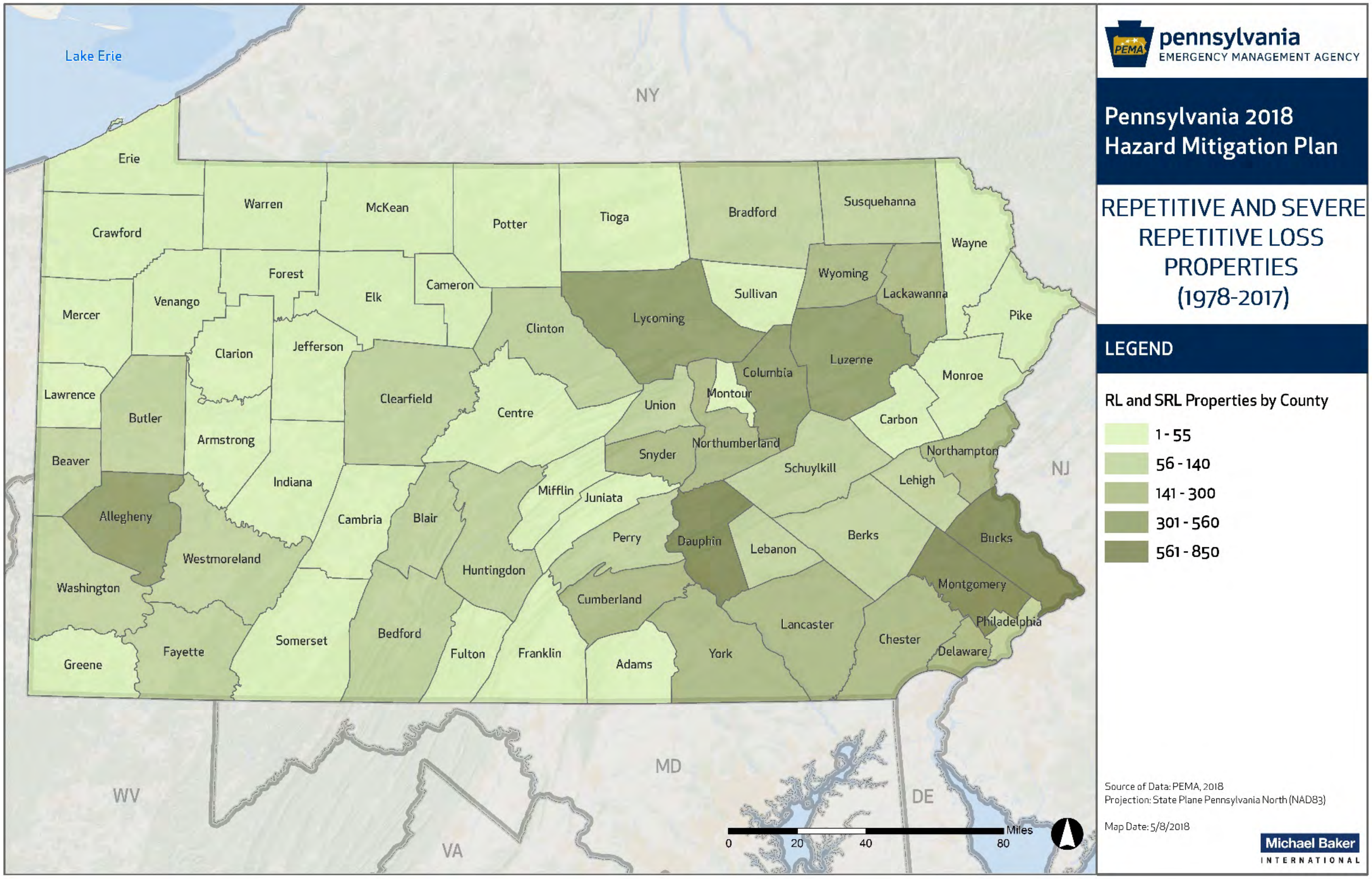
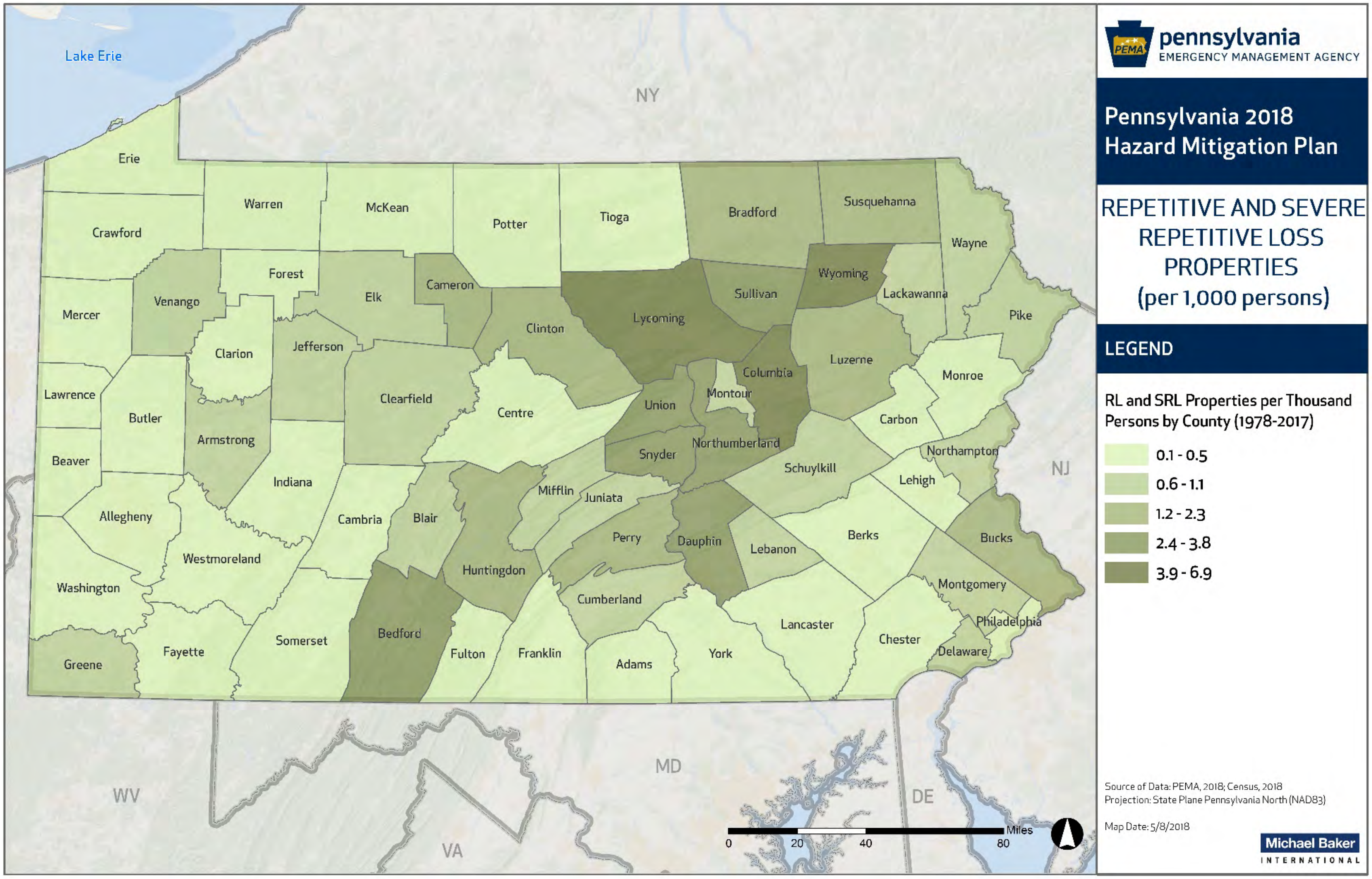


Figure 4.3.5-16 Repetitive Loss and Severe Repetitive Loss Properties per 1,000 Persons by County (FEMA, 2018).



According to the National Centers for Environmental Information (formerly the National Climatic Data Center), previous flood events occurring between 1950 and 2018 have caused over $1 billion in property damage, over $3 million in crop damage, 89 deaths, and 166 injuries. Note that the quality of this data is uncertain; many events are listed as having caused no property or crop damage. This may mean estimates are conservative.

The SBA provides low-interest loans to residential homeowners and small businesses located in SBA-approved disaster areas who have incurred eligible property and/or business losses. Individual Assistance funds are provided by FEMA to homeowners and renters living in Presidentially-declared disaster areas who have incurred eligible housing damages. Public Assistance funds are re-imbursements provided by FEMA to the Commonwealth and its agencies, local governments, and certain non-profits for the repair, reconstruction, etc. of public infrastructure having incurred eligible damage in Presidentially-declared disaster areas. Such reimbursements include, but are not limited to, repairs for the eligible costs of repairs for highways, roads, bridges, water and sewer facilities and certain costs to provide emergency assistance during and immediately after a disaster event. Hazard mitigation funds are made available through the FEMA Hazard Mitigation Grant Program based on a percentage of the total federal cost of a Presidentially-declared disaster awarded to the Commonwealth for eligible hazard mitigation activities. All of these funds are summarized in Table 4.3.5-12. The largest distribution of funds occurred in response to significant flood events in September 2004 and June 2006.

Table 4.3.5-12 Summary of Funds Distributed in Pennsylvania as a Result of Flood-Related Disaster Declarations between 2003 and 2018 (PEMA, 2013 and FEMA, 2018)

YEAR	DECLARATION		NUMBER OF COUNTIES DECLARED	INDIVIDUAL ASSISTANCE APPLICANTS	SMALL BUSINESS ADMIN.	INDIVIDUAL ASSISTANCE $	PUBLIC ASSISTANCE $	HAZARD MITIGATION	TOTAL ASSISTANCE
	DATE	NUMBER							
2003	8/23/2003	DR-1485	11	2,010	$1,712,000	$2,965,355	$4,880,320	$3,104,189	**$12,661,864**
	9/26/2003	DR-1497	1	674	$843,500	$1,009,837	$0	$83,000	**$1,936,337**
2004	8/6/2004	DR-1538	3	11,284	$5,500,000	$10,000,000	$0	$1,000,000	**$16,500,000**
	9/19/2004	DR-1555	10	2,766	$1,751,400	$3,500,000	$0	$370,000	**$5,621,400**
	9/19/2004	DR-1557	54	43,509	$74,900,000	$86,800,000	$112,300,000	$16,700,000	**$290,700,000**
2005	4/14/2005	DR-1587	9	3,103	$4,600,000	$3,800,000	$27,300,000	$1,300,000	**$37,000,000**
2006	7/4/2006	DR-1649	28	13,889	$57,000,000	$206,000,000	$106,900,000	$9,700,000	**$379,600,000**
2007	2/23/2007	DR-1684	8	0	$0	$0	$15,600,000	$2,700,000	**$18,300,000**
2008	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2009	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2010	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2011	4/25/2011	DR-4003	5	*none*	*none*	*none*	$10,568,582	$1,724,035	**$12,292,617**
	8/26/2011	DR-4025	14	18,283	$82,500,000	$41,734,054	$29,638,679	$14,956,724	**$168,829,457**
	9/3/2011	DR-4030	32	25,406	$50,400,000	$103,554,187	$147,395,311	$51,007,332	**$352,356,830**
2012	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2013	1/10/2013	DR-4099	18	*none*	*none*	*none*	$10,741,638	$2,623,955	**$13,365,593**
	10/1/2013	DR-4149	11	*none*	N/A	*none*	$12,166,334	$2,261,550	**$14,427,884**
2014	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2015	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2016	12/2/2016	DR-4292	4	*none*	N/A	*none*	$29,343,705	$2,498,000	**$31,841,705**
2017	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
2018*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	*none*	***none***
TOTALS			**208**	**120,924**	**$279,206,900**	**$459,363,433**	**$506,834,569**	**$39,716,739**	**$1,355,433,687**

*As of March 6, 2018.
Note: Data for disaster declarations from 2006 through January 2013 were obtained from the 2013 SSAHMP. Data for disaster declarations from October 2013 through 2018 were obtained from FEMA.

The most effective solution to reducing flood damages is to minimize development in the floodplain. However, this is often challenging in the face of development pressure. Programs of floodplain zoning and flood insurance have been successful in reducing, but not eliminating, losses.

The USACE, the U.S. Department of Agriculture's Natural Resources Conservation Service (formerly the Soil Conservation Service), and the Pennsylvania Department of Environmental Protection have constructed many flood protection projects throughout the Commonwealth. Most of the projects consist of concrete floodwalls, concrete channels, compacted earth levees, channel improvements, or any combination of these methods. All of the current flood protection projects were constructed because that particular community had a history of flooding and the main purpose of these projects was to prevent recurrent flood damages. Although flood protection projects are still constructed today, many of the existing projects were built in the 1940's, 1950's and 1960's. These projects need rehabilitation and, in some cases, major improvements are needed due to the many watershed changes that have occurred since their original construction. Other potential ways of eliminating flood damages involve either a watershed approach (this could consist of many small projects throughout the watershed to detain or protect an area) or a non-structural solution. Non-structural alternatives can include buyouts (purchase flood-prone homes and businesses and remove them from the floodplain), flood warning systems, elevate structures, or flood-proof structures. Future flood protection feasibility studies should consider all of the potential alternatives for flood damage reduction.

Large flood-control reservoirs can be highly effective in storing storm runoff and thus reducing downstream flood magnitudes. The Kinzua Dam serves as a good example of efficient flood control provided by large dams. With over 500,000 acre-feet of active flood-storage capacity, the Kinzua Dam is capable of reducing flood peaks on the Allegheny River near West Hickory, Forest County. The flood-peak reduction varies between 40 percent for the 50%-annual-chance flood and 60 percent for the 1%-annual-chance flood. A number of large flood control dams have been constructed throughout Pennsylvania. These are multi-purpose dams constructed by the USACE and provide Pennsylvania residents with excellent recreational opportunities as well as save millions of dollars in reduced flood damages. Coordination between agencies regarding flood risks from potential flood-control structure failures remains significant.

4.3.6. Hailstorm

4.3.6.1. Location and Extent

Hailstorm events can occur in all areas of Pennsylvania. Hail precipitation is often produced at the front of a severe thunderstorm system or in conjunction with a tornado event. 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. Hailstones are formed most commonly in thunderstorms with intense updraft, high liquid water content, large vertical extent, large water droplets, and cloud layers below freezing.

4.3.6.2. Range of Magnitude

Hail is described qualitatively and quantitatively by its size and can range from 0.2 inches to 4.5 inches; as shown in Table 4.3.6-1. The size of hail is dependent on the strength of the upward air movement along the front of a thunderstorm, called the updraft. Hailstone nuclei are buoyed or lifted by the updraft and increase in size the longer the stone is held aloft. Weaker updrafts create smaller hailstones while strong updrafts provide a longer amount of time for hailstone nuclei to grow in diameter.

Table 4.3.6-1 Hailstone size and relationship to updraft speed (NOAA, 2018).

HAILSTONE SIZE	MEASUREMENT (INCHES)	UPDRAFT SPEED (MPH)
BB	< 0.25	< 24
Pea	0.25	24
Marble	0.50	35
Dime	0.70	38
Penny	0.75	40
Nickel	0.88	46
Quarter	1.00	49
Half Dollar	1.25	54
Walnut	1.50	60
Golf Ball	1.75	64
Hen Egg	2.00	69
Tennis Ball	2.50	77
Baseball	2.75	81
Tea Cup	3.00	84
Grapefruit	4.00	98
Softball	4.50	103

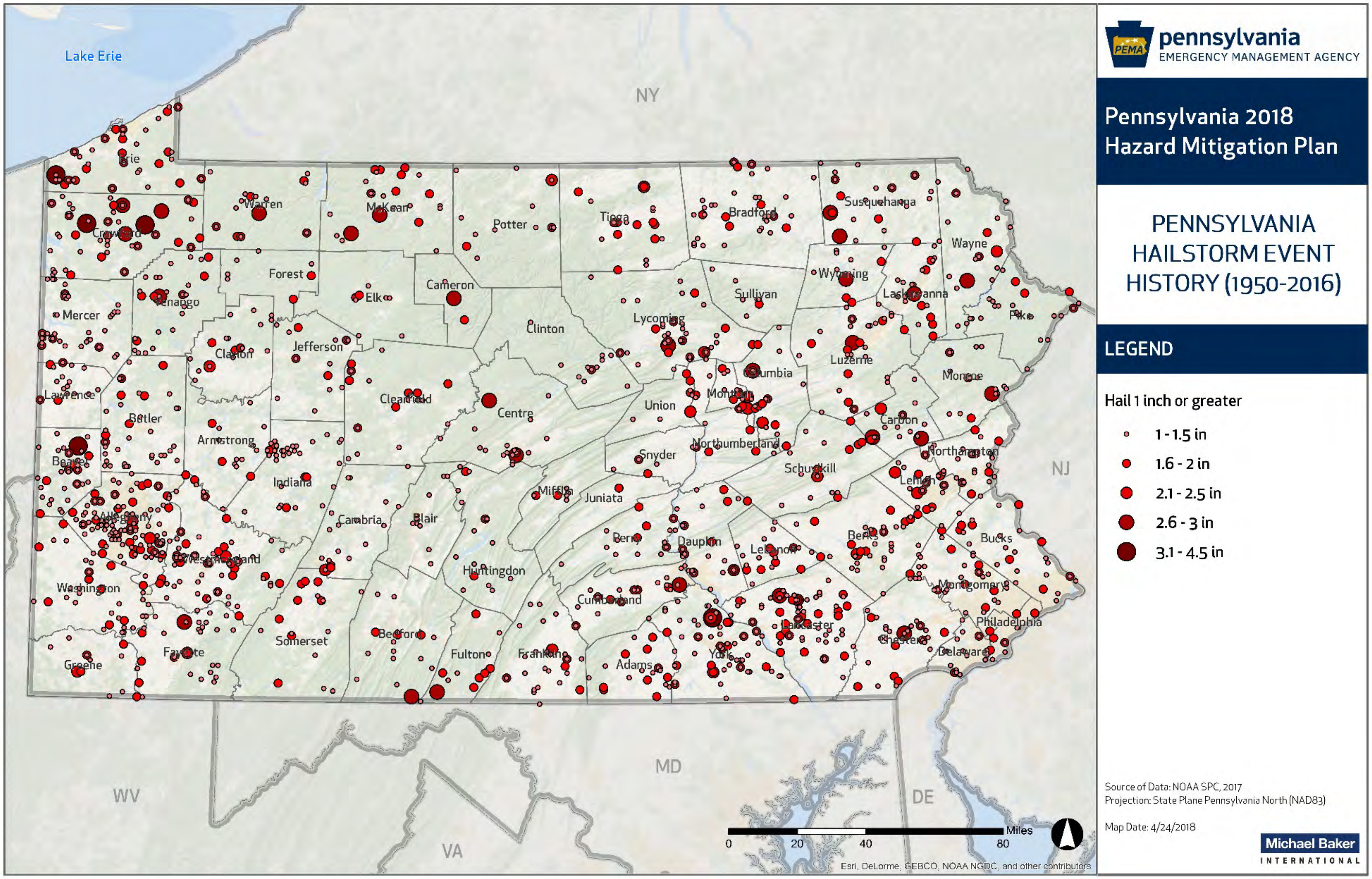
Hailstorms can cause significant damage to crops, livestock and property, depending on the size, duration, and intensity of hail precipitation. Automobiles and aircraft are particularly susceptible to damage. Also, people are at risk for serious injury if they don't seek immediate shelter. Since hail precipitation usually occurs during thunderstorm events, the impacts of other hazards associated with thunderstorms (i.e. strong winds, intense precipitation, etc.) often occur simultaneously.

A potential worst-case scenario of a hailstorm would be if a storm carrying hail of over two inches were to occur over a prolonged period in an agricultural area of one of the Commonwealth's predominantly agricultural counties such as Lancaster or Cumberland. Because hail can cause significant crop damage, a storm of this magnitude would potentially destroy agricultural yields and result in significant lost revenue, as well as property damage and injuries.

4.3.6.3. Past Occurrence

Figure 4.3.6.1 shows a map of the number of recorded hailstorm events by county between 1950 and 2016. A hailstorm event is defined as a storm with hail of ¾ inches or greater in diameter. Previous versions of the SHMP found that approximately 96 percent of hailstorm events occurred during the months of April, May, June, July, August, and September. In addition, approximately 87 percent of historic events occurred during the afternoon or evening. Both of these results are consistent with the relationship between hail and thunderstorms, which most often occur during late spring, summer, and early fall months.

Figure 4.3.6-1 Number of hailstorm events by county between 1950 and 2016 (NOAA, 2017).



The Storm Events Database maintained by the NCEI includes damage estimates for all hailstorms reported by local field offices since 1950. A list of all damages aggregated to the county scale is provided in Table 4.3.6-2.

Table 4.3.6-2 Hailstorms per county, 1950 - 2018 (NCEI, 2018).

COUNTY	HAIL EVENTS	PROP. DAMAGE	CROP DAMAGE	COUNTY	HAIL EVENTS	PROP. DAMAGE	CROP DAMAGE
Adams	45	$15,000	*	Lackawanna	57	$25,000	*
Allegheny	336	$6,000	*	Lancaster	170	$5,000	*
Armstrong	44	*	*	Lawrence	65	$5,000	*
Beaver	126	$1,000	*	Lebanon	46	$5,000	*
Bedford	41	$10,000	$50	Lehigh	57	$125,000	$50,000
Berks	90	*	*	Luzerne	82	$43,000	$1,000
Blair	25	*	*	Lycoming	106	$350,000	$500,000
Bradford	76	$88,000	*	McKean	51	$30,000	*
Bucks	71	*	$400,000	Mercer	116	*	*
Butler	126	$51,000	$500,000	Mifflin	19	$40,000	*
Cambria	43	*	*	Monroe	50	*	*
Cameron	11	*	*	Montgomery	79	*	*
Carbon	40	$1,050,000	*	Montour	17	*	*
Centre	66	*	*	Northampton	51	$250,000	*
Chester	81	$100	*	Northumberland	31	*	*
Clarion	49	$10,000	*	Perry	31	$15,000	*
Clearfield	34	$2,000	*	Philadelphia	31	*	*
Clinton	32	$7,500	*	Pike	58	$13,000	$1,000
Columbia	46	*	*	Potter	34	*	*
Crawford	164	$1,961,000	$15,000	Schuylkill	46	$500	*
Cumberland	57	*	*	Snyder	10	$500	$5,000
Dauphin	73	*	*	Somerset	36	*	$5,000
Delaware	38	*	*	Sullivan	17	*	*
Elk	21	*	*	Susquehanna	64	$66,000	*
Erie	183	$1,555,000	$2,010,000	Tioga	51	$10,000	*
Fayette	102	*	*	Union	14	*	*
Forest	13	$10,000	*	Venango	75	$12,000	*
Franklin	74	*	*	Warren	40	*	*
Fulton	15	$2,000	*	Washington	92	*	*
Greene	26	*	*	Wayne	52	$50,000	*
Huntingdon	38	*	*	Westmoreland	236	*	*
Indiana	71	$100,000	*	Wyoming	22	$2,000	*

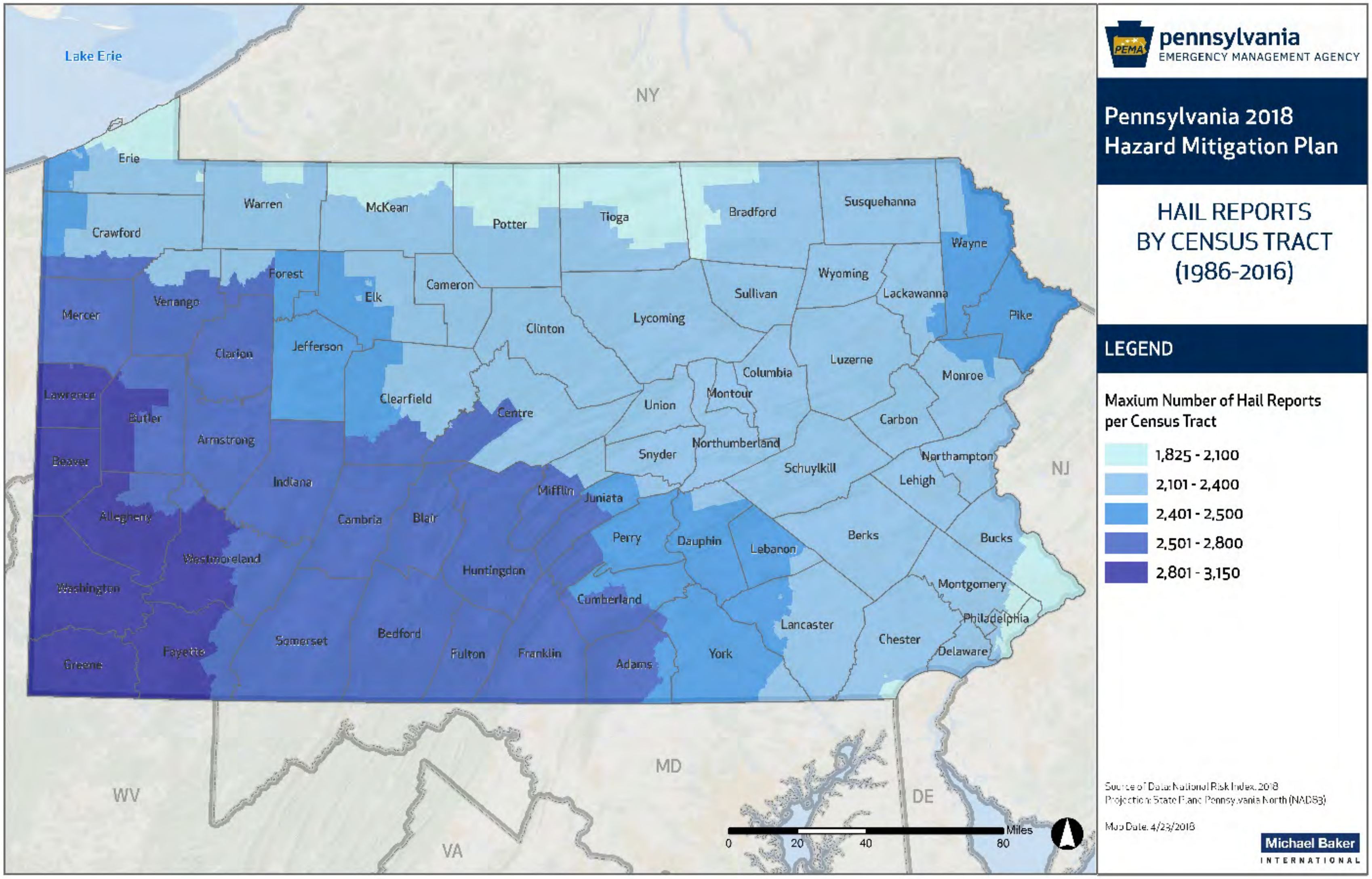
Table 4.3.6-2 Hailstorms per county, 1950 - 2018 (NCEI, 2018).							
COUNTY	**HAIL EVENTS**	**PROP. DAMAGE**	**CROP DAMAGE**	**COUNTY**	**HAIL EVENTS**	**PROP. DAMAGE**	**CROP DAMAGE**
Jefferson	58	*	*	York	143	$4,000	*
Juniata	10	*	*	**TOTAL**	**4,374**	**$5,919,600**	**$3,487,000**

** Damage results marked with an asterisk indicate that no reported damage values were provided by the NCEI, not necessarily that the event did not cause any damage.*

4.3.6.4. Future Occurrence

Hailstorm events are expected to continue to occur annually, primarily between April and August, throughout Pennsylvania. Using events reported between 1986 and 2016, Figure 4.3.6-2 shows the maximum number of hail events per census tract across 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 probability of future hail events can be considered *likely* according to the Risk Factor Methodology (see Section 4.1).

Figure 4.3.6-2 **Hail events per square mile in Pennsylvania (National Risk Index, 2018).**



4.3.6.5. Environmental Impacts

Damage to trees, shrubbery, and other vegetation may occur during hailstorm events through defoliation. Unless there are compounding stresses, natural vegetation can typically recover over time following the event. However, crops such as corn and soybeans can be damaged to the point of total loss, particularly if an event occurs later in the growing season.

4.3.6.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to hailstorms, all structures located in high hazard census tracts were identified. Hailstorm hazard was characterized based on the National Risk Index, which estimated the maximum number of hail reports in each census tract between 1986 and 2016. All census tracts with a maximum number of hail reports exceeding 2,800 were defined as high hazard census tracts, and all structures within these census tracts were identified as vulnerable facilities. Note that the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 620, or 14 percent, are located within census tracts characterized by high hailstorm hazard (Table 4.3.6-3). These facilities have a combined replacement value of more than $280 million, or approximately 7% of the known value of geolocated state facilities.

Table 4.3.6-3 Vulnerability of state facilities to hailstorms.

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	2	22%
Department of Agriculture	1	6%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	112	16%
Department of Education	0	0%
Department of Environmental Protections	2	15%
Department of General Services	8	6%
Department of Health	7	15%
Department of Labor and Industry	8	12%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	12	12%
Department of Revenue	2	20%
Department of Transportation	302	18%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	1	50%

Table 4.3.6-3 Vulnerability of state facilities to hailstorms.		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Fish and Boat Commission	0	0%
Governor's Office	0	0%
Historical and Museum Commission	3	10%
Insurance Department	0	0%
Liquor Control Board	114	21%
Public School Employees' Retirement System	1	17%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	0	0%
State Police	2	6%
State System of Higher Education	42	5%
Thaddeus Stevens College of Technology	0	0%
Treasury	1	50%
Total	**620**	**14%**

Of the 14,011 geolocated critical facilities, 2,166 or 15 percent, are located within census tracts characterized by high hailstorm hazard (Table 4.3.6-4). These facilities have a combined replacement value of approximately $30.7 billion, or 16% of the known value of geolocated critical facilities.

Table 4.3.6-4 Vulnerability of critical facilities to hailstorms.		
TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Agricultural	38	14%
Banking	1	33%
Commercial	6	22%
Communication	75	12%
Dam	364	11%
Education (colleges and universities)	22	14%
Education (public schools)	542	17%
Emergency Operation Center	7	10%
Energy	5	9%
Fire Station	516	19%
Government	2	8%
Hospital	53	15%
National Monument or Icon	0	0%
Nuclear	1	20%

Table 4.3.6-4 Vulnerability of critical facilities to hailstorms.		
TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Police Station	247	20%
Transportation	15	20%
Water	272	15%
Total	**2,166**	**15%**

4.3.6.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to hailstorms, the population, building counts, and building value of all high hazard census tracts were aggregated to the county scale. As in the state vulnerability assessment, high hazard census tracts were defined as those in which the maximum number of hail reports in each census tract between 1986 and 2016 exceeded 2,800. Only eight counties in Pennsylvania are significantly impacted by hailstorm hazards.

Table 4.3.6-5 Vulnerability of people and buildings to hailstorms.				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**EXPOSED BUILDING VALUE (THOUSANDS $)**	**% OF TOTAL COUNTY BUILDING VALUE**
Allegheny	1,099,847	446,912	$145,266,630	90%
Beaver	169,205	73,797	$19,203,313	100%
Butler	82,763	33,017	$10,287,452	48%
Fayette	125,261	56,112	$11,572,745	93%
Greene	37,669	16,370	$3,410,883	100%
Lawrence	86,188	39,329	$8,756,603	95%
Washington	208,269	90,284	$23,606,898	100%
Westmoreland	251,478	112,370	$29,548,682	72%
State Total	**2,060,680**	**868,191**	**$251,653,206**	**17%**

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. 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). According to the Storm Events Database maintained by the NCEI, the hailstorm events that produced the most property and crop damage occurred in Erie County. In one hailstorm, for example, dime size hail reported over a large area damaged an estimated 3,000 acres of grapes on 24 farms and destroyed an estimated 25 percent of the grape crop. The resulting financial loss was estimated to be approximately $2 million.

From the perspective of potential agricultural losses, relative jurisdictional vulnerability can be determined by comparing each jurisdiction's farmland acreage and agricultural production. Table 4.3.6-6 summarizes the county-level data provided by the USDA's 2012 Census of Agriculture. This census is released every five years, and the 2017 data is expected to be released in 2019. According to the 2012 Census of Agriculture, the counties with the highest agricultural production (measured by market value) are Lancaster, Chester, and Berks. The market value of agricultural products in each of these counties exceeds $500 million.

Table 4.3.6-6 Estimated jurisdictional losses relating to agricultural production (USDA Census of Agriculture, 2012)

COUNTY	IMPACTED FARMLAND ACREAGE	MARKET VALUE OF ALL AGRICULTURAL PRODUCTS
Adams	171,305	$201,742,000
Allegheny	34,837	$10,397,000
Armstrong	129,090	$35,861,000
Beaver	55,795	$20,913,000
Bedford	209,795	$122,820,000
Berks	233,744	$528,711,000
Blair	90,117	$107,701,000
Bradford	307,990	$128,794,000
Bucks	64,024	$62,418,000
Butler	136,237	$52,905,000
Cambria	76,889	$32,641,000
Cameron	6,215	$692,000
Carbon	21,162	$9,339,000
Centre	162,041	$91,581,000
Chester	164,495	$660,744,000
Clarion	115,976	$36,136,000
Clearfield	69,250	$13,691,000
Clinton	52,715	$60,558,000
Columbia	122,743	$74,351,000
Crawford	227,731	$116,075,000
Cumberland	154,879	$195,356,000
Dauphin	129,378	$122,589,000
Delaware	4,725	$9,781,000
Elk	23,488	$4,229,000
Erie	168,634	$91,675,000
Fayette	112,871	$27,023,000
Forest	8,283	$1,820,000
Franklin	264,521	$413,806,000
Fulton	112,210	$52,975,000
Greene	112,358	$14,574,000
Huntingdon	158,300	$93,503,000

Table 4.3.6-6 Estimated jurisdictional losses relating to agricultural production (USDA Census of Agriculture, 2012)

COUNTY	IMPACTED FARMLAND ACREAGE	MARKET VALUE OF ALL AGRICULTURAL PRODUCTS
Indiana	153,752	$67,307,000
Jefferson	91,288	$27,729,000
Juniata	91,032	$101,440,000
Lackawanna	32,750	$13,237,000
Lancaster	439,481	$1,474,954,000
Lawrence	80,468	$38,519,000
Lebanon	121,413	$348,933,000
Lehigh	76,331	$90,833,000
Luzerne	66,577	$20,993,000
Lycoming	158,462	$72,202,000
McKean	36,297	$4,952,000
Mercer	163,148	$82,650,000
Mifflin	90,554	$94,023,000
Monroe	26,483	$10,974,000
Montgomery	30,780	$25,594,000
Montour	43,493	$47,425,000
Northampton	65,744	$43,496,000
Northumberland	129,501	$154,339,000
Perry	135,075	$140,401,000
Philadelphia	285	$768,000
Pike	28,260	$2,965,000
Potter	96,689	$35,450,000
Schuylkill	105,749	$165,853,000
Snyder	91,179	$165,493,000
Somerset	214,581	$104,209,000
Sullivan	37,481	$9,517,000
Susquehanna	166,399	$43,321,000
Tioga	205,158	$80,258,000
Union	93,241	$135,970,000
Venango	61,531	$20,747,000
Warren	82,419	$20,747,000
Washington	205,821	$35,412,000
Wayne	112,998	$32,352,000
Westmoreland	143,062	$48,610,000
Wyoming	68,749	$14,616,000
York	262,062	$234,064,000
TOTAL	***7,710,091***	***$7,405,754,000***

4.3.7. Hurricane, Tropical Storm, Nor'easter

4.3.7.1. Location and Extent

Pennsylvania does not have any open-ocean coastline. However, the impacts of coastal storm systems such as hurricanes, tropical storms, and nor'easters can extend well inland. Tropical storm systems (i.e. hurricanes, tropical storms, tropical depressions) impacting Pennsylvania develop in tropical or sub-tropical waters of the Atlantic Ocean, Gulf of Mexico, or Caribbean Sea. Nor'easters are extra-tropical storms which typically develop from low-pressure centers off the Atlantic Coast north of North Carolina during the winter months. Extra-tropical is a term used to describe a hurricane or tropical storm that's cyclone has lost its 'tropical' characteristics. While an extra-tropical storm donates a change in weather pattern and how the storm is gathering energy, it may still have winds that are tropical storm or hurricane force.

In some cases, the center of circulation for these storm systems where wind and precipitation effects are often most intense can track inland and move directly through Pennsylvania. However, due to the size of these storms, the Commonwealth is more often affected when circulation centers pass at a distance of several hundred miles. In either case, these coastal storms are regional events that can impact very large areas hundreds to thousands of miles across over the life of the storm. In general, coastal storm systems affect communities in the eastern portion of Pennsylvania more often than western communities. However, these storms have the potential to impact all communities across Commonwealth.

4.3.7.2. Range of Magnitude

Intense precipitation and wind resulting in flood and wind damage (see Sections 4.3.5 and 4.3.14 respectively) are the most common impacts associated with coastal storm systems in Pennsylvania. Nor'easters develop as extra-tropical cyclonic weather systems over the Atlantic Ocean and are capable of producing winds equivalent to hurricane or tropical storm force; precipitation from these storms may also come in the form of heavy snow or ice (see Section 4.3.16).

Tropical cyclones with maximum sustained winds of less than 39 miles per hour (mph) are called *tropical depressions*. A *tropical storm* is a cyclone with maximum sustained winds between 39-74 mph. These storms sometimes develop into *hurricanes* with wind speeds in excess of 74 mph (NOAA NHC, 2015). The impacts associated with hurricanes and tropical storms are primarily wind damage and flooding. It is not uncommon for tornadoes to develop during these events. Historically, tropical cyclone events have brought intense rainfall to Pennsylvania, sometimes leading to damaging floods, northeast winds, which, combined with waterlogged soils, caused trees and utility poles to fall.

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. The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure and storm surge potential (a threat only to the tidal portions of the Delaware River), which are combined to estimate potential damage. Table 4.3.7-1 lists Saffir-Simpson Scale categories with associated wind speeds and expected damages. Categories 3, 4 and 5 are classified as "major" hurricanes; however, even Category 1 storms can have potentially significant storm surge. While major hurricanes comprise only

20% of all tropical cyclones making landfall, they account for over 70% of the damage in the United States.

Table 4.3.7-1 Saffir-Simpson Scale categories with associated wind speeds and damages (NOAA NHC, 2012).		
STORM CATEGORY	**WIND SPEED (MPH)**	**DESCRIPTION OF DAMAGES**
1	74-95	**Very dangerous winds will produce some damage**: Well-constructed frame homes could have damage to roof, shingles, vinyl siding and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
2	96-110	**Extremely dangerous winds will cause extensive damage**: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
3	111-129	**Devastating damage will occur**: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
4	130-156	**Catastrophic damage will occur**: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
5	>156	**Catastrophic damage will occur**: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

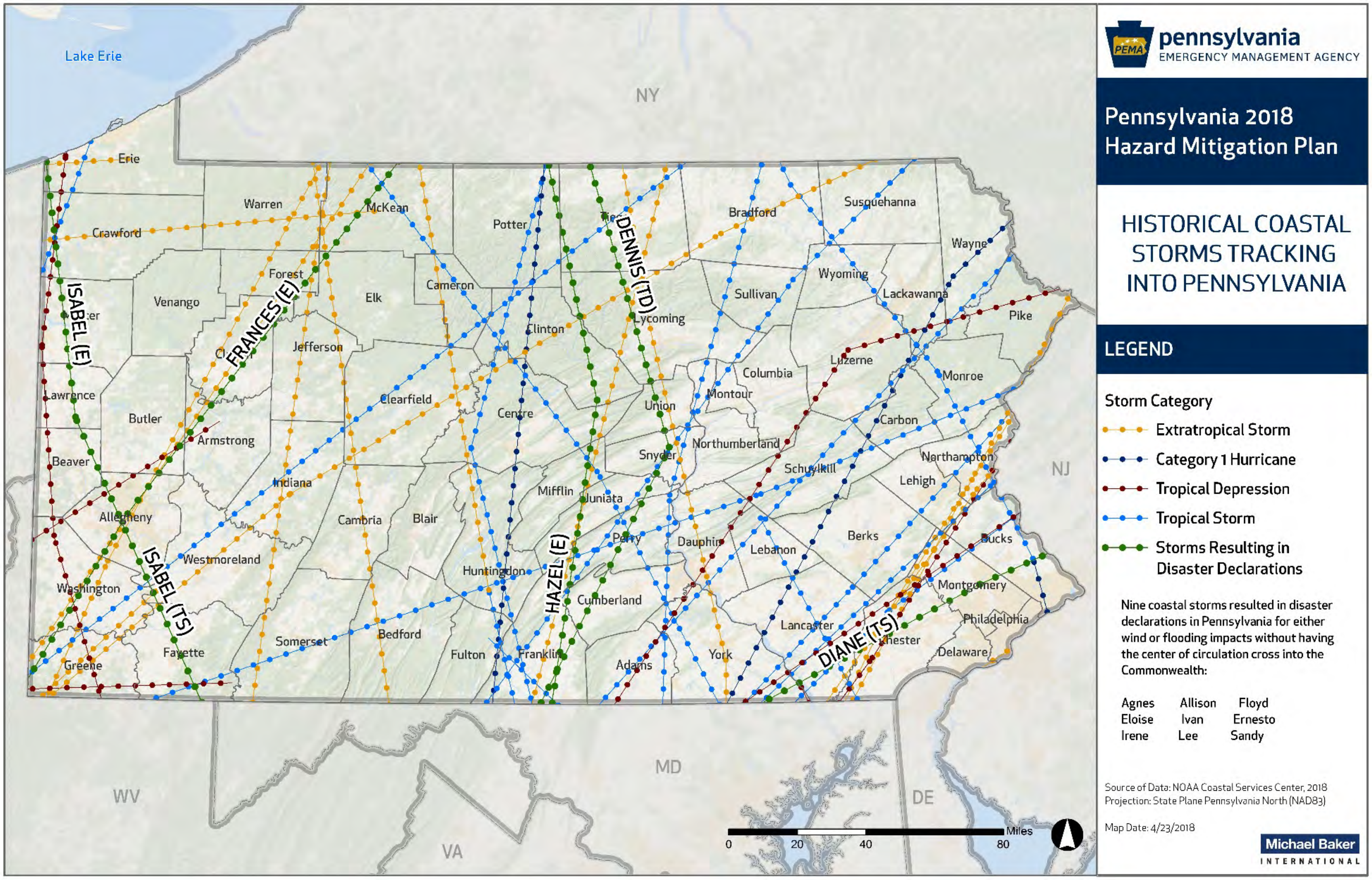
4.3.7.3. Past Occurrence

As shown in Section 4.2.1, 13 Presidential Disaster Declarations, 4 Presidential Emergency Declarations and two additional Gubernatorial Declarations have been made since 1955 due to coastal storm events in Pennsylvania. Using data from the National Oceanic and Atmospheric Administration, a query was performed for historic tropical cyclone events that tracked directly through Pennsylvania. Twenty-four unnamed storms tracked through Pennsylvania between 1876 and 1952. Since 1952, 20 named tropical cyclones have tracked through Pennsylvania; a summary of these storms is provided in Table 4.3.7-2 with storm category as recorded over Pennsylvania. A map of all events since 1876 is provided in Figure 4.3.7-1.

Table 4.3.7-2 Tropical cyclone events which tracked through Pennsylvania between 1952 and present (NOAA OCM, 2018). Note that events with circulation centers that did not move through Pennsylvania are not included in this table, but are identified in text. Storm categories: E = Extra-tropical storm, TD = Tropical depression, TS = Tropical storm

YEAR	EVENT (STORM CATEGORY)
1952	Able (TS)
1954	Hazel (E)
1955	Connie(TS)
1955	Diane (TS)
1957	Audrey (E)
1959	Gracie (E)
1968	Candy (E)
1979	David (TS)
1979	Frederic (TS)
1988	Chris (TD)
1989	Hugo (TS)
1992	Danielle (TS)
1994	Beryl (TD)
1996	Fran (TD)
1999	Dennis (TD)
2002	Isidore (TD)
2003	Isabel (TS)
2004	Frances (E)
2006	Ernesto (E)
2012	Sandy (E)

Figure 4.3.7-1 Map showing historical coastal storm events which tracked through Pennsylvania (NOAA, 2018).



It is important to note that Table 4.3.7-2 and Figure 4.3.7-1 identify only events with centers of circulation that passed over the Commonwealth. Tropical cyclone events which may have affected Pennsylvania, but did not have circulation centers that crossed through the Commonwealth are not provided here due to space limitations. Storms of this type, however, have had serious impacts on Pennsylvania. Perhaps the best example of this is Hurricane Agnes (1972). While it was the most significant tropical storm event to impact the Commonwealth, the storm track for Agnes remained to the east of Pennsylvania and New Jersey until making landfall near New York City and traveling into upstate New York. After making first landfall as a minimal hurricane near Panama City, FL, Agnes weakened and exited back into the Atlantic off the North Carolina coast. However, the storm skirted along the coast, 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, with concentrations of rain in the Susquehanna River Basin. Maximum rainfall from the storm, falling in the period of June 20-25, 1972, was about 18 inches the middle of the Susquehanna drainage area; however, this is an unofficial measurement. The maximum official depth of 15.2 inches was recorded in Harrisburg, PA. Estimated losses in Pennsylvania alone were near $3 billion; total damages for the storm nationwide were estimated at $4 billion. Although storm damages were serious over the entire Commonwealth, both the eastern and western portions escaped the extreme rainfall and losses suffered in central areas. Other tropical cyclones which did not track through Pennsylvania, but caused significant damage to communities in the Commonwealth include Sandy (2012), Lee/Irene (2011), Ivan (2004), Allison (2001), Floyd (1999) and Eloise (1975).

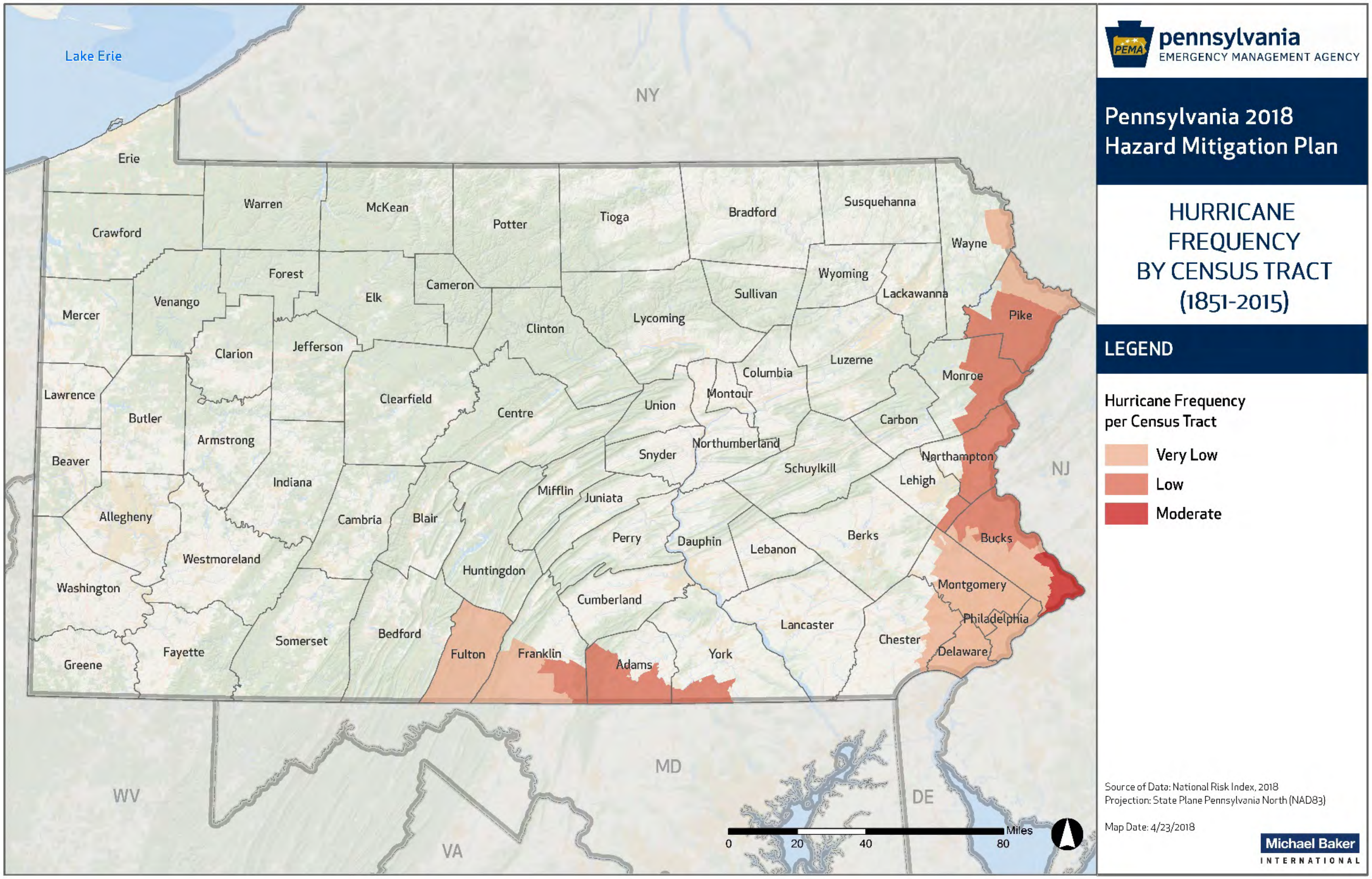
4.3.7.4. Future Occurrence

One approach to determining the future probability of hurricanes is to examine the frequency and spatial distribution of past hurricanes. This is the approach FEMA applied in developing its National Risk Index (NRI). To determine the spatial distribution of hurricane hazard, FEMA calculated the maximum number of hurricane paths overlapping each census tract over the available period of record. Data on hurricane paths were derived from NOAA's National Hurricane Center “Best Track” Data Archive and were available for 1851 to 2015 for the Atlantic. Figure 4.3.7-2 shows the distribution of hurricane hazard in Pennsylvania based on these historic observations. The areas most likely to be affected by a hurricane are confined to two narrow bands along the state’s eastern and southern borders. Note that this figure does not provide information on the probability of various storm intensities. Studies investigating the probability of future occurrence of nor’easters have not been identified.

There has been an increase in North Atlantic hurricane activity since the 1970s with locations of peak intensity tropical cyclones migrating poleward coinciding with tropics expansion (Kossin et al. 2017). An index of potential hurricane destructiveness suggests an increase over the past 30 years (Shortle et al. 2015). Variability in tropical cyclone activity in the Atlantic is due to natural variability in ocean circulation, volcanic eruptions, and Saharan dust, as well as climate change resulting from greenhouse gases and sulfate aerosols.

Tropical cyclone intensities are expected to increase with warming, as both theory and models suggest an increase in intensity with a warmer atmosphere, but models disagree about an increase in frequency. Some suggest an increase in frequency of category 4-5 cyclones with an overall slight reduction in frequency (it is likely the total number of tropical cyclones will stay the same or decrease). It is likely that precipitation rates and maximum sustainable winds associated with tropical cyclones will increase globally, however, regional projections are more uncertain due to differences in circulation patterns and sea surface temperature increases. For the Atlantic, the frequency of intense (stronger and with heavier rainfall) tropical storms is *likely to increase* (Kossin et al. 2017).

Figure 4.3.7-2 Hurricane frequency by census tract across Pennsylvania between 1851 - 2015 (FEMA NRI, 2018).



The relationship between climate change and hurricanes is complex and there are many other factors that affect hurricane development including wind shear and air pollution. Dust from the Sahara Desert that is lifted high in the atmosphere during hot, dry summers can actually inhibit the development of some hurricane formation in the Atlantic. Despite all this complexity, it is very likely there will be more rainfall associated with these storms. A warmer atmosphere holds more moisture which results in higher rainfall (Clausius-Clapeyron relation posits that for every degree Celsius of heat increase, the air holds 7% more water).

Climate change can also worsen the impacts of a hurricane by driving larger rainfall totals and higher storm surge. There is also a tentative connection with a general slowdown of atmospheric circulation which is a result of warming in the Arctic. This leads to storms lingering longer in a given place which enhances destructive impacts. Some other possible connections and impacts are a lengthening of the hurricane season and seeing more hurricanes earlier or later than usual. Additionally, storms could manifest in regions where they haven't previously, farther from the equator, with warming seas. Some studies have found a poleward shift of cyclones over the past 30 years, about one degree of latitude per decade. Storms may also intensify rapidly and could be larger in size (though the trends on these are less clear). The effect of having more intense Category 4-5 storms may increase potential damage in the Atlantic 30% by 2100 (see NOAA GFDL's site for more details here https://www.gfdl.noaa.gov/global-warming-and-hurricanes/).

4.3.7.5. Environmental Impacts

The environmental impacts associated with coastal storms in Pennsylvania are consistent with those described for flood hazards in Section 4.3.5.5 and wind hazards in Section 4.3.14.5.

Beyond the environmental impacts of hurricanes, tropical storms, and nor'easters, Super Storm Sandy demonstrated the wide-ranging impacts of coastal storms. In addition to the flooding and wind-related impacts, Sandy illustrated the fuel and supply chain issues that can occur during a large, regional coastal storm. During and for weeks after the storm, both vehicles and generators could not be fueled. Transportation ground to a halt as well, with major roadway damage and limited power supply to enable safe traffic flow. The duration of Sandy also showed the long-term vulnerability of shelters in many states; few locations were equipped to shelter Sandy evacuees for the three weeks or more needed to get evacuees into temporary housing. The fuel shortages and widespread utility interruptions caused by Sandy illustrated the overall vulnerability of populations in hospitals and nursing homes; these populations are typically difficult to relocate and/or evacuate because of their medical needs, and electric power is frequently needed to keep these populations medically stable.

4.3.7.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to hurricanes, all structures located within a census tract with low to moderate hurricane frequency between 1851 and 2015 were identified (see Figure 4.3.7-2). The results of this assessment represent the potential impacts to state assets based on location, but do not account for other factors such as the age or intended use of buildings.

Of the 4,460 geolocated state facilities, 155, or about 3 percent, are located within census tracts with low to moderate hurricane frequency. These facilities have a combined replacement value of more than $19.7 million, or approximately 0.5% of the known value of geolocated state facilities.

Table 4.3.7-3 Vulnerability of state facilities to hurricanes.

TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Attorney General	0	0%
Department of Agriculture	0	0%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	0	0%
Department of Education	0	0%
Department of Environmental Protection	0	0%
Department of General Services	0	0%
Department of Health	1	2%
Department of Labor and Industry	3	4%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	5	5%
Department of Revenue	0	0%
Department of Transportation	51	3%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	0	0%
Governor's Office	0	0%
Historical and Museum Commission	1	3%
Insurance Department	0	0%
Liquor Control Board	31	6%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	0	0%
State Police	1	3%
State System of Higher Education	62	7%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	**155**	**3%**

Of the 14,011 geolocated critical facilities, 877 or 6 percent, are located within census tracts with low to moderate hurricane frequency (Table 4.3.7-4). These facilities have a combined replacement value of more than $9.8 billion, or approximately 5% of the known value of geolocated critical facilities.

Table 4.3.7-4 Vulnerability of critical facilities to hurricanes.

TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	15	5%
Banking	0	0%
Commercial	1	4%
Communication	25	4%
Dam	351	10%
Education (colleges and universities)	8	5%
Education (public schools)	183	6%
Emergency Operation Center	2	3%
Energy	1	2%
Fire Station	133	5%
Government	0	0%
Hospital	9	3%
National Monument or Icon	1	17%
Nuclear	0	0%
Police Station	64	5%
Transportation	0	0%
Water	84	5%
Total	**877**	**6%**

4.3.7.7. Jurisdictional Vulnerability Assessment

FEMA's Hazus software version 4.0 was used to estimate the relative vulnerability to earthquakes across the state. The methodology uses Hazus default data on hurricane wind hazards and building stock, user-defined essential facilities data, and the software's standard algorithms. The calculation algorithms quantify the potential losses associated with hurricane winds using information about sea surface temperature, central pressure, translation speed, and surface roughness. As discussed in Section 4.1.4, Hazus was used to calculate two kinds of economic losses: 1) direct building losses, and 2) business interruption losses. Direct building losses consist of the damage to structures, contents, and inventory; while business interruption losses consist of the relocation expenses, employee wage loss, business income loss, and rental income loss that accrue during the time that businesses remain inoperable. For more information on the data and methodology used in this analysis, see Section 4.1.4.

The tables below show the average annualized hurricane wind losses for Pennsylvania aggregated to the county scale. While Table 4.3.7-5 shows potential direct building losses, Table 4.3.7-6 shows potential business interruption losses. According to the Hazus analysis, most of the potential loss is attributable to direct building losses, and most of the potential direct building loss is attributable to building damage. Figure 4.3.7-3 shows the spatial distribution of the total average annualized losses (the sum of direct building losses and business interruption losses). Note that losses are shown at the census tract level. Both the county-level tables and the census-tract level map show the highest annualized losses in the populous counties in the state's southeast (i.e., Philadelphia, Bucks, Montgomery, and Delaware Counties).

Table 4.3.7-5 Potential direct building losses from hurricane wind hazards (Average Annualized Loss).

COUNTY	BUILDING LOSS	CONTENTS LOSS	INVENTORY LOSS	TOTAL DIRECT BUILDING LOSSES
Adams	$96,730	$6,824	$156	$103,710
Allegheny	$163,648	$2,558	$15	$166,221
Armstrong	$6,478	$107	$1	$6,586
Beaver	$15,020	$216	$1	$15,237
Bedford	$12,197	$509	$11	$12,716
Berks	$487,595	$35,886	$704	$524,184
Blair	$25,078	$1,236	$27	$26,341
Bradford	$12,207	$4,581	$3	$16,791
Bucks	$2,788,323	$553,113	$4,864	$3,346,300
Butler	$16,552	$167	$2	$16,721
Cambria	$24,011	$1,459	$15	$25,485
Cameron	$1,360	$775	$1	$2,136
Carbon	$44,148	$4,945	$12	$49,105
Centre	$32,036	$2,327	$7	$34,369
Chester	$1,462,709	$217,463	$1,837	$1,682,009
Clarion	$3,843	$992	$1	$4,836
Clearfield	$10,915	$1,962	$9	$12,887
Clinton	$8,943	$2,923	$3	$11,869
Columbia	$33,050	$5,790	$72	$38,912
Crawford	$3,224	$515	$0	$3,740
Cumberland	$175,083	$10,644	$150	$185,877
Dauphin	$218,834	$21,623	$233	$240,690
Delaware	$1,875,091	$168,536	$1,611	$2,045,238
Elk	$5,984	$2,928	$3	$8,914
Erie	$6,847	$1,447	$1	$8,295
Fayette	$23,321	$393	$6	$23,720
Forest	$1,873	$1,231	$0	$3,104
Franklin	$95,884	$6,628	$178	$102,689
Fulton	$5,229	$247	$9	$5,485
Greene	$5,981	$125	$1	$6,106
Huntingdon	$10,578	$396	$3	$10,977
Indiana	$9,228	$260	$5	$9,494
Jefferson	$5,246	$1,087	$6	$6,340

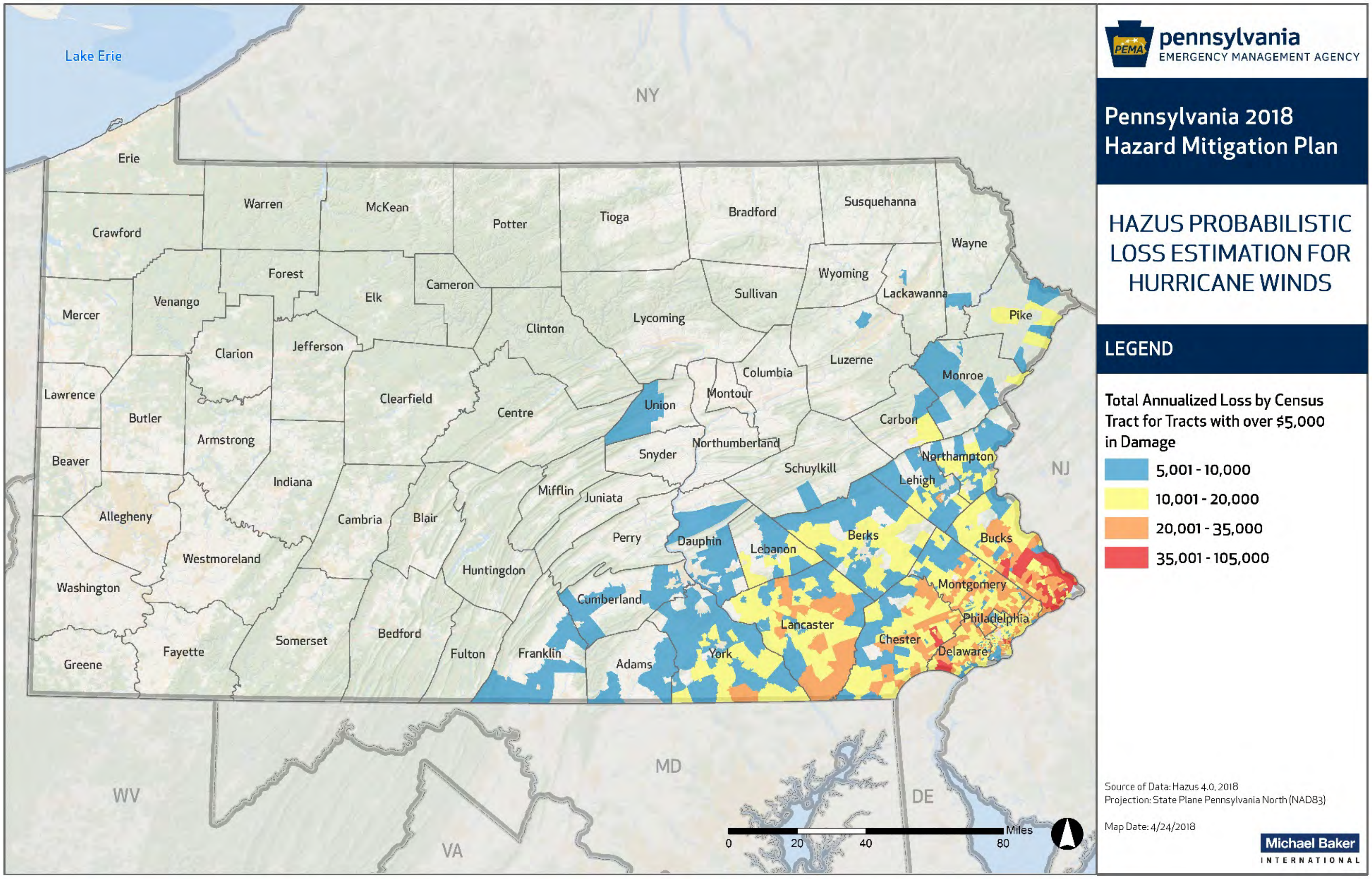
Table 4.3.7-5 Potential direct building losses from hurricane wind hazards (Average Annualized Loss).				
COUNTY	BUILDING LOSS	CONTENTS LOSS	INVENTORY LOSS	TOTAL DIRECT BUILDING LOSSES
Juniata	$7,629	$220	$4	$7,853
Lackawanna	$74,058	$12,163	$38	$86,259
Lancaster	$874,054	$154,761	$2,810	$1,031,625
Lawrence	$5,345	$46	$1	$5,391
Lebanon	$155,327	$21,619	$530	$177,476
Lehigh	$429,647	$46,082	$350	$476,079
Luzerne	$120,973	$21,160	$50	$142,183
Lycoming	$35,841	$9,861	$59	$45,761
McKean	$2,787	$573	$1	$3,362
Mercer	$5,667	$162	$1	$5,830
Mifflin	$12,125	$844	$11	$12,979
Monroe	$132,406	$28,763	$35	$161,204
Montgomery	$2,666,217	$286,323	$3,522	$2,956,062
Montour	$10,517	$2,640	$12	$13,169
Northampton	$411,918	$45,325	$501	$457,745
Northumberland	$44,589	$5,265	$82	$49,935
Perry	$18,535	$665	$5	$19,206
Philadelphia	$5,173,328	$535,028	$7,131	$5,715,486
Pike	$65,381	$21,209	$3	$86,593
Potter	$1,613	$23	$0	$1,636
Schuylkill	$83,724	$5,425	$113	$89,262
Snyder	$14,909	$1,679	$51	$16,639
Somerset	$17,597	$594	$18	$18,209
Sullivan	$3,782	$1,863	$0	$5,645
Susquehanna	$13,860	$6,645	$2	$20,507
Tioga	$4,862	$986	$1	$5,849
Union	$16,479	$4,123	$15	$20,617
Venango	$2,239	$21	$0	$2,259
Warren	$4,520	$2,621	$3	$7,143
Washington	$33,954	$510	$7	$34,471
Wayne	$25,769	$7,036	$2	$32,808
Westmoreland	$57,454	$1,006	$19	$58,480
Wyoming	$10,648	$4,562	$1	$15,211
York	$583,723	$78,989	$1,692	$664,403
Total	**$18,808,722**	**$2,368,681**	**$27,016**	**$21,204,420**

Table 4.3.7-6 Potential business interruption losses from hurricane wind hazards (Average Annualized Loss).

COUNTY	INCOME LOSS (MILLION $)	RELOCATION LOSS (MILLION $)	RENTAL INCOME LOSS (MILLION $)	WAGE LOSS (MILLION $)	TOTAL BUSINESS INTERRUPTION LOSSES (MILLION $)
Adams	$170	$3,787	$1,410	$396	$5,762
Allegheny	$14	$2,191	$1,226	$5	$3,437
Armstrong	$1	$104	$45	$1	$151
Beaver	$0	$178	$96	$0	$275
Bedford	$18	$356	$138	$44	$555
Berks	$1,256	$19,420	$8,337	$2,335	$31,347
Blair	$45	$814	$384	$85	$1,327
Bradford	$3	$218	$93	$6	$320
Bucks	$9,857	$120,301	$48,991	$14,280	$193,428
Butler	$0	$183	$79	$0	$262
Cambria	$48	$586	$273	$112	$1,019
Cameron	$0	$13	$6	$0	$19
Carbon	$34	$853	$357	$77	$1,322
Centre	$33	$756	$413	$46	$1,248
Chester	$4,303	$54,855	$21,533	$6,236	$86,927
Clarion	$1	$51	$24	$2	$79
Clearfield	$18	$274	$119	$45	$456
Clinton	$3	$133	$67	$8	$211
Columbia	$118	$1,506	$646	$208	$2,478
Crawford	$0	$32	$15	$0	$47
Cumberland	$388	$6,265	$2,720	$676	$10,049
Dauphin	$799	$11,087	$4,931	$1,852	$18,669
Delaware	$6,439	$83,506	$37,330	$11,258	$138,533
Elk	$4	$79	$35	$7	$124
Erie	$1	$72	$39	$1	$113
Fayette	$10	$517	$237	$14	$779
Forest	$0	$15	$5	$0	$21
Franklin	$161	$3,789	$1,514	$346	$5,809
Fulton	$4	$157	$51	$10	$223
Greene	$1	$122	$50	$4	$177
Huntingdon	$8	$277	$113	$28	$427
Indiana	$8	$175	$85	$20	$288
Jefferson	$9	$127	$53	$27	$216
Juniata	$5	$204	$74	$12	$296
Lackawanna	$80	$1,448	$906	$151	$2,586

Table 4.3.7-6 Potential business interruption losses from hurricane wind hazards (Average Annualized Loss).					
COUNTY	INCOME LOSS (MILLION $)	RELOCATION LOSS (MILLION $)	RENTAL INCOME LOSS (MILLION $)	WAGE LOSS (MILLION $)	TOTAL BUSINESS INTERRUPTION LOSSES (MILLION $)
Lancaster	$4,369	$52,252	$20,665	$7,483	$84,769
Lawrence	$0	$64	$30	$0	$94
Lebanon	$571	$9,033	$3,511	$1,037	$14,151
Lehigh	$1,225	$14,336	$7,218	$1,835	$24,614
Luzerne	$85	$2,243	$1,197	$170	$3,695
Lycoming	$69	$1,117	$522	$165	$1,873
McKean	$0	$40	$17	$0	$57
Mercer	$0	$88	$42	$0	$131
Mifflin	$7	$284	$124	$15	$430
Monroe	$113	$2,298	$1,017	$173	$3,600
Montgomery	$12,353	$117,675	$51,652	$17,004	$198,684
Montour	$26	$499	$202	$78	$805
Northampton	$890	$15,255	$6,306	$1,720	$24,170
Northumberland	$88	$2,154	$856	$240	$3,338
Perry	$16	$459	$176	$33	$684
Philadelphia	$29,922	$291,590	$152,536	$42,004	$516,052
Pike	$17	$908	$374	$46	$1,345
Potter	$0	$21	$8	$0	$29
Schuylkill	$129	$2,985	$1,182	$400	$4,696
Snyder	$31	$553	$219	$73	$875
Somerset	$27	$493	$217	$54	$790
Sullivan	$0	$44	$16	$1	$61
Susquehanna	$2	$136	$56	$7	$201
Tioga	$3	$89	$41	$5	$138
Union	$30	$507	$239	$73	$849
Venango	$0	$17	$9	$0	$26
Warren	$4	$48	$22	$9	$83
Washington	$9	$619	$290	$7	$925
Wayne	$6	$372	$147	$10	$535
Westmoreland	$15	$947	$424	$24	$1,410
Wyoming	$3	$134	$54	$5	$195
York	$1,829	$30,609	$11,349	$3,161	$46,949
Total	**$75,679**	**$862,318**	**$393,113**	**$114,125**	**$1,445,235**

Figure 4.3.7-3 Map of average annualized losses for hurricane wind hazard (Hazus, 2018).



As discussed in Section 4.1.3, the 2018 SHMP recognized the importance of protecting not just lives and property, but sense of place as well. To this end, historic buildings were also included in the assessment of jurisdictional vulnerability to hurricane winds. The data source and definition of historic buildings is described further in Section 4.1.3. Table 4.3.7-7 shows the number and percent of historic buildings in each county located in census tracts characterized by high hurricane risk. As in the state vulnerability assessment, high risk census tracts were identified based on the hazard values available through FEMA's National Risk Index (FEMA NRI, 2018). A total of 365 historic buildings are located in high hazard census tracts, with 128 located in Philadelphia alone.

Table 4.3.7-7 Vulnerability of historic buildings to hurricane winds (PHMC, as of June 14, 2018).

COUNTY	AT-RISK HISTORIC BUILDINGS	% OF COUNTY HISTORIC BUILDINGS
Adams	29	53%
Allegheny	0	0%
Armstrong	0	0%
Beaver	0	0%
Bedford	0	0%
Berks	0	0%
Blair	0	0%
Bradford	0	0%
Bucks	128	42%
Butler	0	0%
Cambria	0	0%
Cameron	0	0%
Carbon	0	0%
Centre	0	0%
Chester	0	0%
Clarion	0	0%
Clearfield	0	0%
Clinton	0	0%
Columbia	0	0%
Crawford	0	0%
Cumberland	0	0%
Dauphin	0	0%
Delaware	0	0%
Elk	0	0%
Erie	0	0%
Fayette	0	0%
Forest	0	0%
Franklin	16	15%
Fulton	0	0%
Greene	0	0%

Table 4.3.7-7 Vulnerability of historic buildings to hurricane winds (PHMC, as of June 14, 2018).		
COUNTY	AT-RISK HISTORIC BUILDINGS	% OF COUNTY HISTORIC BUILDINGS
Huntingdon	0	0%
Indiana	0	0%
Jefferson	0	0%
Juniata	0	0%
Lackawanna	0	0%
Lancaster	0	0%
Lawrence	0	0%
Lebanon	0	0%
Lehigh	16	14%
Luzerne	0	0%
Lycoming	0	0%
McKean	0	0%
Mercer	0	0%
Mifflin	0	0%
Monroe	54	92%
Montgomery	0	0%
Montour	0	0%
Northampton	84	73%
Northumberland	0	0%
Perry	0	0%
Philadelphia	0	0%
Pike	23	72%
Potter	0	0%
Schuylkill	0	0%
Snyder	0	0%
Somerset	0	0%
Sullivan	0	0%
Susquehanna	0	0%
Tioga	0	0%
Union	0	0%
Venango	0	0%
Warren	0	0%
Washington	0	0%
Wayne	0	0%
Westmoreland	0	0%
Wyoming	0	0%
York	10	6%
Total	**365**	**6%**

4.3.8. Invasive Species

4.3.8.1. Location and Extent

An invasive species is any living species that is not native to an ecosystem and causes damage. The environment, the economy, and even human health can be impacted by an invasive species. Often, an invasive species spreads and reproduces quickly. They aren't limited to organisms that come from a foreign country; invasive species can come from a different region in the United States (National Wildlife Federation, 2018). The Commonwealth of Pennsylvania hosts several invasive pathogens, insects, plants, invertebrates, fish, and mammals. These species have largely been introduced by the actions of humans. Common pathways for invasive species threats include unintentional release of species, the movement of goods and equipment that may unknowingly harbor species, smuggling, ship ballast, hull fouling, and escape from cultivation (PISC, 2010). The Governor's Invasive Species Council of Pennsylvania (PISC), the lead organization for invasive species threats, recognizes two types of invasive species: Aquatic and Terrestrial.

- ***Aquatic Invasive Species*** are nonnative viruses, invertebrates, fish, and aquatic plants that threaten the diversity or abundance of native species, the ecological stability of the infested waters, human health and safety, or commercial, agriculture, aquaculture, or recreational activities dependent on such waters.
- ***Terrestrial Invasive Species*** are nonnative arthropods, vascular plants, higher vertebrates, or pathogens that complete their lifecycle on land instead of in an aquatic environment and whose introduction does or is likely to cause economic or environmental harm or harm to human health.

PISC identifies many species threats that are now or could potentially become significant in Pennsylvania but does not prioritize or rank them. These species are listed in Table 4.3.8-1.

Table 4.3.8-1 Invasive species of concern to the Commonwealth.

INVASIVE SPECIES OF CONCERN IN PENNSYLVANIA*		
Aquatic Invasive Species		
Amphibians and Reptiles		
Red-Eared Slider	Yellow-bellied Slider	
Fishes, Diseases, Invertebrates		
Northern Snakehead	Round Goby	
European Rudd	Sea Lamprey	Zebra Mussel
Tubenose Goby	West Nile Virus	Asian Clam
Asian Carp	Viral Hemorrhagic Septicemia	Rusty Crayfish
Eurasian Ruffe	Spring Viremia of Carp	Spiny Waterflea
Flathead Catfish	Quagga Mussel	Fishhook Waterflea
Mammals and Birds		
Nutria	Mute Swans	Canada Goose
Submerged Aquatic Plants		
Wild Taro	Water Chestnut	Limnophila Sessiliflora
Hydrilla	Eurasian Watermilfoil	Carolina fanwort
Curly Leaf Pondweed	Giant Salvinia	Parrot feather
Alligator Weed	East Indian Hygrophila	Brazilian waterweed

Table 4.3.8-1 Invasive species of concern to the Commonwealth.

INVASIVE SPECIES OF CONCERN IN PENNSYLVANIA*		
Aquatic Invasive Species		
Water Spinach	Didymo	Hydrilla
Terrestrial Aquatic Plants		
Narrow Leaved Cattail	Japanese Knotweed	Giant Knotweed
Japanese Hops	Common Reed	Hybrid Cattail
Giant Hogweed	Purple Loosestrife	
Terrestrial Invasive Species		
Human and Animal Pathogens		
Avian Influenza	Plague	Q Fever
Smallpox	Salmonellosis	Chronic Wasting Disease
West Nile Virus	Brucellosis	Bovine Spongiform Encephalopathy
Foot and Mouth Disease	Anthrax	
Botulism	Glanders	
Plant Pathogens		
Chrysanthemum White Rust	Potato Wart	Plum Pox Virus
Dutch Elm Disease	White Pine Blister	Ralstonia Blight
Sudden Oak Death	European Stone Fruit Yellows	Ring Rot
Birds		
European Starling	Pigeons	House Sparrows
Monk Parakeet		
Insects and Other Invertebrates		
Japanese Beetle	Gypsy Moth	Tracheal Mite
Pine Shoot Beetle	Brown Marmorated Stink Bug	Non-Native Earthworms
Emerald Ash Borer	Ahemlock Wooly Adelgid	Potato Cyst Nematode
Exotic Bark Beetle	Elongate Hemlock Scale	Golden Nematode
Asian Longhorned Beetle	Beech Bark Scale	Soybean Cyst Nematode
Siren Wood Wasp	Varroa Mite	Giant African Snail
Spotted Lanternfly		
Higher Mammals		
Norway Rat	13-Lined Ground Squirrel	Feral Swine
House Mouse		
Vascular Plants		
Tropical Soda Apple	Goatsrue	Asiatic Bittersweet
Beach Vitex	Multiflora Rose	Japanese Knotweed
Benghal Dayflower	Johnsongrass	Tree of Heaven
Rosary Pea	Garlic Mustard	Purple Loosestrife
Cagon Grass	Mile-A-Minute	Japanese Hops
Kudzu	Canada Thistle	Common Reed

*The species listed in this table were identified as invasive species of concern by the Governor's Council on Invasive Species and/or the Pennsylvania Department of Agriculture. This list is not comprehensive.

The location and extent of these invasive threats depends on the preferred habitat of the species as well as the species' ease of movement and establishment. For example, kudzu vine is an aggressive vascular plant; with its wide ecological parameters and ease of spread, the vine is a more widespread invasive species threat. Other species' spread has been limited by state agency activity, like the spotted lanternfly. First discovered in Berks County in 2014, this Asian plant hopper was placed under a quarantine by the Pennsylvania Department of Agriculture in thirteen counties: Berks, Bucks, Carbon, Chester, Delaware, Lancaster, Lebanon, Lehigh, Monroe, Montgomery, Northampton, Philadelphia, and Schuylkill (PA Department of Agriculture, 2018). Overall, though, consistent with their invasive nature, these threats can infiltrate most areas of the Commonwealth.

Most new introductions of invasive species occur because of human activity. There are a few key pathways to introduction into Pennsylvania:

- 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

4.3.8.2. Range of Magnitude

The magnitude of invasive species threats ranges from nuisance to widespread killer. Some invasive species like the Brown Marmorated Stink Bugs are not considered an agricultural pest and do not harm humans. Other invasive species can cause significant changes in the composition of Pennsylvania ecosystems. For example, the spotted lanternfly will inflict weeping wounds on trees, and the sap will attract other insects, especially ants and wasps. Another insect originally from Asia, the Emerald Ash Borer, has a 99% mortality rate for any ash tree it infects. Didymo, an aggressive form of algae, can clog waterways and smother native aquatic plants and animals. Microbial species can also be invasive, and can cause widespread illness or death in humans. Among the animal invasive pathogens profiled by the USDA's National Invasive Species Information Center are Avian Influenza, West Nile Virus, and Zika Virus Disease.

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 possible worst-case scenario would be if the spotted lanternfly spread to the rest of the Commonwealth, and then ultimately, to the rest of the country. Though the spotted lanternfly isn't known to kill trees, the insect has caused major damage to agriculture in other countries, especially South Korea. If the insect spreads, it could seriously affect the grape, hops, and logging industries. With the weeping wounds the spotted lanternfly creates on trees, more unwanted insects will flock to feed on the tree sap (PA Department of Agriculture).

4.3.8.3. Past Occurrence

Invasive species have been entering the Commonwealth since the arrival of early European settlers, but not all occurrences have required government action. The first invasive species outbreak requiring state attention occurred in 1862 when legislation was enacted to provide for the destruction of and to prevent the spread of Canada Thistle, Johnson Grass, and Marijuana. Since then, there have been 26 acts and quarantines enacted to prevent the spread of invasive species. As illustrated in Table 4.3.8-2, the volume of acts and quarantines has increased since 2000 (PISC, 2013).

Table 4.3.8-2 Previous Occurrences of Invasive Species Events Requiring State Action or Quarantine.

YEAR	SPECIES	YEAR	SPECIES
1911	Chestnut Blight Disease	2003	Black Carp, Bighead Carp, Silver Carp
1917	Tuberculosis	2005	Eurasian Watermilfoil
1919	European Wart Disease of the Potato	2006	Chronic Wasting Disease
1923	Japanese Beetle	2006	Scrapie
1925	European Corn Borer	2006	Vesicular Stomatitis
1927	Canada Thistle, Wild Garlic, Orange Hockweed, King-Devil, Sow Thistle, Field Bindweed	2007	Emerald Ash Borer
1933	White Pine Blister	2007	Feral Pig
1933	Gypsy Moth	2008	Viral Hemorrhagic Septicemia Virus
1935	Mosquitos	2009	Avian Influenza
1953	Black Stem Rust	2009	Tuberculosis
1983-84	Avian Influenza	2009	Emerald Ash Borer (expansion of previous quarantine)
1992	Pine Shoot Beetle	2009	West Nile encephalitis, Chronic Wasting Disease, Spring Viremia of Carp, Viral Hemorrhagic Septicemia, Lymphocitic Choriomeningitis Virus, Equine Rhinopneumonitis
1996	Reptile and Amphibian Species	2010	Emerald Ash Borer (expansion of quarantine to Allegheny, Armstrong, Beaver, Bedford, Butler, Indiana, Juniata, Lawrence, Mercer, Mifflin, Washington and Westmoreland Counties)
1999	Plum Pox Virus	2014	Thousand Canker Disease
		2014	Spotted Lanternfly

The PISC has begun tackling human and animal pathogens, aquatics, insects, mammals, plant pathogens, and vascular plants through management programs between the PA Fish and Boat Commission, the Game Commission, the Department of Agriculture, and DCNR. Notably, the

PISC lists management programs for feral swine, kudzu, giant hogweed, mile-a-minute, emerald ash borer, plum pox virus, zebra and quagga mussels, and viral hemorrhagic septicemia under its "completed actions." This does not mean that these threats have been eliminated; rather, it indicates that there is an active management plan in place to reduce future occurrences.

4.3.8.4. Future Occurrence

According to the PISC, the probability of future occurrence for invasive species threats is on the rise because of the growing volume of transported goods, increasing technology, 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 countries and regions. In 2017 Pennsylvania imported over $83 billion in goods from abroad, including agricultural, forestry, and fisheries goods that commonly carry unknown pests (U.S. Census, 2017). Furthermore, climate change is contributing to the introduction of new invasive species. As maximum and minimum seasonal temperatures change and growing seasons lengthen, pests are able to establish themselves in areas with previously inhospitable climates. The longer growing season also gives introduced species an earlier start and more time to outcompete native species. This may shift the dominance of ecosystems in favor of nonnative species over time. For more information on recent changes in extreme temperatures, see Section 4.3.4.

Recent state actions to combat the growing threat of invasive species include a 2017 executive order to expand PISC, the 2017 Noxious Weed Act to help protect farms and properties from some of the most invasive plant species of concern, and the Invasive Species Management Plan released in April 2010. This plan outlines the Commonwealth's goals for the management of the spread of nonnative invasive species and creates a framework for responding to threats through research, action, and public outreach and communication. More information on the Management Plan can be found online at http://www.invasivespeciescouncil.com. Individual management plans by PISC member agencies and organizations will also help to reduce the number and/or magnitude of invasive species threats in the future.

4.3.8.5. Environmental Impacts

There is a wide range of environmental impacts caused by invasive species. 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. Beyond causing human, animal, and plant harm, there are secondary impacts of invasive species that go beyond harm to host species and ecosystems – for example, the impacts caused by invasive species that attack forests. Pennsylvania's forests prevent soil degradation and erosion, protect watersheds, stabilize slopes, and absorb carbon dioxide emissions. The key role of forests in the hydrologic system means that if forest land is wiped out, the effects of erosion and flooding will be amplified. There is also an impact on agricultural harvests like honey, potatoes, and stone fruits. As a state with strong agricultural production, Pennsylvania is at risk of significant economic disruption from invasive species.

4.3.8.6. State Facility Vulnerability Assessment and Loss Estimation

Invasive species do not pose a direct threat to state critical facility buildings. However, the critical facilities inventory developed for this plan update identifies 275 agricultural critical facilities. It can be expected that invasive species will have either a direct effect on critical facilities in this category by hindering production or an indirect effect by increasing the cost of food production inputs. However, the exact vulnerability depends on the species in question.

State facility vulnerability is low for invasive species when referring to buildings owned by the state, but the buildings owned and leased by the Department of Conservation and Natural Resources, Game Commission, and Fish and Boat Commission are potentially more at risk if they are sited in Pennsylvania's wild and natural areas. Additionally, while they are not identified as state critical facilities, the Commonwealth owns and administers 2.5 million acres of state forests that provide clean water, recreational opportunities, habitat for wildlife, and places to enjoy the tranquility of nature. These forests are constantly vulnerable to invasive species threats.

The Pennsylvania Wilds Initiative, a consortium of thirteen counties in north-central Pennsylvania with significant forest resources, recently indicated that their 2 million acres of public natural landscape represent a $126 million-dollar state investment (PA Wilds, 2018). An aggressive invasive species threat to these or other state-owned lands could result in significant economic loss. Additionally, the total value of Pennsylvania's agricultural products is nearly $6 billion; an invasive species that affects agricultural products and production can cause significant losses to the Commonwealth's economy.

In addition to the potential losses to state facilities, combatting invasive species is an expensive task. In its Invasive Species Management Plan, DNCR reports spending $220,000 in 2011 alone to suppress the Hemlock Woolly Adelgid. Other forest pest surveys cost $500,000 per year, and the gypsy moth suppression program ranges from $500,000 to $10 million annually. Currently, DNCR is working to revise and update its invasive species plan. Should the invasive species threat grow, the budgets of DCNR and other state agencies could be strained. These programs could cause an undue burden on budgets.

4.3.8.7. Jurisdictional Vulnerability Assessment and Loss Estimation

Nationally, the United States Department of Agriculture estimates that lost agricultural production, pest management costs, and monetary losses from decreased tourism and recreation surpass $138 billion annually. In Pennsylvania, losses will depend from jurisdiction to jurisdiction depending on the aggressiveness of the invasive species of concern. Jurisdictional losses due to invasive species threats stem from three sources: lost revenue from diseased, damaged, or deceased crops, livestock, lumber, or other agricultural commodities; economic losses from the cost of eradication programs; and losses in the form of illness or death of humans.

From the perspective of potential agricultural losses, relative jurisdictional vulnerability could be determined by comparing each jurisdiction's timber and agricultural production. County-by-county estimates for the market value of timber, lumber and wood products are unavailable, but DCNR estimates that the total value of the state's wood products is $11.5 billion (PA DCNR, 2017). County-by-county estimates of farmland acreage and the market value of agricultural products (excluding timber) are presented in Table 4.3.8-3. The counties with the highest agricultural production and the greatest potential agricultural losses are Lancaster, Chester, and Berks. The market value of agricultural products in each of these counties exceeds $500 million.

Table 4.3.8-3 Estimated jurisdictional losses relating to agricultural production (USDA Census of Agriculture, 2012)

COUNTY	IMPACTED FARMLAND ACREAGE	MARKET VALUE OF ALL AGRICULTURAL PRODUCTS
Adams	171,305	$201,742,000
Allegheny	34,837	$10,397,000
Armstrong	129,090	$35,861,000
Beaver	55,795	$20,913,000
Bedford	209,795	$122,820,000
Berks	233,744	$528,711,000
Blair	90,117	$107,701,000
Bradford	307,990	$128,794,000
Bucks	64,024	$62,418,000
Butler	136,237	$52,905,000
Cambria	76,889	$32,641,000
Cameron	6,215	$692,000
Carbon	21,162	$9,339,000
Centre	162,041	$91,581,000
Chester	164,495	$660,744,000
Clarion	115,976	$36,136,000
Clearfield	69,250	$13,691,000
Clinton	52,715	$60,558,000
Columbia	122,743	$74,351,000
Crawford	227,731	$116,075,000
Cumberland	154,879	$195,356,000
Dauphin	129,378	$122,589,000
Delaware	4,725	$9,781,000
Elk	23,488	$4,229,000
Erie	168,634	$91,675,000
Fayette	112,871	$27,023,000
Forest	8,283	$1,820,000
Franklin	264,521	$413,806,000
Fulton	112,210	$52,975,000
Greene	112,358	$14,574,000
Huntingdon	158,300	$93,503,000
Indiana	153,752	$67,307,000
Jefferson	91,288	$27,729,000
Juniata	91,032	$101,440,000
Lackawanna	32,750	$13,237,000
Lancaster	439,481	$1,474,954,000

Table 4.3.8-3 Estimated jurisdictional losses relating to agricultural production (USDA Census of Agriculture, 2012)		
COUNTY	**IMPACTED FARMLAND ACREAGE**	**MARKET VALUE OF ALL AGRICULTURAL PRODUCTS**
Lawrence	80,468	$38,519,000
Lebanon	121,413	$348,933,000
Lehigh	76,331	$90,833,000
Luzerne	66,577	$20,993,000
Lycoming	158,462	$72,202,000
McKean	36,297	$4,952,000
Mercer	163,148	$82,650,000
Mifflin	90,554	$94,023,000
Monroe	26,483	$10,974,000
Montgomery	30,780	$25,594,000
Montour	43,493	$47,425,000
Northampton	65,744	$43,496,000
Northumberland	129,501	$154,339,000
Perry	135,075	$140,401,000
Philadelphia	285	$768,000
Pike	28,260	$2,965,000
Potter	96,689	$35,450,000
Schuylkill	105,749	$165,853,000
Snyder	91,179	$165,493,000
Somerset	214,581	$104,209,000
Sullivan	37,481	$9,517,000
Susquehanna	166,399	$43,321,000
Tioga	205,158	$80,258,000
Union	93,241	$135,970,000
Venango	61,531	$20,747,000
Warren	82,419	$20,747,000
Washington	205,821	$35,412,000
Wayne	112,998	$32,352,000
Westmoreland	143,062	$48,610,000
Wyoming	68,749	$14,616,000
York	262,062	$234,064,000
TOTAL	***7,710,091***	***$7,405,754,000***

4.3.9. Landslide

4.3.9.1. Location and Extent

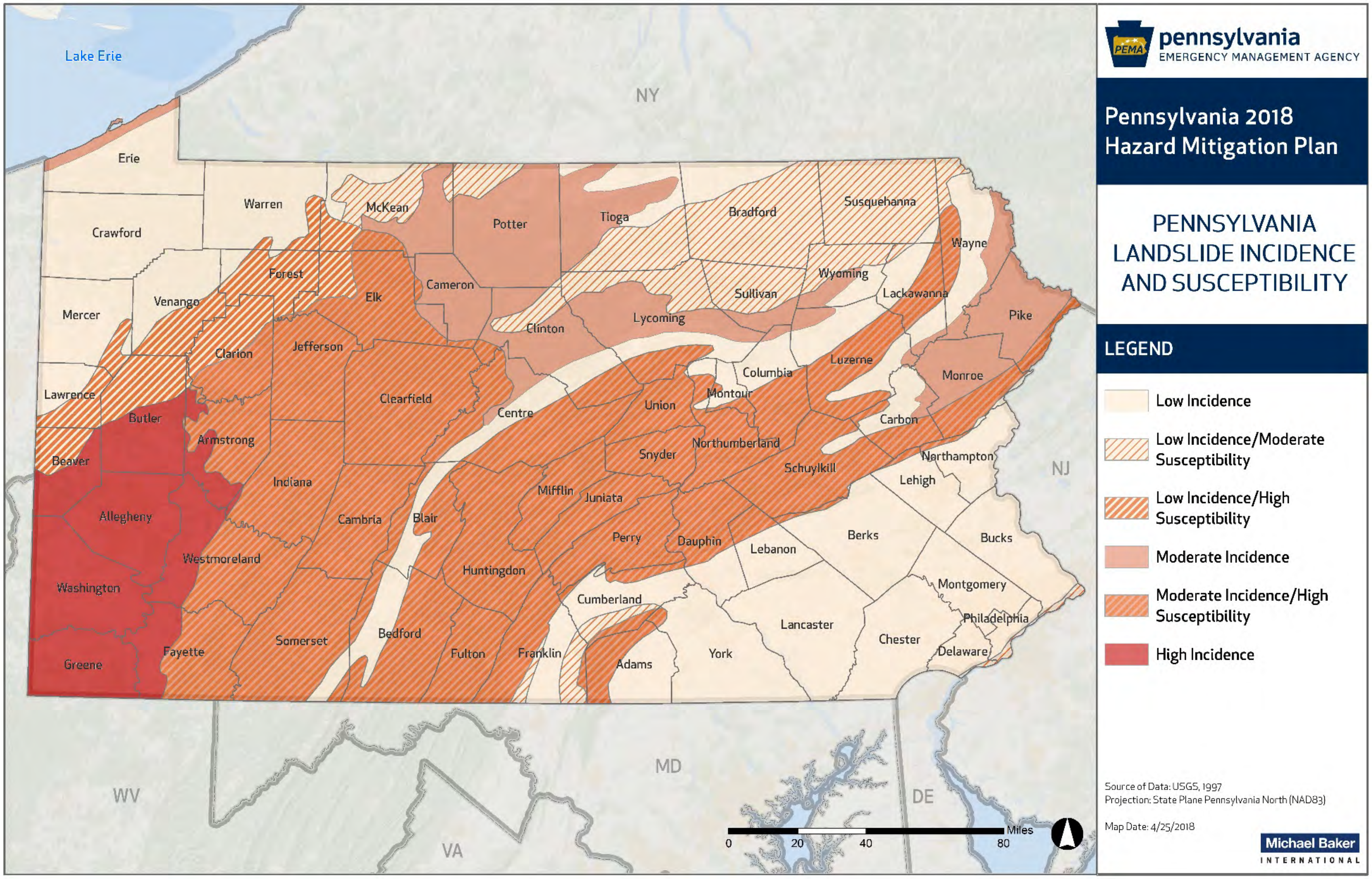
A landslide is the downward and outward movement of earth materials reacting under the force of gravity. As such, “landslide” can be used to describe a number of different types of events displaying different movement characteristics and involving different materials. Rockslides, rock falls, mudflows, mudslides, debris flows, and debris avalanches are all types of landslide events that involve different materials moving in a different manner. Landslides typically occur when some factor (e.g., increased water content or change in load) causes the force of gravity to outweigh the forces working to hold material in place, resulting in the downslope movement of the subject material. Several natural and human factors may contribute to or influence landslides. These factors include topography, geology, precipitation, steepness of cut and fill slopes, and cut-slope stability.

Mudslides, also referred to as mudflows, lahars, or debris avalanches, are quick moving rivers of earth, rock, and other debris flooded with water. Mudslides develop when water rapidly accumulates in the ground, typically from heavy rainfall or rapid snowmelt, creating a river of “slurry” or mud. A slurry can travel several miles from its original location, and increase in volume as it carries materials such as trees and cars. Slurries are especially dangerous due to their fast movement down slopes, and little warning when at avalanche speeds. Once the mudslide reaches flatter ground, the mudflow will spread out over a broad area where it can gather in thick deposits. In the United States alone, landslides have been known to cause up to $3.5 billion in damages, and nearly 25 to 50 deaths annually (USGS, 2004).

Rockfalls and other slope failures occur in areas of Pennsylvania with moderate to steep slopes. Many slope failures are associated with precipitation events – periods of sustained above-average precipitation, severe rainstorms, or snowmelt events. Areas experiencing erosion, decline in vegetation cover and earthquakes are also susceptible to landslides. Landslides can also occur on manmade slopes such as along highways or through development that contributes to slope failure by altering the natural slope gradient, increasing soil water content or removing vegetation cover. Figure 4.3.9-1 shows the range of landslide susceptibility and incidence for Pennsylvania indicating which areas are most vulnerable to landslide events. The southwest region of the state has the highest risk of landslide, impacting the following counties: Greene, Washington, Allegheny, Butler, Beaver, Westmoreland, Armstrong, and Fayette.

Landslides have occurred in many parts of Pennsylvania, but are most abundant and most troublesome in much of the Appalachian Plateaus physiographic province of western and north-central Pennsylvania. This region is recognized as one of the major areas of landslide susceptibility and severity in the United States (Baker and Chieruzzi, 1959; Radbruch-Hall et al., 1982). The Monongahela River Valley of northern West Virginia and southwestern Pennsylvania has a special place in landslide folklore. The name “Monongahela” is derived from an American Indian word that is translated as “river with the sliding banks” or “high banks which break off and fall down” (Espenshade, 1925). The Monongahela Valley and Pittsburgh in southwestern Pennsylvania is the most landslide-prone portion of the Commonwealth.

Figure 4.3.9-1 Landslide susceptibility and incidence across Pennsylvania (USGS, 1997).



4.3.9.2. Range of Magnitude

Landslides cause damage to transportation routes, utilities and buildings (Figure 4.3.9-2). They can also create travel delays and other side effects. Fortunately, deaths and injuries due to landslides are rare in Pennsylvania. Almost all of the known deaths due to landslides have occurred when rockfalls or other slides along highways have involved vehicles. Storm-induced debris flows are the only other type of landslide likely to cause death and injuries. As residential and recreational development increases on and near steep mountain slopes, the hazard from these rapid events will also increase. In addition, landslides can potentially have disastrous flood effects when they descend into water bodies, diverting or entirely blocking water flows.

Figure 4.3.9-2 Photos showing damage to a private home (left) and PA Route 51 (right) due to landslide incidents.

(Photograph by *V.W.H. Campbell, Jr., Pittsburgh Post-Gazette. February 1983*)

The effect of landslides on the human population in Pennsylvania is substantial. However, cost data for historical landslide damages is sparse. Landslide damage estimates for Allegheny County (Pittsburgh and suburbs) from 1970-1976 estimate that annual costs ranged from $1.3 to $4.0 million over this 7-year period, averaging $2.2 million per year (PEMA, 2007). The maximum annual cost of $4.0 million occurred in 1972, the year of Tropical Storm Agnes. Data from Pennsylvania Department of Transportation indicate that $6.0 million was spent to repair landslide damage along state roads in Allegheny County during the 6.5-year period from January 1971 through July 1977. Costs to private citizens (e.g. transportation delays or detours) are not included in these estimates.

The Pennsylvania Department of Transportation and large municipalities incur substantial costs due to landslide damage and to 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 is spent on mitigation costs for grading projects (PA DCNR, 2009).

4.3.9.3. Past Occurrence

Pennsylvania has a long history of landslide activity. This has resulted from a combination of the state's humid temperate climate, locally steep and rugged topography, and great diversity in the erosion and weathering characteristics of near-surface sedimentary rocks. Human activities such as commercial, industrial, and residential developments, transportation, and mining often compound landslide problems. Precipitation events which have triggered significant landslides in Pennsylvania include: Tropical Storm Agnes in June 1972, the Johnstown (Cambria County) storm in July 1977, and the East Brady (Armstrong County) storm in August 1980.

More recently, 2018 was a record year for landslides in the greater Pittsburgh area. According to the mayor of Pittsburgh, the city was already five times over budget for landslide remediation by mid-April. The causes of the increased landslide activity included record rainfall, the annual freeze-thaw cycle, and a record number of water breaks (90.5 WESA, 2018). Landslide events across the region resulted in damaged vehicles, closed roads, and home evacuations. Among the most destructive was a landslide along Route 30 in East Pittsburgh that collapsed a 300-foot section of the roadway.

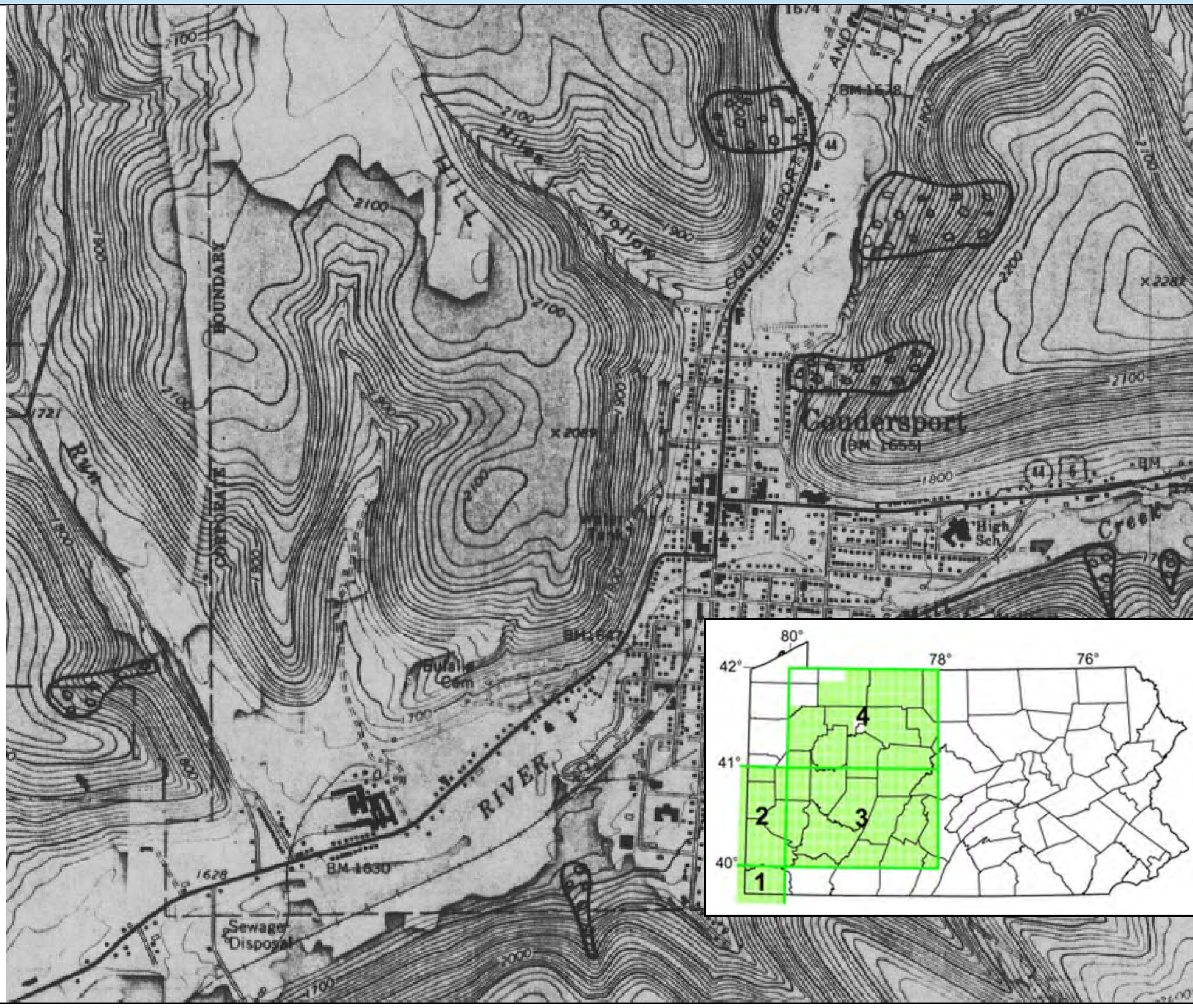
Figure 4.3.9-3 Photos showing damage to a private home (left) and PA Route 51 (right) due to landslide incidents.

(Photograph by *Gov. Tom Wolf/Flickr. 90.5 WESA. April 11, 2018*)

A comprehensive inventory of landslide events across the Commonwealth is not available, and the USGS does not maintain a formal inventory of landslides. Instead, the USGS Landslide

Hazards Program collects data as events are reported to the agency. However, the USGS created landslide inventory maps in the late 1970s and early 1980s for areas of central and western Pennsylvania as part of an Appalachians-wide study of landslides. These maps show landslides that were identified mainly from aerial photographs for most areas of Pennsylvania were landslides commonly occur. An example of one of these maps is shown in Figure 4.3.9-4. Additional maps are available at:
http://www.dcnr.state.pa.us/topogeo/hazards/landslides/slidepubs.aspx.

Figure 4.3.9-4 Example of landslide inventory map for Coudersport, PA from USGS Open File Map 81-238 (G-16 by John S. Pomeroy, 1981). An index map showing the coverage of the inventory is also provided (PA DCNR, 2009).



The NCEI has also begun capturing landslides as they occur in conjunction with severe storms. There are only two landslides recorded in the NCEI database. On July 4, 2011, isolated severe thunderstorms caused two landslides in Allegheny County. The first was a mudslide onto Forward Avenue in Pittsburgh that caused $5,000 in property damage. The second landslide reported with these thunderstorms was a rockslide on Bigelow Boulevard and Herron Avenue, also in Pittsburgh, which caused $10,000 in property damage. No injuries or fatalities were reported in either event.

Historically, Pennsylvania has experienced two catastrophic landslide events which resulted in multiple fatalities. In December 1942, a 150-cubic-yard rockslide along a highway near Ambridge, Beaver County, crushed a bus. Twenty-two people were killed and four were injured (Ackenheil, 1954; Gray and others, 1979). In February 1983, a 300-cubic yard rock fall occurred in Pittsburgh in during remedial excavation of a highway slope having a long history of rock falls. This rock fall crushed three vehicles, killing two people and injuring one. These events can be considered worst-case scenarios for Pennsylvania. In addition, every year one or more construction workers are typically killed or injured in cave-ins of trenches or other excavations in Pennsylvania.

The Southwestern Pennsylvania Commission (SPC) converted 125 USGS topographic maps in the southwest Pennsylvania that USGS had classified as active or recently active landslide events (SPC, 2017). SPC then digitized USGS's topographic maps and identified 4,565 sites from the maps where landslides had occurred in the past so that these locations would be further reviewed when they are in the proximity of future infrastructure projects. Considering all landslides are a significant hazard, SPC is attempting to increase the use and availability of accurate data to assist planners in making the most informed decisions. Table 4.3.9-1 below displays the summary of landslide events in southwestern Pennsylvania, with the majority of instances taking place in Greene County.

Table 4.3.9-1 Landslides in Southwestern Pennsylvania (Southwestern Pennsylvania Commission, 2017)

COUNTY	NUMBER OF LANDSLIDES	ACRES LOST
Allegheny	578	850
Armstrong	235	457
Beaver	213	132
Butler	63	40
Fayette	14	24
Greene	1,379	2,556
Indiana	47	47
Lawrence	3	10
Washington	1,945	3,075
Westmoreland	88	131
Total:	**4,565**	**7,322**

4.3.9.4. Future Occurrence

Landslides are often triggered by periods of heavy rainfall or rapid snow thaw, and often worsen the effects of flooding. In areas burned by forest and brush fires, a lower threshold of precipitation may initiate landslides. Some landslides move slowly and cause damage gradually, whereas others move so rapidly that they can destroy property and take lives suddenly and unexpectedly.

Areas that are generally prone to landslide hazards include previous landslide areas, the bases of steep slopes, the bases of drainage channels, and developed hillsides where leach-field septic systems are used. Considering frequent landslide events have occurred throughout the southeastern region of Pennsylvania, future occurrences can be expected in those same areas. Areas that are typically considered safe from landslides include areas that have not moved in the past, relatively flat-lying areas without sudden changes in slope, and areas at the top or along ridges, set back from the tops of slopes. Storm induced debris flows are landslides that may cause death and injuries. As residential and recreational development increases on and near steep mountain slopes, the hazards from these rapid events will also increase.

Using Figure 4.3.9-1, it is evident that the probability of future occurrence of landslide events varies depending on location. Additionally, of the events that do occur, the size and impact of those events also varies. The occurrence of landslide events ranges from low in southeastern and northwestern Pennsylvania to high in southwestern Pennsylvania. Studies investigating the probability of future occurrence of landslide events have not been identified. Based on historical events, knowledge of the topography of the Commonwealth, and input from the SPT, the annual occurrence of a landslide event of any magnitude is considered *highly likely* as defined by the Risk Factor Methodology (see Section 4.1). While landslides will continue to occur across Pennsylvania, the damage and magnitude of the events will continue to vary widely.

4.3.9.5. Environmental Impacts

The impact of landslides on the environment depends on the size and specific location of the event. In general, impacts include:

- Changes to topography
- Damage or destruction of vegetation
- Potential diversion or blockage of water in the vicinity of streams, rivers, etc.
- Increased sediment runoff both during and after event

Beyond the environmental impacts, landslides can have serious impacts on transportation routes, utilities, and buildings depending on their location.

4.3.9.6. State Facility Vulnerability Assessment and Loss Estimation

The vulnerability of state-owned or leased facilities and critical facilities to landslide was evaluated by identifying facilities located in areas classified as *high incidence* (more than 15% of the land involved in landsliding) or *high susceptibility* by USGS (Figure 4.3.9-1). Note that the vulnerability of individual state facilities will depend on many different site-specific characteristics, including local topography and soil type. For example, facilities located on steep slopes or built on loose soils are more likely to experience landslides. Additionally, facilities located in valleys are more likely to be buried by debris flow from upslope. The results of this assessment represent the potential impacts to state assets based on regional landslide incidence and susceptibility, but do not account for these site-specific factors.

Of the 4,460 geolocated state facilities, 2,183, or 49 percent, are located in areas characterize by high landslide hazard (Table 4.3.9-2 4.3.9-2). More than 78 percent of these vulnerable facilities belong to just three entities: Departments of Transportation and Corrections, and the Pennsylvania State System of Higher Education. The state facilities vulnerable to landslide hazard have a combined replacement value of more than $1.1 billion, or approximately 29% of the known value of geolocated state facilities.

Table 4.3.9-2 Vulnerability of state facilities to landslide

TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	4	44%
Department of Banking and Securities	0	0%
State Civil Service Commission	0	0%
Department of Community and Economic Development	2	50%
Department of Agriculture	3	19%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	408	59%
Department of Education	0	0%
Department of Environmental Protection	7	54%
Department of General Services	10	8%
Department of Health	23	48%
Department of Labor and Industry	30	43%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	44	45%
Department of Revenue	3	30%
Department of Transportation	925	55%
Drug and Alcohol Programs	0	0%
Executive Offices	2	100%
Fish and Boat Commission	71	46%
Governor's Office	1	100%
Insurance	0	0%
Liquor Control Board	236	43%
Emergency Management Agency	8	100%
Historical & Museum Commission	10	33%
State Police	17	47%
Public School Employees' Retirement System	3	50%
State Department	0	0%
State Employees' Retirement System	1	25%
Thaddeus Stevens College of Technology	0	0%
Treasury	2	100%
State System of Higher Education	373	44%

Table 4.3.9-2 Vulnerability of state facilities to landslide		
TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Total	2,183	**49%**

Of the 14,011 geolocated critical facilities, a total of 6,318, or 45 percent of the total, were identified as vulnerable to landslide hazard (4.3.9-2). Dams and fire stations were identified as having the highest numbers of vulnerable structures, with 1,404 and 1,407 vulnerable structures, respectively. Police stations were identified as having the highest percentage of total structures vulnerable to landslide, with 49 percent of all structures in high hazard areas. The critical facilities vulnerable to landslide hazard have a combined replacement value of more than $85 billion, or approximately 44 percent of the known value of geolocated critical facilities.

Table 4.3.9-3 Vulnerability of critical facilities to landslide		
TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Agricultural	99	36%
Banking	1	33%
Commercial	6	22%
Communication	329	53%
Dams	1,404	41%
Education (colleges and universities)	51	32%
Education (public schools)	1,247	39%
Emergency Operation Centers	33	48%
Energy	14	25%
Fire Stations	1,407	52%
Government	5	20%
Hospitals	151	44%
National Monuments or Icons	1	17%
Nuclear	2	40%
Police Stations	614	49%
Transportation	30	40%
Water	924	51%
Total	**6,318**	**45%**

4.3.9.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to landslide hazard, all census tracts with centers located in areas classified by the USGS as *high incidence* or *high susceptibility* were identified. The population, building counts, and building value of all vulnerable census tracts were then aggregated to the county scale (Table 4.3.9-4). As noted above, landslides are a highly localized hazard and the estimates presented here are general estimates based on broad regional conditions. In addition, the vulnerability of people and buildings to landslide hazard is shaped by local land development regulations and permitting and enforcement processes. Municipalities that adopt and enforce subdivision and land development regulations to limit development in landslide-prone areas can significantly reduce vulnerability to landslides. The results of this assessment represent the potential impacts to buildings and people based on regional landslide incidence and susceptibility, but do not account for these site-specific and municipality-specific factors.

The counties with the largest numbers of vulnerable people and buildings are Allegheny, Westmoreland, and Luzerne Counties. Across the state, the total exposed building value for buildings located in high hazard census tracts is more than $510 million, which represents about 35 percent of the total building value in Pennsylvania.

Table 4.3.9-4 Vulnerability of people and buildings to landslide by county.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSANDS $)	% OF TOTAL BUILDING VALUE
Adams	12,752	5,686	$1,384,623	13%
Allegheny	1,230,360	501,670	$162,158,360	100%
Armstrong	67,512	32,065	$6,580,820	100%
Beaver	169,205	73,797	$19,203,313	100%
Bedford	31,496	15,844	$3,170,366	70%
Berks	0	0	0	0%
Blair	53,197	22,078	$5,424,725	42%
Bradford	0	0	0	0%
Bucks	0	0	0	0%
Butler	185,974	76,022	$21,424,680	100%
Cambria	137,762	63,511	$15,890,834	100%
Cameron	0	0	0	0%
Carbon	35,358	16,003	$3,692,394	50%
Centre	145,824	45,183	$14,746,891	93%
Chester	0	0	0	0%
Clarion	38,939	19,482	$4,144,992	100%
Clearfield	81,170	38,265	$7,716,072	100%
Clinton	8,263	3,455	$654,118	17%
Columbia	56,133	23,031	$6,106,898	86%
Crawford	0	0	0	0%
Cumberland	28,505	10,781	$2,718,194	10%
Dauphin	76,885	33,256	$8,725,761	27%
Delaware	0	0	0	0%
Elk	31,111	17,549	$4,163,676	100%
Erie	0	0	0	0%

Table 4.3.9-4 Vulnerability of people and buildings to landslide by county.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSANDS $)	% OF TOTAL BUILDING VALUE
Fayette	134,229	61,205	$12,455,931	100%
Forest	7,493	8,846	$1,313,439	100%
Franklin	33,253	14,305	$2,923,936	20%
Fulton	14,653	7,423	$1,359,021	100%
Greene	37,669	16,370	$3,410,883	100%
Huntingdon	45,844	22,004	$4,178,057	100%
Indiana	87,491	36,419	$8,257,699	100%
Jefferson	44,575	22,310	$4,559,018	100%
Juniata	24,811	10,842	$2,115,736	100%
Lackawanna	151,284	59,276	$18,026,499	70%
Lancaster	0	0	0	0%
Lawrence	35,130	16,365	$3,483,237	38%
Lebanon	6,063	2,447	$653,387	5%
Lehigh	0	0	0	0%
Luzerne	243,710	105,887	$27,664,869	78%
Lycoming	19,431	7,783	$1,728,915	15%
McKean	2,292	1,244	$242,883	5%
Mercer	14,162	4,991	$1,501,839	11%
Mifflin	46,585	21,202	$4,370,585	100%
Monroe	81,362	33,239	$8,881,945	47%
Montgomery	0	0	0	0%
Montour	14,464	6,153	$1,583,680	85%
Northampton	0	0	0	0%
Northumberland	82,994	38,527	$8,627,582	90%
Perry	45,647	20,310	$4,146,443	100%
Philadelphia	0	0	0	0%
Pike	17,943	9,941	$2,276,886	27%
Potter	0	0	0	0%
Schuylkill	145,503	67,956	$15,558,237	100%
Snyder	40,246	16,013	$3,699,402	100%
Somerset	72,724	36,189	$7,524,657	96%
Sullivan	0	0	0	0%
Susquehanna	2,092	837	$186,757	4%
Tioga	0	0	0	0%
Union	45,178	16,505	$4,099,142	100%
Venango	10,001	5,911	$1,367,277	24%
Warren	0	0	0	0%
Washington	208,269	90,284	$23,606,898	100%

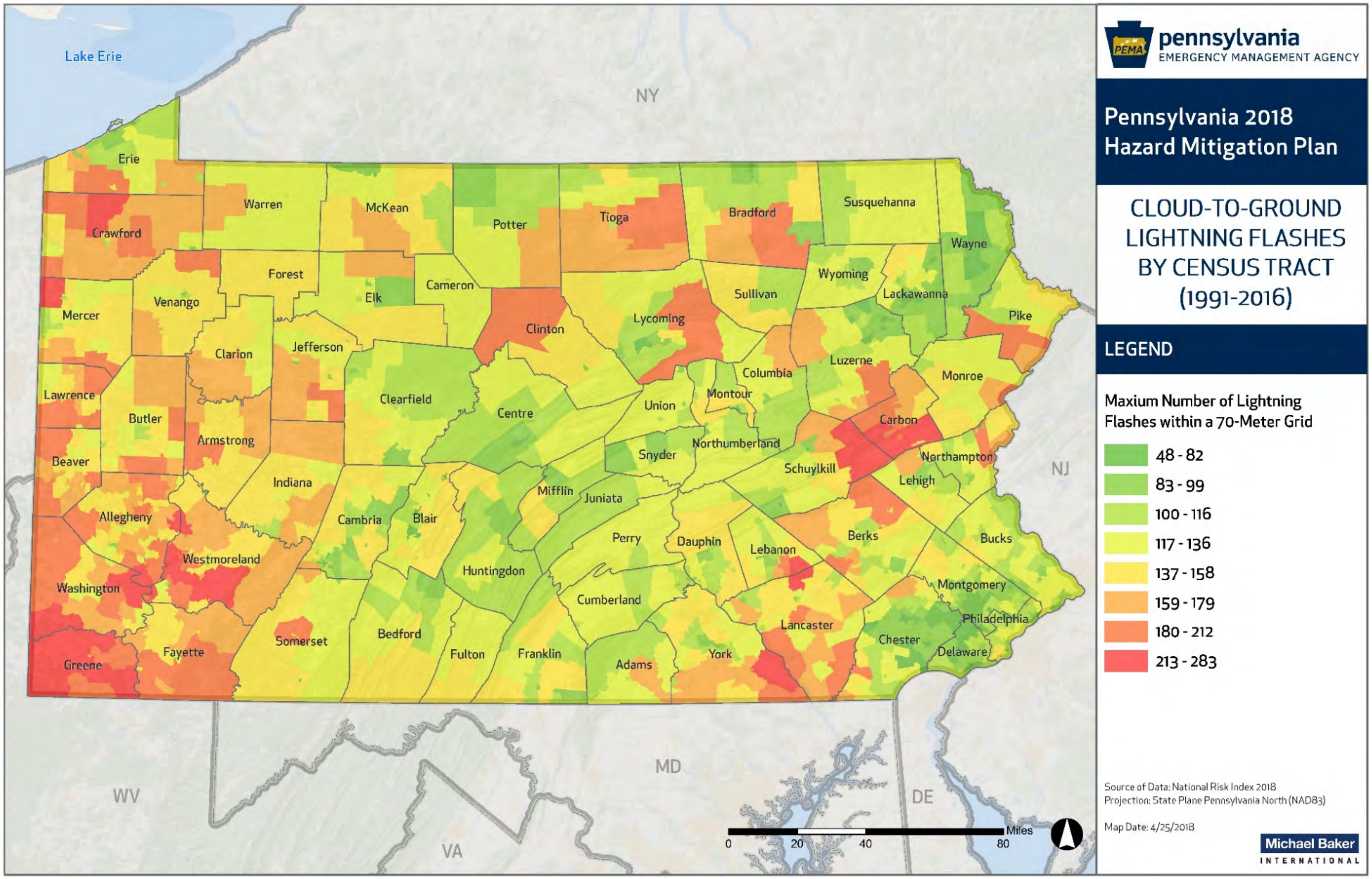
Table 4.3.9-4 Vulnerability of people and buildings to landslide by county.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSANDS $)	% OF TOTAL BUILDING VALUE
Wayne	9,255	3,080	$680,544	11%
Westmoreland	359,377	162,621	$41,191,281	100%
Wyoming	0	0	0	0%
York	5,396	2,137	$475,449	1%
TOTAL	**4,479,572**	**1,926,300**	**$510,058,831**	**35%**

4.3.10. Lightning Strike

4.3.10.1. Location and Extent

Lightning events occur across the entire Commonwealth. Although different areas experience varying event frequencies, lightning strikes occur primarily during the summer months. Figure 4.3.10-1 below illustrates the density of cloud-to-ground lightning flashes by Census Tract based on flashes that occurred between 1991 and 2016. The data was obtained from FEMA's National Risk Index in 2018. The map indicates that relatively more lightning flashes occur in southwestern Pennsylvania and in the Lehigh Valley than in other areas of the Commonwealth. 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 or large public venue. Eastern and southeastern Pennsylvania are at greater risk for death, injury, or damage to lightning than central and north-central sections of the Commonwealth due to higher population density.

Figure 4.3.10-1 Cloud-to-Ground Lightning Flashes by Census Tract, 1991-2016 (National Risk Index, 2018).



4.3.10.2. Range of Magnitude
Each year in the United States, lightning is responsible for an average of 47 deaths, injuries to hundreds more, and millions of dollars in property damage (NOAA NWS, 2018). In many cases, lightning events have caused heart damage. Inflated lungs and brain damage have also been observed from lightning fatality history. Loss of consciousness, amnesia, paralysis, and burns are reported by many who have survived. Deaths and injuries to livestock and other animals, thousands of forest and brush fires, as well as millions of dollars in damage to buildings, communications systems, power lines, and electrical systems are also the result of lightning.

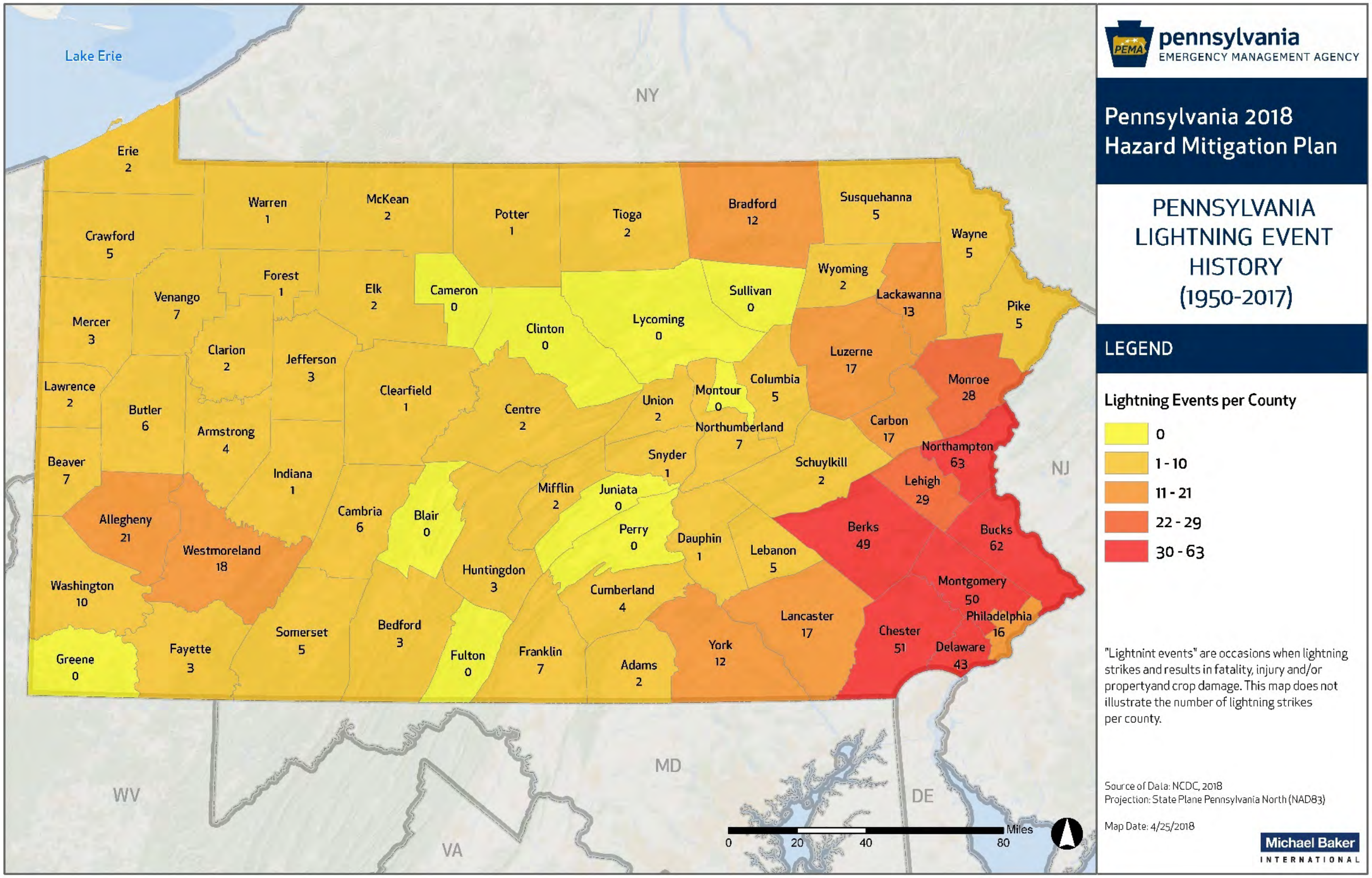
Between 1959 and 2016, Pennsylvania had 134 total lightning deaths. This is the ninth highest number of total lightning deaths among all states. It represents approximately 3% of all lightning deaths that occurred throughout the U.S. over that 57-year period. However, when considering population density, Pennsylvania ranked 38th among all states in terms of lightning deaths per year (Vaisala, 2017).

A worst-case lightning event would be lightning striking in a large crowd or gathering of people as might be found at a large sporting event or outdoor concert. This could result in mass deaths or injuries.

4.3.10.3. Past Occurrence
Records from the National Centers for Environmental Information (NCEI) (formerly the National Climatic Data Center) show that there were 657 lightning events in the 57 counties across Pennsylvania between 1950 and 2018. A lightning “event” is defined as a lightning strike that results in fatality, injury, and/or property or crop damage (NOAA NWS, 2016). Of these 57 counites, 33 have reported five or fewer events, 15 counties reported six to 20 events, and nine counties have reported more than twenty events over this 68-year period. Northampton and Bucks Counties have both reported the most events with 63 and 62 events, respectively (see Figure 4.3.10-2). Evaluation of previous versions of the SHMP show that while the absolute number of events have changed for individual counties, the basic pattern of vulnerability across the Commonwealth has remained relatively consistent. The recording of lightning events is highly subjective and therefore lightning vulnerability is clearly epistemic.

During the years from 1950 to 2018, the NCEI reports that, in Pennsylvania, lightning has caused 30 deaths and 2,257 injuries. The highest reported loss in property damage occurred in Braddock Borough, Allegheny County in 1995 when lightning caused $5 million dollars in damage after striking a deodorizer manufacturing plant. The subsequent fire completely engulfed and destroyed the entire facility.

Figure 4.3.10-2 Pennsylvania Lightning Event History, 1950-2018 (NCEI, 2018).



4.3.10.4. Future Occurrence

Figure 4.3.1-10 shows the frequency of cloud-to-ground lightning flashes in Pennsylvania between 1991 and 2016. While the map should not be used to predict future lightning activity, it provides a basic estimate of the number of lightning flashes that can be expected. As shown, in Pennsylvania, these values range from 48 to 283 lightning strikes within a 70-meter grid during this 25-year period.

It is worth noting that, while lightning flashes appear to be more frequent in western Pennsylvania, lightning strike events as shown in Figure 4.3.10-2 appear to be more common in southeast Pennsylvania and Allegheny and Westmoreland Counties. This is due to denser populations with an increased number of associated properties or structures in these areas.

The number of lightning events are influenced by the frequency of a severe thunderstorm occurrence. Therefore, potential future changes in climate and weather conditions may impact the future occurrences of lightning strikes. According to the Pennsylvania Climate Impacts Assessment Update, thunderstorms are projected to increase in frequency (Shortle et al, 2015). However, the future occurrence of lightning activity is not forecasted as lightning strikes are frequent and widespread and forecasters' understanding of the cloud electrification process is incomplete (NOAA NSSL, 2018).

4.3.10.5. Environmental Impacts

The environmental impacts most often associated with lightning strikes include damage or death to trees and ignition of wildfires.

4.3.10.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to lightning, all said facilities located in areas characterized as high risk were identified. High risk areas are defined as those where the maximum number of cloud-to-ground lightning flashes was greater than or equal to 180 within a 70-meter grid between 1991 and 2016. These areas were then intersected with state-owned or leased facilities and critical facilities. However, it should be noted that the precise vulnerability of lightning strikes will depend on a facility's height, surrounding buildings, as well as the absence or presence of a lightning rod or other lightning channeling technology in the structure.

As provided in Table 4.3.10-1, 433 state-owned or leased facilities were identified in areas at high risk to lightning, the highest concentration of which are structures owned or leased by the Department of Transportation. The State System of Higher Education similarly has a large number of facilities identified as vulnerable. However, these vulnerable facilities represent a relatively small percentage of the total structures for these departments. The replacement value of the 433 total vulnerable facilities is estimated to be more than $360 million, or nine percent of the value of all state-owned or leased facilities.

Table 4.3.10-1 Vulnerability of state facilities to lighting.		
DEPARTMENT	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF DEPARTMENT STRUCTURES**
Attorney General	1	11%
Department of Agriculture	0	0%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	60	9%
Department of Education	0	0%
Department of Environmental Protection	2	15%
Department of General Services	0	0%
Department of Health	1	2%
Department of Labor and Industry	3	4%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	3	3%
Department of Revenue	0	0%
Department of Transportation	182	11%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	3	2%
Governor's Office	0	0%
Historical and Museum Commission	2	7%
Insurance Department	0	0%
Liquor Control Board	40	7%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	1	25%
State Police	2	6%
State System of Higher Education	133	16%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	**433**	**10%**

With respect to critical facilities, the types of facilities most vulnerable to lightning strikes include fire departments, schools, police departments, and dams (Table 4.3.10-2). Any of the 18 food and agriculture facilities that raise livestock may be more vulnerable to lightning strikes as these animals tend to shelter under trees in storm situations. Should lightning strike the tree, it could kill all the animals under it at once. Additionally, two nuclear facilities were identified as at-risk, which represents 40 percent of all structures for that facility type.

Table 4.3.10-2 Vulnerability of critical facilities to lightning.

TYPE	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF STRUCTURES BY TYPE
Agricultural	18	7%
Banking	0	0%
Commercial	0	0%
Communication	51	8%
Dam	426	12%
Education (colleges and universities)	3	2%
Education (public schools)	258	8%
Emergency Operation Center	2	3%
Energy	4	7%
Fire Station	315	12%
Government	0	0%
Hospital	11	3%
National Monument or Icon	0	0%
Nuclear	2	40%
Police Station	124	10%
Transportation	2	3%
Water	209	12%
Total	**1,425**	**10%**

A total of 1,425 critical facilities were identified in areas at high risk to lightning. The total replacement cost of these critical facilities is estimated to be more than $20.5, or 11 percent of the total value of all critical facilities in the Commonwealth. Note that losses due to lightning strikes will differ based on the magnitude of the event and the lightning protection measures on a given facility.

4.3.10.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To determine jurisdictional vulnerability to lightning strikes, GIS analysis was conducted to identify all Census Tracts located within areas characterized as high risk to lightning. As previously defined, high-risk areas are those where the maximum number of cloud-to-ground lightning flashes was greater than or equal to 180 within a 70-meter grid between 1991 and 2016. The total population and buildings within these Census Tracts were summed by County to determine the total vulnerable population and the total number and value of vulnerable buildings. Table 4.3.10-3 shows the results of this assessment.

Table 4.3.10-3 Vulnerability of people and buildings to lightning.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Adams	0	0	$0	0%
Allegheny	216,481	91,557	$27,689,640	17%
Armstrong	16,405	7,673	$1,559,963	24%
Beaver	35,561	15,667	$3,923,004	20%
Bedford	0	0	$0	0%
Berks	38,018	13,394	$3,794,863	8%
Blair	0	0	$0	0%
Bradford	10,855	5,570	$1,022,667	18%
Bucks	0	0	$0	0%
Butler	22,099	9,511	$2,387,873	11%
Cambria	0	0	$0	0%
Cameron	0	0	$0	0%
Carbon	47,411	22,068	$4,839,809	66%
Centre	0	0	$0	0%
Chester	2,693	924	$257,898	0%
Clarion	0	0	$0	0%
Clearfield	0	0	$0	0%
Clinton	3,031	3,151	$494,685	13%
Columbia	0	0	$0	0%
Crawford	18,640	10,063	$1,836,614	19%
Cumberland	0	0	$0	0%
Dauphin	0	0	$0	0%
Delaware	0	0	$0	0%
Elk	0	0	$0	0%
Erie	8,396	3,703	$843,685	3%
Fayette	32,733	15,949	$2,874,891	23%
Forest	0	0	$0	0%
Franklin	0	0	$0	0%
Fulton	0	0	$0	0%
Greene	33,599	14,985	$2,944,879	86%
Huntingdon	0	0	$0	0%
Indiana	0	0	$0	0%
Jefferson	4,362	1,731	$263,887	6%
Juniata	0	0	$0	0%
Lackawanna	0	0	$0	0%
Lancaster	82,833	30,532	$9,384,926	17%
Lawrence	18,116	8,434	$1,567,967	17%

Table 4.3.10-3 Vulnerability of people and buildings to lightning.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Lebanon	8,878	3,323	$999,409	7%
Lehigh	0	0	$0	0%
Luzerne	11,786	5,711	$1,475,862	4%
Lycoming	29,253	12,522	$2,716,374	23%
McKean	0	0	$0	0%
Mercer	10,192	4,608	$1,144,143	9%
Mifflin	0	0	$0	0%
Monroe	2,501	1,566	$426,477	2%
Montgomery	0	0	$0	0%
Montour	0	0	$0	0%
Northampton	31,402	12,390	$3,629,044	11%
Northumberland	0	0	$0	0%
Perry	0	0	$0	0%
Philadelphia	0	0	$0	0%
Pike	8,291	6,443	$1,391,112	16%
Potter	0	0	$0	0%
Schuylkill	24,280	11,455	$2,344,849	15%
Snyder	0	0	$0	0%
Somerset	16,458	5,897	$1,519,324	19%
Sullivan	0	0	$0	0%
Susquehanna	0	0	$0	0%
Tioga	15,777	6,922	$1,346,706	33%
Union	0	0	$0	0%
Venango	3,453	1,796	$294,315	5%
Warren	0	0	$0	0%
Washington	67,252	31,772	$7,129,546	30%
Wayne	0	0	$0	0%
Westmoreland	120,540	53,766	$13,893,749	34%
Wyoming	0	0	$0	0%
York	18,337	7,760	$1,795,610	4%
Total	**959,633**	**420,843**	**$105,793,771**	**7%**

A total of 30 counties were identified as including census tracts characterized by high lightning hazard. The assessment found that nearly 960,000 people and 421,000 buildings are located in these high risk census tracts. The largest concentrations of vulnerable population and buildings are in Allegheny and Westmoreland Counties, which include urban and suburban areas with high population and structure densities.

The total value of all vulnerable buildings in all high-risk areas is estimated to be $105.8 billion, which is seven percent of the total value of all buildings in the Commonwealth. The jurisdiction most threatened by lightning strikes in terms of the dollar value of loss is Allegheny County, with an estimated $27.7 billion in exposed building value. However, this represents only 17 percent of the total value of all buildings in the County. In Greene County, approximately 15,000 buildings valued at $2.9 billion were identified in high risk area, which represents 86 percent of the total value of all building in the County.

Losses due to lightning can be lessened by installing surge protection on critical electronic lighting or information technology systems. Lightning protection devices and methods such as lightning rods and grounding can be installed on a community's communications infrastructure and other critical facilities to reduce losses.

4.3.11. Pandemic and Infectious Disease

4.3.11.1. Location and Extent

Pandemic is defined as a disease affecting or attacking the population of an extensive region, including several countries, and/or continent(s). It is further described as extensively epidemic. Generally, pandemic diseases cause sudden, pervasive illness in all age groups on a global scale. Infectious diseases are also highly virulent, but are not spread person-to-person.

Pandemic and infectious disease events cover a wide geographical area and can affect large populations, potentially including the entire population of the Commonwealth. The exact size and extent of an infected population is dependent upon how easily the illness is spread, the mode of transmission and the amount of contact between infected and uninfected individuals. The transmission rates of pandemic illnesses are often higher in denser areas where there are large concentrations of people. The transmission rate of infectious disease will depend on the mode of transmission of a given illness. Pandemic events can also occur after other natural disasters, particularly floods, when there is the potential for bacteria to grow and contaminate water.

Historically, the Commonwealth is primarily concerned with three diseases with pandemic and infectious potential: Zika virus, West Nile virus, and influenza. Zika virus is an illness that is spread primarily through mosquito bites, but can also be transmitted through sexual intercourse or blood transfusion or passed from mother to child in the womb. The virus first became a public health concern after the 2015 outbreak in Brazil. Zika infection during pregnancy can cause serious birth defects, including microcephaly and other severe brain defects. In addition, Zika infection may be linked to an increased incidence of Guillain-Barre syndrome – a relatively uncommon neurological disease (CDC, 2018).

West Nile virus is a vector-borne disease that can cause headache, high fever, neck stiffness, disorientation, tremors, convulsions, muscle weakness, paralysis, and, in its most serious form, death. This virus is also spread via mosquito bite, and is therefore aided by warm temperatures and wet climates conducive to mosquito breeding. West Nile virus has been detected in all 67 counties at least once in the past 10 years. The virus is highly temporal with most cases occurring between April and October (PA DEP-WNCP, 2009).

Pandemic influenza 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. In 2009, H1N1 (swine) flu broke out into pandemic proportions, but now has been reduced to a regular human flu virus that circulates each season (CDC 2010). According to the federal government's Pandemic Influenza Plan 2017 Update, "pandemic influenza viruses can originate anywhere, vary in severity and population penetration, and each pandemic will differ in its range and impact" (U.S. Department of Health, 2017).

Influenza, also known as the flu, is a contagious disease that is caused by the influenza virus and most commonly attacks the respiratory tract in humans. The Influenza Pandemic Response Plan released by the Pennsylvania Department of Health in 2005 estimated the potential impact of an influenza pandemic within 12-16 weeks both across the country and within Pennsylvania. These estimates are shown in Table 4.3.11-1.

Table 4.3.11-1 Estimated morbidity and mortality during an influenza pandemic within 12-16 weeks

	UNITED STATES	PENNSYLVANIA
Require Outpatient Care	50 Million	1.6 Million
Hospitalizations	2 Million	37,800
Deaths	500,000	9,100

4.3.11.2. Range of Magnitude

The magnitude of a pandemic or infectious disease threat in the Commonwealth will range significantly depending on the aggressiveness of the virus in question and the ease of transmission. In the case of West Nile virus, slightly less than 80 percent of cases are clinically asymptomatic. Approximately 20 percent of cases result in mild infection, called West Nile fever, lasting two to seven days. However, one in 150 cases result in severe neurological disease or death. Since the appearance of West Nile virus in Pennsylvania in 2000, the worst year was 2003 when 237 Pennsylvanians were infected with the virus and 9 people died. The virus is typically more serious in older adults.

Pandemic influenza is more easily transmitted from person-to-person than West Nile, but advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. The magnitude of a pandemic may be exacerbated by the fact that an influenza pandemic will cause outbreaks across the United States, limiting the ability to transfer assistance from one jurisdiction to another. Additionally, effective preventative and therapeutic measures, including vaccines and other medications, will likely be in short supply or will not be available.

The 1918 Spanish flu pandemic remains the worst-case pandemic event on record both in Pennsylvania and worldwide. While mortality figures were probably under-reported, in the first month of the pandemic alone, 8,000 Pennsylvanians died from the flu or its complications (US DHHS, 2010). As the densest city in the Commonwealth, Philadelphia was experienced particularly high losses from this event.

4.3.11.3. Past Occurrence

More than 230 Zika virus cases were reported to the Pennsylvania Department of Health from 2015 to May of 2018. These include 183 virus disease cases (symptomatic individuals who tested positive for Zika virus), 51 virus infection cases (asymptomatic individuals who tested positive for Zika virus), and one presumptive viremic blood donor case (individuals who had no symptoms at the time of donating blood, but whose blood tested positive for Zika virus (PA Department of Health, 2018).

West Nile virus arrived in the United States in 1999 and was first detected in Pennsylvania in 2000 when mosquito pools, dead birds and/or horses in 19 counties tested positive for the virus. Since then, the number of positive counties, human cases, and West Nile deaths has fluctuated with the temperature and precipitation each year. Pennsylvania's West Nile Control Program tracks reported cases of the West Nile virus (Table 4.3.11-2).

Table 4.3.11-2 Previous West Nile virus occurrences in Pennsylvania 2007 to 2017 (PA West Nile Virus Control Program, 2018)

YEAR	NUMBER OF COUNTIES WITH VIRUS DETECTED	POSITIVE HUMAN CASES	HUMAN DEATHS
2007	25	8	0
2008	37	14	1
2009	33	0	0
2010	37	28	0
2011	59	6	0
2012	52	60	4
2013	42	12	1
2014	39	14	1
2015	56	30	1
2016	41	16	0
2017	49	20	0

While West Nile virus occurrences are fairly recent, the United States Department of Health and Human Services estimates that influenza pandemics have occurred for at least 300 years at unpredictable intervals. There have been several pandemic influenza outbreaks over the past 100 years. A list of events worldwide is shown in Table 4.3.11-3.

Table 4.3.11-3 List of previous significant outbreaks of influenza over the past century (Global Security, 2009; WHO, 2009).

DATE	PANDEMIC NAME/SUBTYPE	WORLDWIDE DEATHS (APPROXIMATE)
1918-1920	Spanish Flu / H1N1	50 million
1957-1958	Asian Flu / H2N2	1.5-2 million
1968-1969	Hong Kong Flu / H3N2	1 million
2009 - 2010	Swine Flu / A/H1N1	12,000

Deaths occurred in the United States as a result of the Spanish Flu, Asian flu, and Hong Kong Flu outbreaks. The Spanish Flu claimed 500,000 lives in the United States, and there were 350,000 cases in Pennsylvania – 150,000 in Philadelphia alone. Most deaths resulting from the Asian flu occurred between September 1957 and March 1958; there were about 70,000 deaths in the United States and approximately 15 percent of the population of Pennsylvania was affected. The first cases of the Hong Kong Flu in the U.S. were detected in September of 1968 with deaths peaking between December 1968 and January 1969 (Global Security, 2009).

More recently, the 2014-2015 flu season was marked as severe by the CDC, with approximately 710,000 hospitalizations. The CDC does not track national deaths in adults, but the organization reported 148 pediatric deaths from influenza. The 2017-2018 flu season was another severe season. The CDC reported that the H3N2 flu, along with other strains including H1N1, led to more cases, doctors' visits, hospital visits, and deaths than previous flu seasons. The CDC also noted that the flu became widespread in all states and jurisdictions at the same time. In January 2018, approximately halfway through the flu season, 37 pediatric deaths were reported. The CDC estimated that 34 million Americans were affected by the flu (CDC, 2018).

4.3.11.4. Future Occurrence

Future occurrences of pandemics and infectious diseases are unclear. Instances of the West Nile virus have been generally decreasing due to aggressive planning and eradication efforts. Prevention against the Zika virus, like mosquito control and insect repellent, has also increased, leading to less cases (PA Department of Health, 2018). Climate change may influence diseases spread through mosquitos.

As with West Nile Virus, the precise timing of pandemic influenza is uncertain, but occurrences are most likely when the Influenza Type A virus makes a dramatic change, or antigenic shift, that results in a new or "novel" virus to which the population has no immunity. This emergence of a novel virus is the first step toward a pandemic.

Future pandemics may also emerge from other diseases, especially invasive pathogens for which Pennsylvanians lack natural immunity.

4.3.11.5. Environmental Impacts

There are no true environmental impacts of pandemics and infectious disease threats, but there will be significant economic and social costs beyond the possibility of disease-related deaths. Widespread illness may increase the likelihood of shortages of personnel to perform essential community services. In addition, high rates of illness and worker absenteeism occur within the business community, and these contribute to social and economic disruption. Social and economic disruptions could be temporary but may be amplified in today's closely interrelated and interdependent systems of trade and commerce. Social disruption may be greatest when rates of absenteeism impair essential services, such as power, transportation, and communications.

4.3.11.6. State Facility Vulnerability Assessment and Loss Estimation

State facilities are no more or less vulnerable to pandemic and infectious disease than the general population. There are some occupation-specific risks that may make some employees more vulnerable, though. For example, those working in direct patient care situations are more likely to be exposed to a pandemic disease. Similarly, state employees working outdoors for extended periods of time in the warm months may be more vulnerable to West Nile or Zika virus.

The physical plant and facilities of the Commonwealth are not likely to be damaged by a pandemic disease outbreak. However, high rates of absenteeism associated with a pandemic or an infectious disease will likely lead to significant economic costs in lost productivity and increased medical costs in nearly all state agencies.

4.3.11.7. Jurisdictional Vulnerability Assessment and Loss Estimation

In general, jurisdictions that are more densely populated are more vulnerable to disease threats when the disease is directly spread from human to human, but every jurisdiction in the Commonwealth has some vulnerability to pandemic and infectious disease threats.

Jurisdictional losses in a pandemic or infectious disease outbreak stem from lost wages and productivity, not losses to buildings or land. Losses are difficult to estimate because the exact rates of absenteeism and cost of treating a widespread disease will depend on the virus or bacterium in question, the availability of vaccination or treatment, and the severity of symptoms. For historical context, though, the Asian and Hong Kong Flu pandemics killed over 1.5 million people worldwide and caused an estimated $32 billion loss due to lost productivity and medical expenses (Smith, 2004). With Pennsylvania’s economy so integral to the national economy, economic losses from a pandemic or infectious disease threat could be significant.

4.3.12. Radon Exposure

4.3.12.1. Location and Extent

Radioactivity caused by airborne radon has been recognized for many years as an important component in the natural background radioactivity exposure of humans, but it was not until the 1980s that the wide geographic distribution of elevated values in houses and the possibility of extremely high radon values in houses were recognized. In 1984, routine monitoring of employees leaving the Limerick nuclear power plant near Reading, PA, showed that readings on Mr. Stanley Watras frequently exceeded expected radiation levels, yet only natural, non-fission-product radioactivity was detected on him. Radon levels in his home were detected around 2,500 pCi/L (pico Curies per Liter), much higher than the 4 pCi/L guideline of the Environmental Protection Agency (EPA) or even the 67 pCi/L limit for uranium miners. As a result of this event, the Reading Prong section of Pennsylvania where Watras lived became the focus of the first large-scale radon scare in the world.

Radon is a noble gas that originates by the natural radioactive decay of uranium and thorium. Like other noble gases (e.g., helium, neon, and argon), radon forms essentially no chemical compounds and tends to exist as a gas or as a dissolved atomic constituent in groundwater. Two isotopes of radon are significant in nature, 222Rn and 220Rn, formed in the radioactive decay series of 238U and 232Th, respectively. The isotope thoron (i.e. 220Rn) has a half-life (time for decay of half of a given group of atoms) of 55 seconds, barely long enough for it to migrate from its source to the air inside a house and pose a health risk. However, radon (i.e. 222Rn), which has a half-life of 3.8 days, is a widespread hazard.

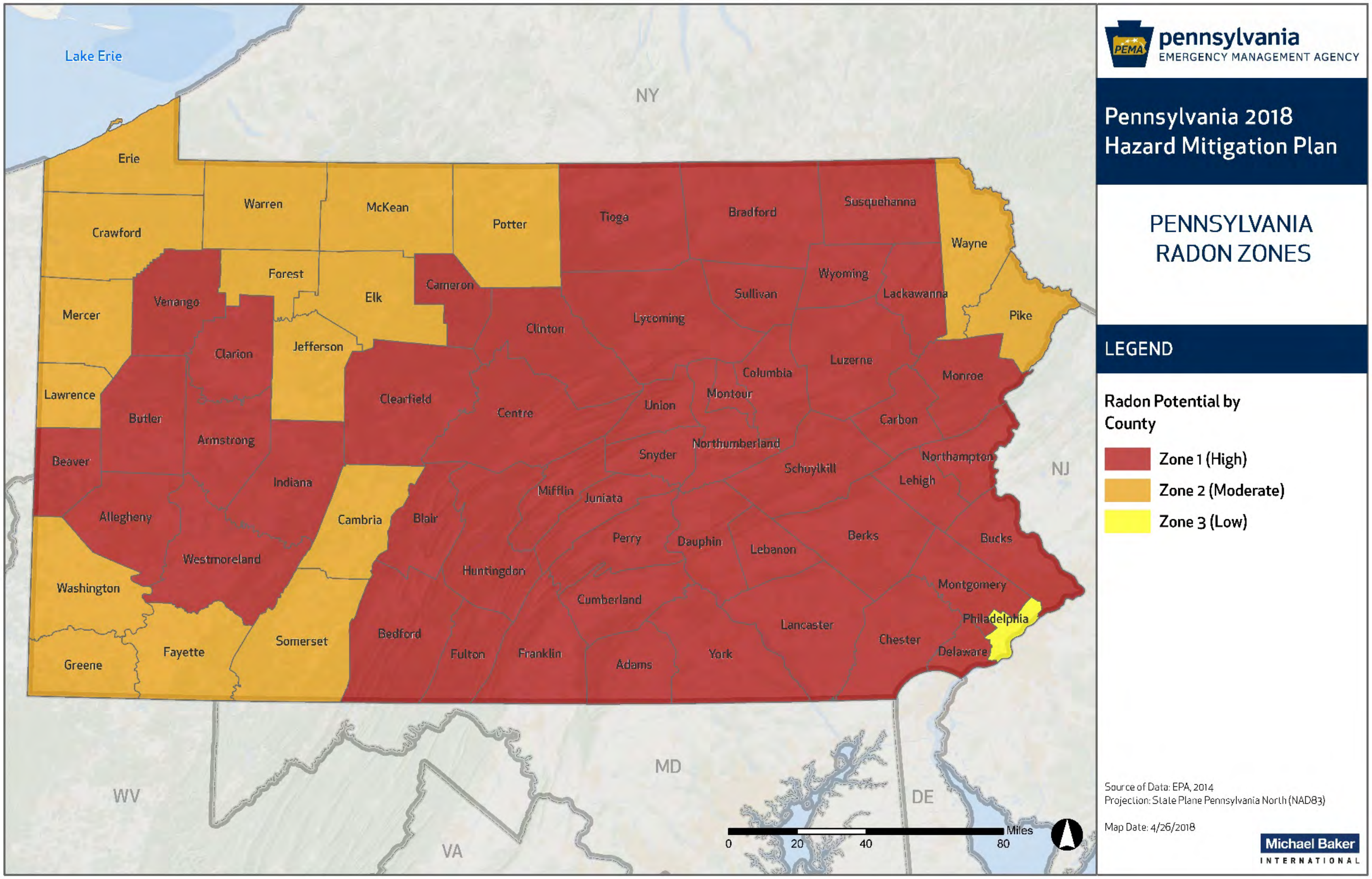
The distribution of radon is correlated with the distribution of radium (i.e. 226Ra), its immediate radioactive parent, and with uranium, its original ancestor. Due to the short half-life of radon, the distance that radon atoms can travel from their parent before decay is generally limited to distances of feet or tens of feet.

Three sources of radon in houses are now recognized:

- Radon in soil air that flows into the house;
- Radon dissolved in water from private wells and exsolved during water usage; this is rarely a problem in Pennsylvania; and
- Radon emanating from uranium-rich building materials (e.g. concrete blocks or gypsum wallboard); this is not known to be a problem in Pennsylvania.

Each county in Pennsylvania is classified as having a *low*, *moderate*, or *high* radon hazard potential (see Figure 4.3.12-1). While this analysis has not been repeated since 2014, it represents the best available comprehensive radon hazard potential information available. A majority of counties across the Commonwealth, particularly counties in eastern Pennsylvania, have a *high* hazard potential. A high hazard potential indicates that the average indoor radon screening level for these counties is greater than 4 pico-curies per liter (pCi/L). Counties with a moderate radon potential have an average indoor radon screening level between 2 pCi/L and 4 pCi/L. The City of Philadelphia is the only jurisdiction designated with a *low* radon hazard potential (less than 2 pCi/L) (EPA, 2014).

Figure 4.3.12-1 Radon hazard zones in Pennsylvania (EPA, 2014).



High radon levels were initially thought to be exacerbated in houses that are tightly sealed, but it is now recognized that rates of air flow into and out of houses, plus the location of air inflow and the radon content of air in the surrounding soil, are key factors in radon concentrations. Outflows of air from a house, caused by a furnace, fan, thermal “chimney” effect, or wind effects, require that air be drawn into the house to compensate. If the upper part of the house is tight enough to impede influx of outdoor air (radon concentration generally <0.1 pCi/L), then an appreciable fraction of the air may be drawn in from the soil or fractured bedrock through the foundation and slab beneath the house, or through cracks and openings for pipes, sumps, and similar features. Soil gas typically contains from a few hundred to a few thousand pCi/L of radon; therefore, even a small rate of soil gas inflow can lead to elevated radon concentrations in a house.

The radon concentration of soil gas depends upon a number of soil properties, the importance of which is still being evaluated. In general, ten to fifty percent of newly formed radon atoms escape the host mineral of their parent radium and gain access to the air-filled pore space. The radon content of soil gas clearly tends to be higher in soils containing higher levels of radium and uranium, especially if the radium occupies a site on or near the surface of a grain from which the radon can easily escape. The amount of pore space in the soil and its permeability for air flow, including cracks and channels, are important factors determining radon concentration in soil gas and its rate of flow into a house. Soil depth and moisture content, mineral host and form for radium, and other soil properties may also be important. For houses built on bedrock, fractured zones may supply air having radon concentrations similar to those in deep soil.

Areas where houses have high levels of radon can be divided into three groups in terms of uranium content in rock and soil:

- Areas of very elevated uranium content (>50 ppm) around uranium deposits and prospects. Although very high levels of radon can occur in such areas, the hazard normally is restricted to within a few hundred feet of the deposit. In Pennsylvania, such localities occupy an insignificant area.
- Areas of common rocks having higher than average uranium content (5 to 50 ppm). In Pennsylvania, such rock types include granitic and felsic alkali igneous rocks and black shales. In the Reading Prong, high uranium values in rock or soil and high radon levels in houses are associated with Precambrian granitic gneisses commonly containing 10 to 20 ppm uranium, but locally containing more than 500 ppm uranium. In Pennsylvania, elevated uranium occurs in black shales of the Devonian Marcellus Formation and possibly the Ordovician Martinsburg Formation. High radon values are locally present in areas underlain by these formations.
- Areas of soil or bedrock that have normal uranium content but properties that promote high radon levels in houses. This group is incompletely understood at present. Relatively high soil permeability can lead to high radon, the clearest example being houses built on glacial eskers. Limestone-dolomite soils also appear to be predisposed for high radon levels in houses, perhaps because of the deep clay-rich residuum in which radium is concentrated by weathering on iron oxide or clay surfaces, coupled with

moderate porosity and permeability. The importance of carbonate soils is indicated by the fact that radon contents in 93 percent of a sample of houses built on limestone-dolomite soils near State College, Centre County, exceeded 4 pCi/L, and 21 percent exceeded 20 pCi/L, even though the uranium values in the underlying bedrock are all in the normal range of 0.5 to 5 ppm uranium.

4.3.12.2. Range of Magnitude

Exposure to radon is the second leading cause of lung cancer after smoking. It is the number one cause of lung cancer among non-smokers. Radon is responsible for about 21,000 lung cancer deaths every year; approximately 2,900 of which occur among people who have never smoked. Lung cancer is the only known effect on human health from exposure to radon in air and thus far, there is no evidence that children are at greater risk of lung cancer than are adults (EPA, 2016).

According to the EPA, the average radon concentration in the indoor air of America's homes is about 1.3 pCi/L. The EPA recommends homes be fixed if the radon level is 4 pCi/L or more. However, because there is no known safe level of exposure to radon, the EPA also recommends that Americans consider fixing their home for radon levels between 2 pCi/L and 4 pCi/L. Table 4.3.12-1 shows the relationship between various radon levels, probability of lung cancer, comparable risks from other hazards, and action thresholds. As is shown in Table 4.3.12-1, a smoker exposed to radon has a much higher risk of lung cancer (EPA, 2016).

Table 4.3.12-1 Radon risk for smokers and non-smokers (EPA, 2016).

RADON LEVEL (PCI/L)	IF 1,000 PEOPLE WERE EXPOSED TO THIS LEVEL OVER A LIFETIME… *	RISK OF CANCER FROM RADON EXPOSURE COMPARES TO… **	ACTION THRESHOLD
SMOKERS			
20	About 260 people could get lung cancer	250 times the risk of drowning	Fix structure
10	About 150 people could get lung cancer	200 times the risk of dying in a home fire	Fix structure
8	About 120 people could get lung cancer	30 times the risk of dying in a fall	Fix structure
4	About 62 people could get lung cancer	5 times the risk of dying in a car crash	Fix structure
2	About 32 people could get lung cancer	6 times the risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3	About 20 people could get lung cancer	(Average indoor radon level)	Reducing radon levels below 2 pCi/L is difficult
0.4	About 3 people could get lung cancer	(Average outdoor radon level)	
NON-SMOKERS			
20	About 36 people could get lung cancer	35 times the risk of drowning	Fix structure
10	About 18 people could get lung cancer	20 times the risk of dying in a home fire	Fix structure

Table 4.3.12-1 Radon risk for smokers and non-smokers (EPA, 2016).			
RADON LEVEL (PCI/L)	**IF 1,000 PEOPLE WERE EXPOSED TO THIS LEVEL OVER A LIFETIME… ***	**RISK OF CANCER FROM RADON EXPOSURE COMPARES TO… ****	**ACTION THRESHOLD**
8	About 15 people could get lung cancer	4 times the risk of dying in a fall	Fix structure
4	About 7 people could get lung cancer	The risk of dying in a car crash	Fix structure
2	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing between 2 and 4 pCi/L
1.3	About 2 people could get lung cancer	(Average indoor radon level)	Reducing radon levels below 2 pCi/L is difficult
0.4		(Average outdoor radon level)	
NOTE: Risk may be lower for former smokers. * Lifetime risk of lung cancer deaths from EPA Assessment of Risks from Radon in Homes (EPA 402-R-03-003). ** Comparison data calculated using the Centers for Disease Control and Prevention's 1999-2001 National Center for Injury Prevention and Control Reports.			

The worst-case scenario for radon exposure would be that a large area of tightly sealed homes provided residents high levels of exposure over a prolonged period of time without the resident being aware. This worst-case scenario exposure then could lead to a large number of people with cancer attributed to the radon exposure.

4.3.12.3. Past Occurrence

Current data on abundance and distribution of radon in Pennsylvania houses is considered incomplete and potentially biased, but a study was conducted testing the basements and first floors of over 800,000 buildings throughout all 67 counties in Pennsylvania. A total of nearly 2 million data points were gathered and analyzed to determine radon concentrations in PA. 0 and Figure 4.3.12-3 show maps depicting the unadjusted median concentrations throughout the state and the levels of predicted radon contribution from geologic unit, county, and well water after accounting for variations in the tests, seasons, buildings, year, and average rainfall (Casey et al., 2015).

Figure 4.3.12-2 Unadjusted median basement radon concentrations in PA by geologic unit, 2006-2013. (Casey et al, 2015).

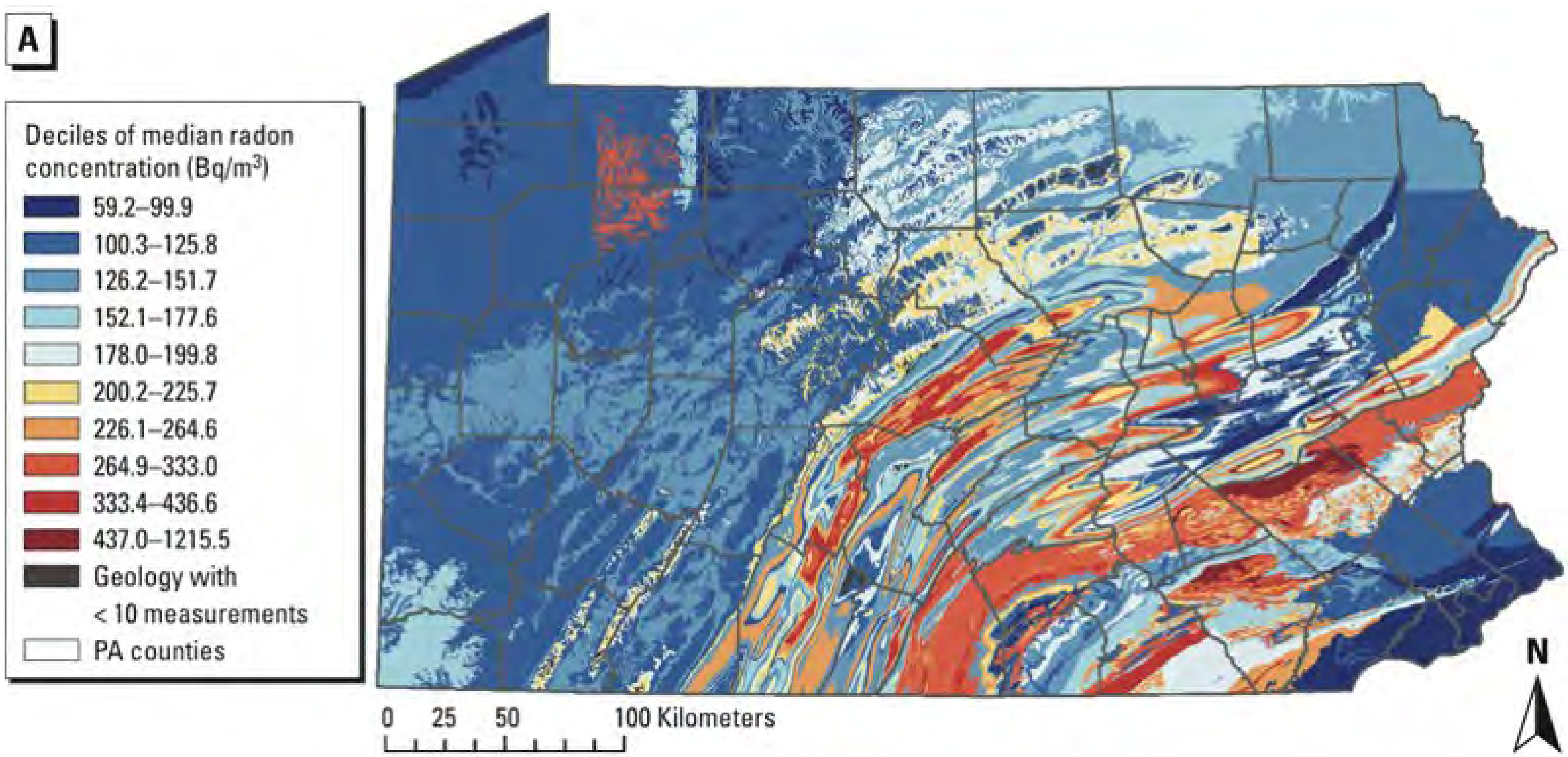
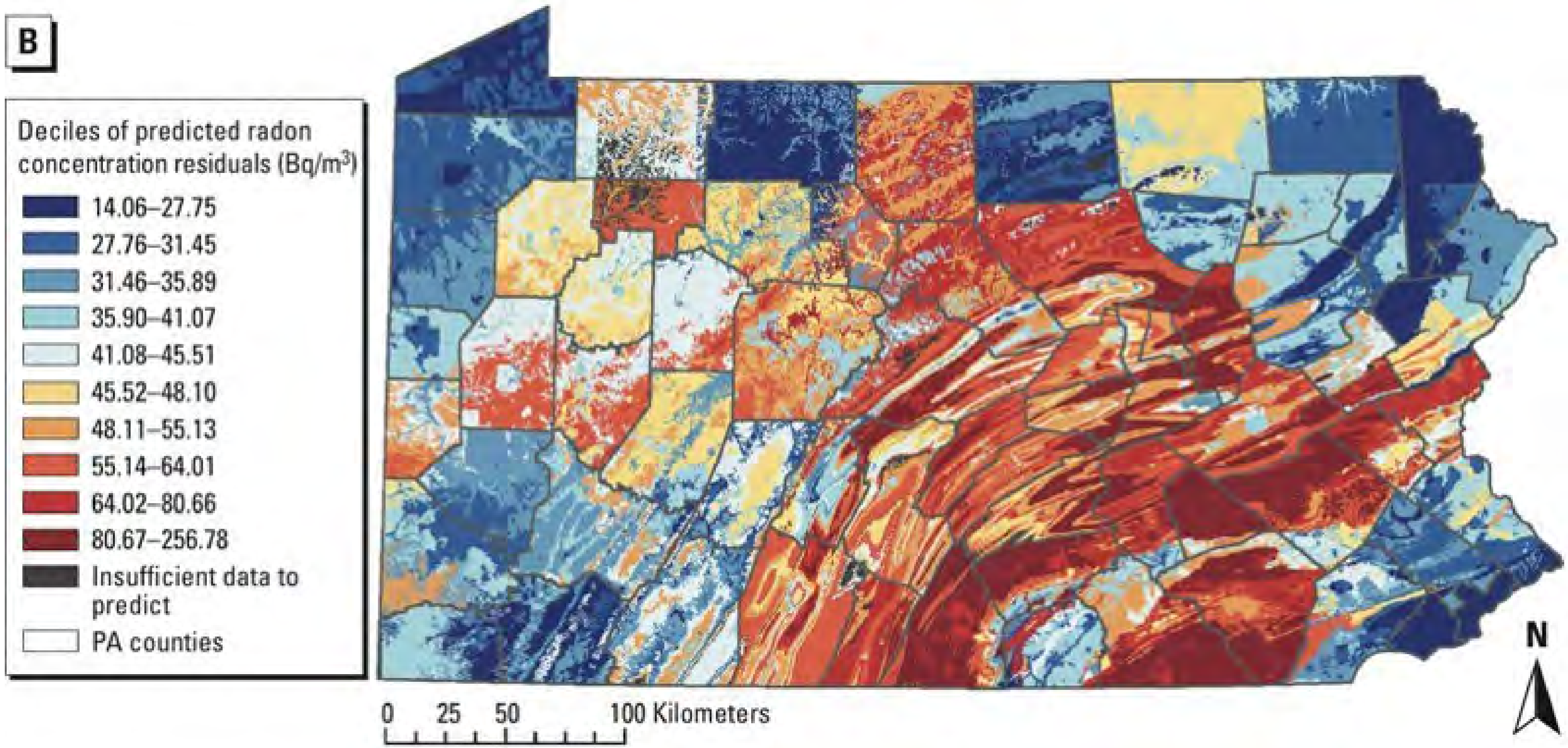
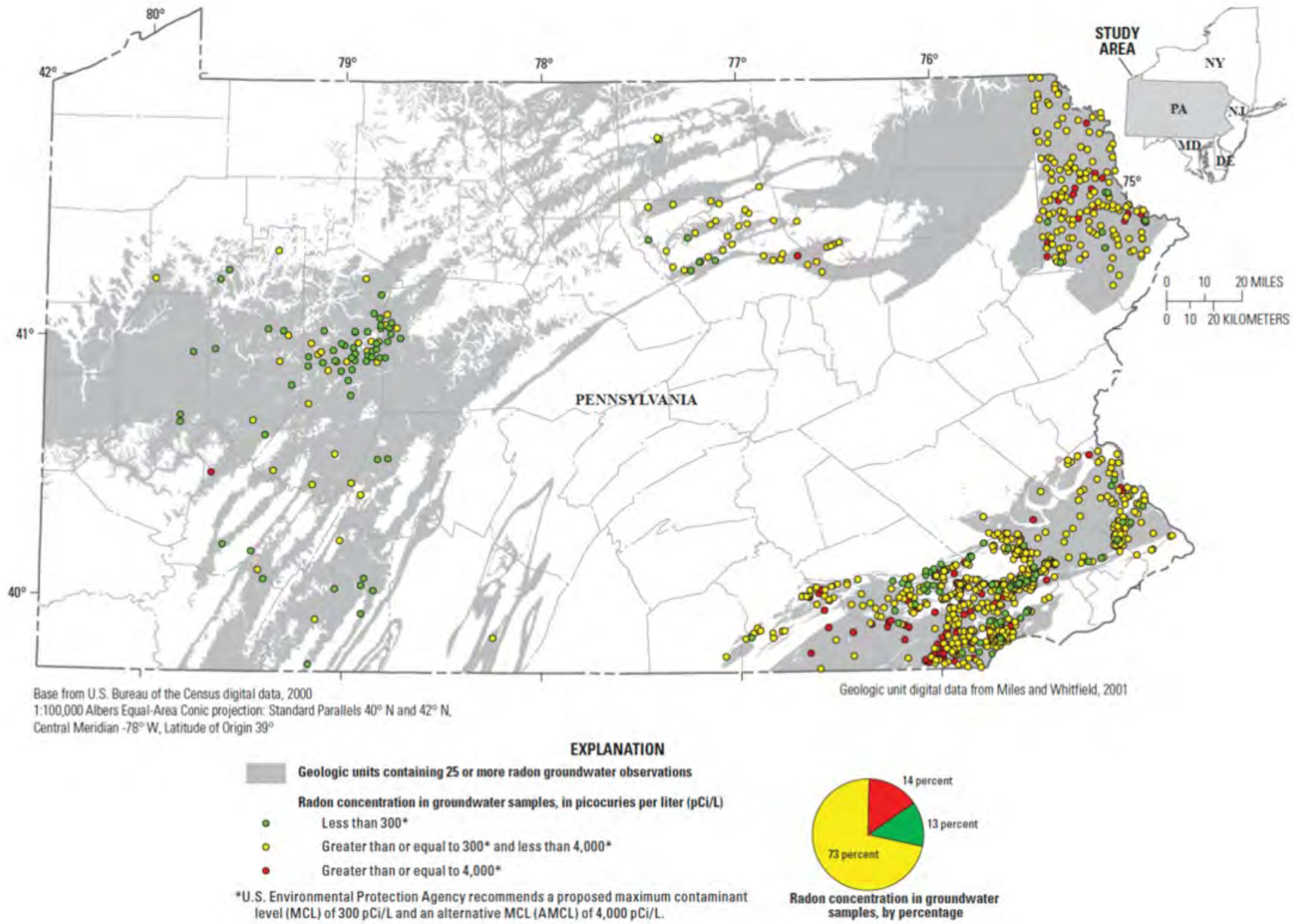


Figure 4.3.12-3 Predicted contribution to basement radon concentration from geologic unit, county, and well water after accounting for variation due to year, building type, test type, test duration, season, average temperature, and average rainfall (Casey et al, 2015).



The United State Geological Survey conducted a study with the Pennsylvania Department of Health and Environmental Protection to examine radon levels in wells throughout the state. The data for the study was collected from 1986 to 2015 and accounts for approximately 31 percent of the land area of Pennsylvania. The study concluded that more than 14 percent of the tested wells had radon levels “at or above the Environmental Protection Agency’s proposed alternative maximum contaminant level of 4,000 picocuries per liter.” The standard maximum concentration that the EPA suggests is 300 pCi/L, but they also have this alternative maximum for states with an EPA-approved radon indoor air quality program, which Pennsylvania does have. However, the limits are just proposed since the EPA does not currently regulate radon level in drinking water. Figure 4.3.12-4 shows where these wells are located throughout the states and what levels the other wells were tested at (USGS, 2017).

Figure 4.3.12-4 A map of Pennsylvania indicating radon concentrations of water samples collected during a multi-year groundwater radon study. (USGS, 2017).



4.3.12.4. Future Occurrence

Radon exposure is inevitable given present soil, geologic, and geomorphic factors across Pennsylvania. Development in areas where previous radon levels have been significantly high will continue to be more susceptible to exposure. However, new incidents of concentrated exposure may occur with future development or deterioration of older structures. Exposure can be limited with proper testing for both past and future development and appropriate mitigation measures. Overall, the probability of future radon exposure hazards is considered *likely* as defined by the Risk Factor Methodology (see Section 4.1).

4.3.12.5. Environmental Impacts

Radon exposure has minimal environmental impacts. Due to the relatively short half-life of radon, it tends to only affect living and breathing organisms such as humans or pets which are routinely in contained areas (i.e. basement or house) where the gas is released.

4.3.12.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to radon exposure, all structures located within zip codes where average basement and/or first floor radon readings between 1990 and 2010 were greater than or equal to 4 Pci/L. The results of this assessment represent the potential impacts to state assets based on location, but do not account for other factors. Of the 4,460 geolocated state facilities, 4,263, or 96 percent, are located within these zip codes (Table 4.3.12-2).

Table 4.3.12-2 Vulnerability of state facilities to Radon exposure

STATE DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	8	89%
Department of Agriculture	13	81%
Department of Banking and Securities	1	50%
Department of Community and Economic Development	4	100%
Department of Conservation and Natural Resources	2	100%
Department of Corrections	695	100%
Department of Education	1	100%
Department of Environmental Protection	13	100%
Department of General Services	126	96%
Department of Health	48	100%
Department of Labor and Industry	68	99%
Department of Military and Veterans Affairs	1	100%
Department of Public Welfare	96	98%
Department of Revenue	10	100%
Department of Transportation	1,590	94%
Drug and Alcohol Programs	1	100%
Emergency Management Agency	8	100%
Executive Offices	2	100%
Fish and Boat Commission	144	94%

Table 4.3.12-2 Vulnerability of state facilities to Radon exposure		
STATE DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Governor's Office	1	100%
Historical and Museum Commission	30	100%
Insurance Department	2	100%
Liquor Control Board	530	97%
Public School Employees' Retirement System	6	100%
State Civil Service Commission	1	100%
State Department	1	100%
State Employees' Retirement System	4	100%
State Police	35	97%
State System of Higher Education	800	94%
Thaddeus Stevens College of Technology	20	100%
Treasury Department	2	100%
Total	**4,263**	**96%**

Table 4.3.12-3 lists a breakdown of the types of state critical facilities contained within the zip codes where average basement and/or first floor radon readings between 1990 and 2010 were greater than or equal to 4 Pci/L. Due to the large number of schools, fire departments, and police stations in the Commonwealth, it is unsurprising that those categories of facility have the highest number of critical facilities. Of the 14,011 geolocated critical facilities, 1,278, or 9 percent, are located within zip codes with elevated radon test results.

Table 4.3.12-3 State Critical Facilities in high risk areas by Critical Facility Type.		
STATE CRITICAL FACILITY TYPE	**NUMBER OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Agricultural	262	95%
Banking	3	100%
Commercial	22	81%
Communication	580	94%
Dams	3,214	94%
Education (colleges and universities)	151	95%
Education (public schools)	3,057	96%
Emergency Operation Centers	67	97%
Energy	33	60%
Fire Stations	2,542	94%
Government	25	100%
Hospitals	333	97%
National Monuments or Icons	6	100%
Nuclear	5	100%
Police Stations	1,195	96%
Transportation	49	65%
Water	1,671	93%

Table 4.3.12-3 State Critical Facilities in high risk areas by Critical Facility Type.		
STATE CRITICAL FACILITY TYPE	**NUMBER OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Total	**13,215**	**94%**

4.3.12.7. Jurisdictional Vulnerability Assessment

Vulnerability to radon exposure is primarily being defined as jurisdictions and/or critical facilities located in a zip code whose average first floor and/or basement radon reading is greater than 4 pCi/L, the threshold for action.

Jurisdictional and state critical facility vulnerability assessments were completed by spatially overlaying hazards with census tracts and state critical facility layers in GIS. When spatial analysis determined that the hazard would impact a census tract within a county or the location of state critical facilities these locations where deemed vulnerable to the hazard. Loss estimates were prepared based on the value of the facilities impacted by census tract and by state critical facility. Each hazard uses a methodology that is specific to the type of risk it may cause; Table 4.2.2-2 includes a complete methodology description for vulnerability assessments and loss estimates for each hazard.

The EPA determines that an average radon mitigation system costs $1,200. The EPA also states that current state surveys show that 1 home in 5 has elevated radon levels. Using this methodology, radon loss estimation is factored by assuming that 20% of the buildings within the zip codes with elevated test results have elevated radon values and each would require a radon mitigation system installed at the EPA estimated average of $1,200, as shown in Table 4.3.12-4.

Table 4.3.12-4 Estimated jurisdictional losses in areas with high radon test results.			
COUNTY	**TOTAL NUMBER OF BUILDINGS IN AREAS WITH HIGH RADON TEST RESULTS**	**NUMBER OF IMPACTED BUILDINGS (20% OF TOTAL)**	**RADON MITIGATION COSTS (SYSTEM COST X IMPACTED BUILDING)**
Adams	41,876	8,375	$10,050,240
Allegheny	501,606	100,321	$120,385,440
Armstrong	32,065	6,413	$7,695,600
Beaver	73,797	14,759	$17,711,280
Bedford	24,592	4,918	$5,902,080
Berks	155,019	31,004	$37,204,560
Blair	53,225	10,645	$12,774,000
Bradford	23,704	4,741	$5,688,960
Bucks	229,503	45,901	$55,080,720
Butler	68,508	13,702	$16,441,920
Cambria	60,493	12,099	$14,518,320
Cameron	1,017	203	$244,080
Carbon	31,143	6,229	$7,474,320
Centre	51,853	10,371	$12,444,720

Table 4.3.12-4 Estimated jurisdictional losses in areas with high radon test results.			
COUNTY	TOTAL NUMBER OF BUILDINGS IN AREAS WITH HIGH RADON TEST RESULTS	NUMBER OF IMPACTED BUILDINGS (20% OF TOTAL)	RADON MITIGATION COSTS (SYSTEM COST X IMPACTED BUILDING)
Chester	172,769	34,554	$41,464,560
Clarion	19,482	3,896	$4,675,680
Clearfield	33,236	6,647	$7,976,640
Clinton	18,059	3,612	$4,334,160
Columbia	28,471	5,694	$6,833,040
Crawford	42,147	8,429	$10,115,280
Cumberland	92,940	18,588	$22,305,600
Dauphin	99,211	19,842	$23,810,640
Delaware	192,390	38,478	$46,173,600
Elk	15,578	3,116	$3,738,720
Erie	106,963	21,393	$25,671,120
Fayette	56,285	11,257	$13,508,400
Forest	5,235	1,047	$1,256,400
Franklin	61,517	12,303	$14,764,080
Fulton	7,423	1,485	$1,781,520
Greene	12,815	2,563	$3,075,600
Huntingdon	19,538	3,908	$4,689,120
Indiana	34,811	6,962	$8,354,640
Jefferson	16,035	3,207	$3,848,400
Juniata	10,842	2,168	$2,602,080
Lackawanna	86,014	17,203	$20,643,360
Lancaster	184,518	36,904	$44,284,320
Lawrence	37,883	7,577	$9,091,920
Lebanon	52,948	10,590	$12,707,520
Lehigh	124,489	24,898	$29,877,360
Luzerne	133,021	26,604	$31,925,040
Lycoming	47,992	9,598	$11,518,080
McKean	11,145	2,229	$2,674,800
Mercer	45,730	9,146	$10,975,200
Mifflin	21,202	4,240	$5,088,480
Monroe	78,643	15,729	$18,874,320
Montgomery	275,692	55,138	$66,166,080
Montour	7,708	1,542	$1,849,920
Northampton	113,956	22,791	$27,349,440
Northumberland	37,627	7,525	$9,030,480
Perry	20,310	4,062	$4,874,400
Philadelphia	510,138	102,028	$122,433,120

Table 4.3.12-4 Estimated jurisdictional losses in areas with high radon test results.			
COUNTY	TOTAL NUMBER OF BUILDINGS IN AREAS WITH HIGH RADON TEST RESULTS	NUMBER OF IMPACTED BUILDINGS (20% OF TOTAL)	RADON MITIGATION COSTS (SYSTEM COST X IMPACTED BUILDING)
Pike	38,416	7,683	$9,219,840
Potter	8,070	1,614	$1,936,800
Schuylkill	59,868	11,974	$14,368,320
Snyder	16,013	3,203	$3,843,120
Somerset	36,589	7,318	$8,781,360
Sullivan	6,303	1,261	$1,512,720
Susquehanna	22,448	4,490	$5,387,520
Tioga	21,005	4,201	$5,041,200
Union	12,934	2,587	$3,104,160
Venango	24,260	4,852	$5,822,400
Warren	23,010	4,602	$5,522,400
Washington	90,284	18,057	$21,668,160
Wayne	29,289	5,858	$7,029,360
Westmoreland	151,004	30,201	$36,240,960
Wyoming	7,331	1,466	$1,759,440
York	166,500	33,300	$39,960,000
Total	**4,896,488**	**979,298**	**$1,175,157,120**

4.3.13. Subsidence, Sinkhole

4.3.13.1. Location and Extent

There are two common causes of subsidence in Pennsylvania: 1) dissolution of carbonate rock such as limestone or dolomite and 2) mining activity. In the first case, water passing through naturally occurring fractures and bedding planes dissolves bedrock leaving voids below the surface. Eventually, overburden on top of the voids collapses, leaving surface depressions resulting in karst topography. Characteristic structures associated with karst topography include sinkholes, linear depressions and caves. Often, sub-surface solution of limestone will not result in the immediate formation of karst features. Collapse sometimes occurs only after a large amount of activity, or when a heavy burden is placed on the overlying material.

Figure 4.3.13-1 shows the distribution of areas in Pennsylvania having karst or the potential for karst development (USGS, 2014). The map identifies areas underlain by soluble rocks based primarily on State geologic maps of rock units. These areas are further classified by general climate setting and degree of exposure. In Pennsylvania, thick sequences of structurally deformed carbonates comprise the surface bedrock of a sizable area in central, south-central and southeastern Pennsylvania. Note that Figure 4.3.13-1 provides only a first approximation for delineating the degree of karst hazard across Pennsylvania. While the areas underlain by carbonate rock are known to have karst landforms or karst potential, ground collapse potential within these areas varies greatly.

To better evaluate degrees of karst hazard within areas underlain by soluble rocks, Figure 4.3.13-2 shows the locations of observed sinkholes and surface depressions in Pennsylvania (DCNR, 2016). Common sinkhole locations in Pennsylvania include the Saucon Valley of Lehigh County, the greater Harrisburg metropolitan area in Dauphin and Cumberland Counties, and the Nittany Valley in Blair, Centre, and Clinton Counties.

Figure 4.3.13-1 Areas in Pennsylvania with karst or potential for karst development (USGS, 2014).

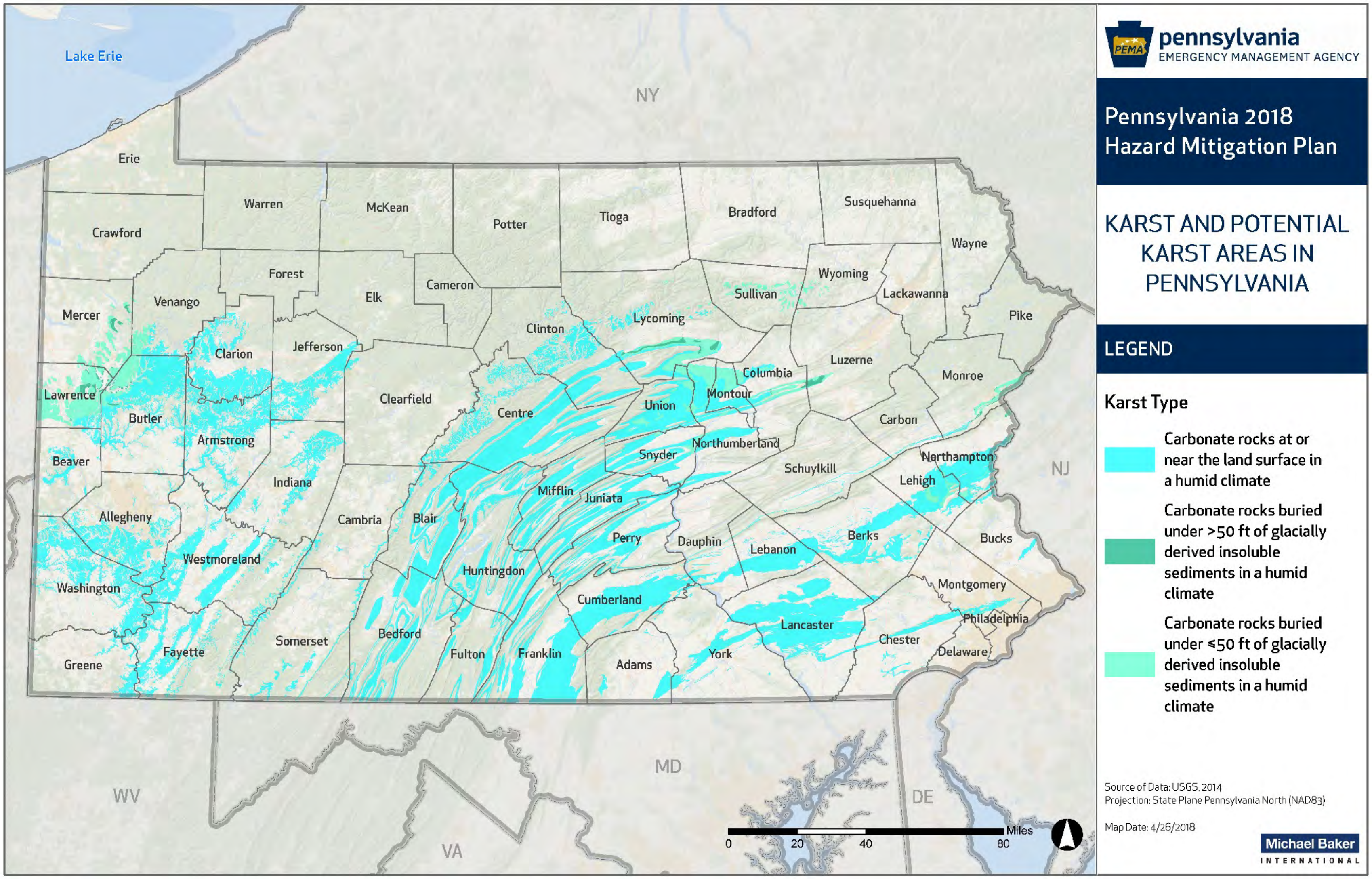
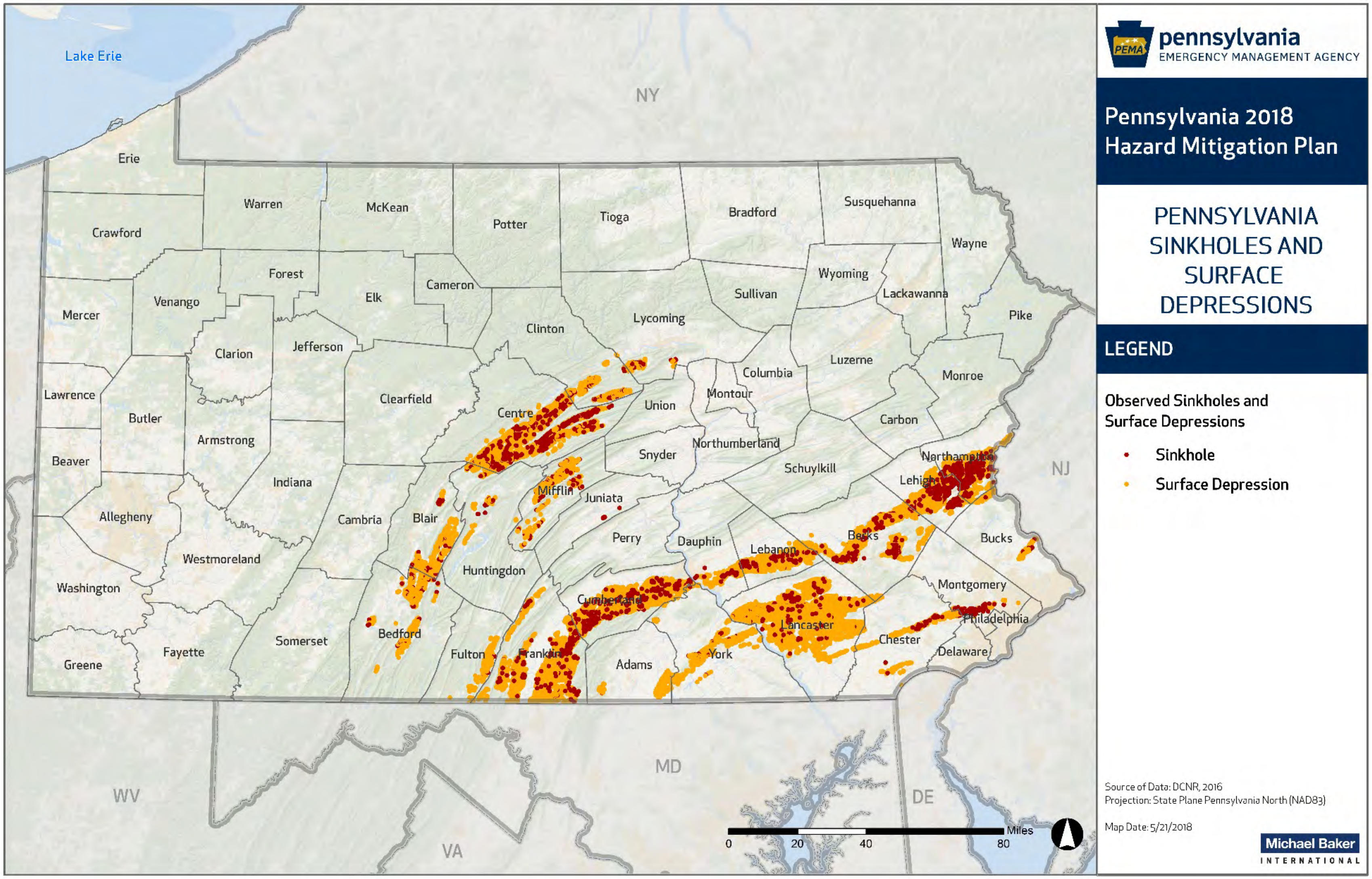
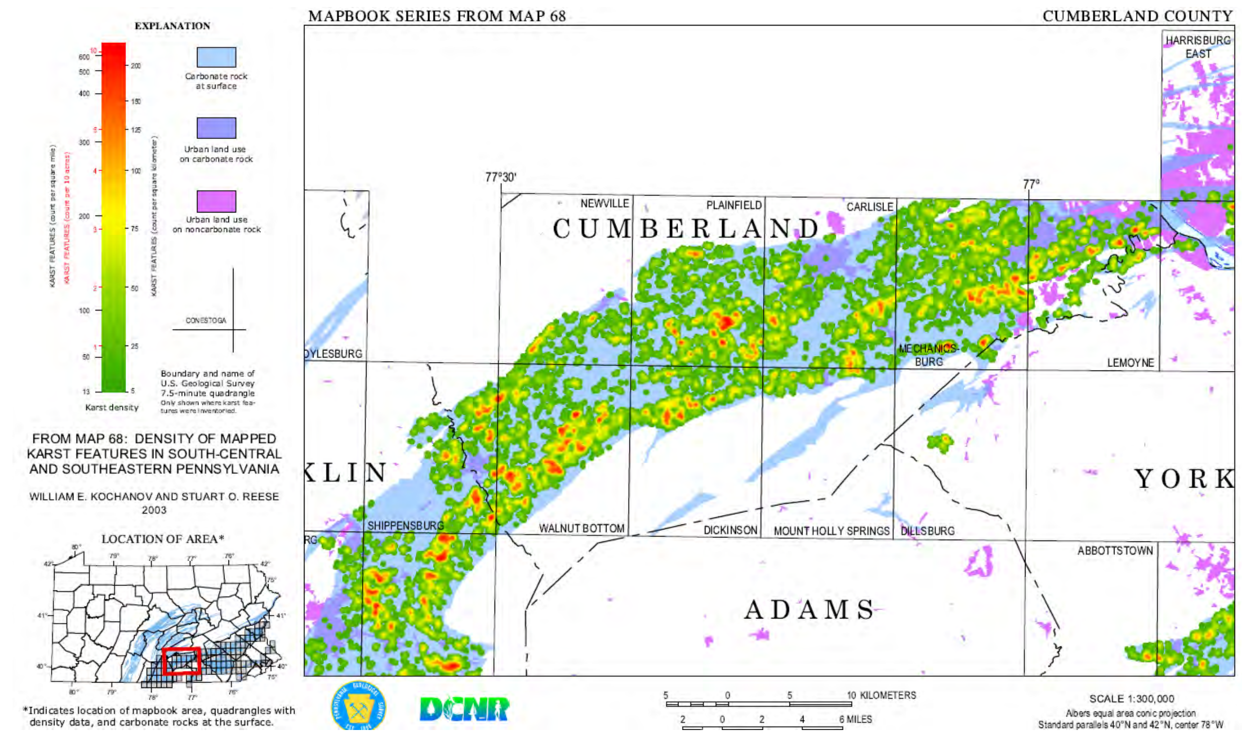


Figure 4.3.13-2 Inventoried sinkholes and surface depressions in Pennsylvania (DCNR, 2016).



DCNR has created a series of maps showing the density of identified karst features across south-central and eastern Pennsylvania (see Figure 4.3.13-3 for example). Karst features are defined as pockets of limestone or dolomite bedrock located within more stable geological formations that could cause subsidence or sinkholes. The density of karst features ranges from 0 to 600 features per square mile with wide variations in size. Fewer karst features have been mapped in existing urban areas; however, this is likely a result of development activities that disguise, cover, or fill existing features rather than an absence of the features themselves (PA DCNR, 2003).

Figure 4.3.13-3 Example of map showing density of karst features in Cumberland County. An index map showing the coverage of the inventory is also provided.



Human activity can also result in subsidence or sinkhole events. Leaking water pipes or structures that convey storm-water runoff may also result in areas of subsidence as the water dissolves substantial amounts of rock over time. Poorly managed stormwater has particularly been an exacerbating factor in subsidence events in Cumberland County, Lebanon County, and Palmyra. In some cases, construction, land grading or earthmoving activities that cause changes in stormwater flow can trigger sinkhole events.

Subsidence or sinkhole events may also occur in the presence of mining activity, even in areas where bedrock is not necessarily conducive to their formation. Mining activity is concentrated in the southwestern region of the state, as well as Schuylkill, Northumberland, and Carbon Counties. Because sub-surface (i.e. underground) extraction of materials such as oil, gas, coal, metal ores (i.e. copper, iron, and zinc), clay, shale, limestone, or water may result in slow-moving or abrupt shifts in the ground surface, these areas have a higher potential to be impacted by sinkholes and subsidence.

Sinkholes often develop where the cover above a mine is thin. Piggott and Eynon (1978) indicated that sinkhole development normally occurs where the interval to the ground surface is less than three to five times the thickness of the extracted seam and the maximum interval is up to ten times the thickness of the extracted seam. In western Pennsylvania, most sinkholes develop where the soil and rock above a mine are less than fifty feet thick (Bruhn et al., 1978). A study of subsidence in the Pittsburgh area revealed that the majority of sinkholes, which constituted about 95% of all reported subsidence incidents, occurred on sites located less than sixty feet above mine level (Bruhn et al., 1981). This profile focuses most on karst-related subsidence and sinkholes; for more information on mine-related subsidence and sinkholes, see Section 4.3.21.

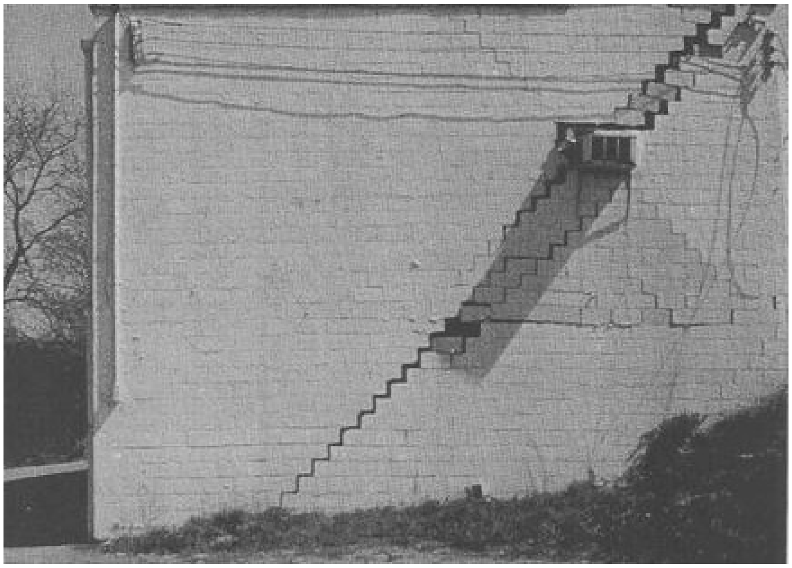
4.3.13.2. Range of Magnitude

No two subsidence areas or sinkholes are exactly alike. Variations in size and shape, time period under which they occur (i.e. gradually or abruptly), and their proximity to development ultimately determines the magnitude of damage incurred. Events could result in minor elevation changes or deep, gaping holes in the ground surface. Subsidence and sinkhole events can cause severe damage in urban environments, although gradual events can be addressed before significant damage occurs. Primarily, problems related to subsidence include the disruption of utility services and damages to private and public property including buildings, roads, and underground infrastructure. Figure 4.3.13-4 provides examples of the damage that can occur as a result of these events. If long-term subsidence or sinkhole formation is not recognized and mitigation measures are not implemented, fractures or complete collapse of building foundations and roadways may result. If mitigation measures are not taken, the cost to fill in and stabilize sinkholes can be significant although sinkholes are limited in extent. The 1994 event in Allentown (see top-left image in Figure 4.3.13-4) is one of the worst-case known events in Pennsylvania. Damage to the Corporate Plaza Building was significant, but dollar information is unknown.

Figure 4.3.13-4 Example of damage which can occur as a result of abrupt sinkhole and long-term subsidence events.

Sinkhole at Corporate Plaza Building in Allentown, Lehigh County, PA in February, 1994 (Photograph by *William E. Kochanov*. PA DCNR, 2009).

Sinkhole in Dauphin County has exposed a utility pipeline (Kochanov, 1999).



Building damage as a result of subsidence in western Pennsylvania. An abandoned mine is located approximately 175 feet below the ground surface. The source of this photograph is unknown.

4.3.13.3. Past Occurrence

DCNR provides an online inventory of sinkholes which lists 3,619 sinkholes that have been identified across Pennsylvania. Note that this inventory has not been updated since the 2013 SSAHMP. The distribution of these sinkholes by county is provided in Table 4.3.13-1. Note that some of these sinkholes have been filled. This inventory represents best available information at the state-wide level. The fact that no sinkholes are identified does not necessarily mean there are no sinkholes or historical subsidence hazards in a given county. For instance, Westmoreland County has 5 sinkholes identified in their County HMP, even though they do not have any sinkholes identified by DCNR. Additionally, PA DEP staff indicated that small sinkholes occur several times per week and cause limited damage; many of these are related to failing infrastructure like water main breaks or collapsed pipes.

Table 4.3.13-1 Summary of sinkholes identified in Pennsylvania (PA DCNR, 2016)			
COUNTY	**NO. OF SINKHOLES**	**COUNTY**	**NO. OF SINKHOLES**
Adams	31	Lackawanna	none identified
Allegheny	none identified	Lancaster	159
Armstrong	none identified	Lawrence	none identified
Beaver	none identified	Lebanon	129
Bedford	55	Lehigh	470
Berks	211	Luzerne	none identified
Blair	55	Lycoming	70
Bradford	none identified	McKean	none identified
Bucks	9	Mercer	none identified
Butler	none identified	Mifflin	176
Cambria	none identified	Monroe	none identified
Cameron	none identified	Montgomery	131
Carbon	none identified	Montour	*not provided*
Centre	546	Northampton	677
Chester	50	Northumberland	none identified
Clarion	none identified	Perry	none identified
Clearfield	none identified	Philadelphia	none identified
Clinton	75	Pike	none identified
Columbia	none identified	Potter	none identified
Crawford	none identified	Schuylkill	none identified
Cumberland	366	Snyder	none identified
Dauphin	48	Somerset	none identified
Delaware	none identified	Sullivan	none identified
Elk	none identified	Susquehanna	none identified
Erie	none identified	Tioga	none identified
Fayette	none identified	Union	none identified
Forest	*not provided*	Venango	none identified
Franklin	260	Warren	none identified
Fulton	5	Washington	none identified
Greene	none identified	Wayne	none identified
Huntingdon	27	Westmoreland	none identified
Indiana	none identified	Wyoming	none identified
Jefferson	none identified	York	60
Juniata	9	**TOTAL**	**3,619**

4.3.13.4. Future Occurrence

Based on geological conditions and current mining activity in Pennsylvania, the annual occurrence of subsidence and sinkhole events in areas of the Commonwealth underlain by carbonate rock or where mining occurs is considered *likely* as defined by the Risk Factor Methodology (see Section 4.1). The precise location of future occurrences is difficult to predict give the site-specific conditions that contribute to sinkhole development. Several signs, however, can signal potential development. These include:

- Slumping or falling fence posts, trees, or foundations
- Sudden formation of small ponds
- Wilting vegetation
- Discolored well water
- Structural cracks in walls, floors

4.3.13.5. Environmental Impacts

The presence of sinkholes can result in increased potential for groundwater contamination. Due to their porous nature, sinkholes are sometimes used as instruments for enhancing groundwater recharge. However, if hazardous materials are spilled at a recharge point, groundwater can quickly be contaminated due to the lack of soil substrate which normally would slow migrating contaminants. Vegetation is usually damaged during abrupt subsidence events. However, re-growth takes place over time. Land subsidence can also result in more frequent and expansive flooding and changes in river canal and drain flow systems.

4.3.13.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to subsidence, all structures located in areas having karst or the potential for karst development were identified (see Figure 4.3.13-1). As discussed above, the degree of karst hazard varies within these areas. However, these areas broadly have the potential for subsidence or sinkhole development, and this analysis was designed to provide a conservative estimate of the facilities vulnerable to ground collapse. As in other profiles, it is important to note that the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 1,384, or 31 percent, are located in areas with karst or the potential for karst development (Table 4.3.13-2). These facilities have a combined replacement value of nearly $2.2 billion, or approximately 55 percent of the known value of geolocated state facilities.

Table 4.3.13-2 Vulnerability of state facilities to subsidence or sinkholes.		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Attorney General	2	22%
Department of Agriculture	2	13%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	1	25%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	132	19%
Department of Education	0	0%
Department of Environmental Protection	1	8%
Department of General Services	26	20%
Department of Health	15	31%
Department of Labor and Industry	18	26%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	27	28%
Department of Revenue	4	40%
Department of Transportation	510	30%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	1	50%
Fish and Boat Commission	70	45%
Governor's Office	0	0%
Historical and Museum Commission	7	23%
Insurance Department	2	100%
Liquor Control Board	152	28%
Public School Employees' Retirement System	1	17%
State Civil Service Commission	1	100%
State Department	0	0%
State Employees' Retirement System	1	25%
State Police	6	17%
State System of Higher Education	385	45%
Thaddeus Stevens College of Technology	20	100%
Treasury Department	0	0%
Total	**1,384**	**31%**

Of the 14,011 geolocated critical facilities, 2,166 or 15 percent, are located within census tracts characterized by high hailstorm hazard (Table 4.3.13-3). These facilities have a combined replacement value of approximately $30.7 billion, or 16% of the known value of geolocated critical facilities.

Table 4.3.13-3 Vulnerability of critical facilities to subsidence or sinkholes.		
TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Agricultural	81	29%
Banking	0	0%
Commercial	6	22%
Communication	122	20%
Dam	554	16%
Education (colleges and universities)	39	25%
Education (public schools)	860	27%
Emergency Operation Center	19	28%
Energy	12	22%
Fire Station	653	24%
Government	8	32%
Hospital	72	21%
National Monument or Icon	1	17%
Nuclear	1	20%
Police Station	301	24%
Transportation	11	15%
Water	361	20%
Total	**3,101**	**22%**

4.3.13.7. Jurisdictional Vulnerability Assessment and Loss Estimation

The northeast-trending valleys of the Ridge and Valley province are more desirable than adjacent ridges as sites for homes, farms, industry, and transportation routes. The residual soil in these valleys is excellent for agriculture, and, in many places, the carbonate rock is a valuable mineral resource and is a host rock for some metallic ore deposits. However, these areas are where most subsidence events occur.

Municipal governments determine guidelines for construction in high-subsidence areas. A community can reduce its vulnerability to subsidence or sinkholes by implementing solutions such as land use controls, insurance programs, subsidence-resistant designs, or in the case of mine-related subsidence, conduct selective support or mine filling. If a sinkhole occurs on private property, it is normally the responsibility of the property owner to initiate repairs. Homeowners' insurance often does not cover damages attributed to sinkholes. Since 1987, sinkhole insurance has been available within Pennsylvania and may serve to eliminate the financial burdens placed on the homeowner.

Careful planning is the least-costly and most effective method for reducing vulnerability to subsidence hazards. Municipalities could minimize the potential for sinkhole development through proper maintenance and updating of water utility lines. Zoning laws can also be enacted to regulate development within highly karst areas.

The Surface Mining Control and Reclamation Act of 1977 imposes land use controls on active mines. This law requires an evaluation of whether subsidence could occur and cause material damage or diminution of use of structures or renewable resource lands. If there is potential for damage, a plan to prevent or mitigate the damage is required.

To assess the relative vulnerability of each county to subsidence or sinkhole development, all census tracts with centers located in areas with karst or karst potential were identified. These census tracts were considered to have a moderate to high hazard of subsidence and sinkhole development. The population, building counts, and building value of these moderate-to-high hazard census tracts were then aggregated to the county scale. The results of this analysis are shown in Table 4.3.13-4.

Table 4.3.13-4 Vulnerability of people and buildings to subsidence or sinkhole development.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Adams	17,807	7,255	$1,947,627	19%
Allegheny	377,577	157,607	$43,260,518	27%
Armstrong	24,086	11,820	$2,480,069	38%
Beaver	36,709	15,882	$5,031,598	26%
Bedford	18,277	8,870	$1,715,399	38%
Berks	209,758	75,363	$22,688,549	50%
Blair	47,514	20,422	$5,290,713	41%
Bradford	0	0	$0	0%
Bucks	4,748	2,045	$679,109	1%
Butler	53,089	21,929	$5,947,979	28%
Cambria	0	0	$0	0%
Cameron	0	0	$0	0%
Carbon	5,330	2,278	$570,171	8%
Centre	121,209	33,644	$11,855,050	75%
Chester	64,617	22,170	$9,943,198	15%
Clarion	14,780	7,307	$1,575,031	38%
Clearfield	0	0	$0	0%
Clinton	15,934	7,276	$1,492,573	40%
Columbia	21,412	6,908	$2,547,752	36%
Crawford	0	0	$0	0%
Cumberland	141,907	55,008	$17,105,403	61%
Dauphin	38,790	14,355	$4,572,510	14%
Delaware	0	0	$0	0%
Elk	0	0	$0	0%
Erie	0	0	$0	0%
Fayette	42,055	18,916	$4,087,225	33%

Table 4.3.13-4 Vulnerability of people and buildings to subsidence or sinkhole development.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Forest	0	0	$0	0%
Franklin	95,082	38,000	$9,472,626	66%
Fulton	4,845	2,313	$511,239	38%
Greene	9,116	2,864	$807,498	24%
Huntingdon	20,309	9,122	$1,563,397	37%
Indiana	3,957	1,861	$388,511	5%
Jefferson	6,345	2,945	$569,225	12%
Juniata	18,785	7,963	$1,656,113	78%
Lackawanna	0	0	$0	0%
Lancaster	361,532	127,767	$38,062,182	70%
Lawrence	37,164	16,733	$3,449,825	38%
Lebanon	82,222	31,267	$9,026,477	63%
Lehigh	255,306	89,061	$29,798,102	74%
Luzerne	0	0	$0	0%
Lycoming	58,455	23,343	$5,608,007	47%
McKean	0	0	$0	0%
Mercer	10,573	4,433	$894,303	7%
Mifflin	30,631	13,694	$2,929,115	67%
Monroe	11,994	5,554	$1,497,471	8%
Montgomery	52,342	19,444	$8,780,041	8%
Montour	9,522	4,013	$797,648	43%
Northampton	209,825	77,807	$23,765,200	72%
Northumberland	47,566	20,980	$4,951,047	52%
Perry	15,625	6,791	$1,411,469	34%
Philadelphia	0	0	$0	0%
Pike	0	0	$0	0%
Potter	0	0	$0	0%
Schuylkill	5,289	2,339	$660,024	4%
Snyder	5,810	1,632	$595,002	16%
Somerset	0	0	$0	0%
Sullivan	0	0	$0	0%
Susquehanna	0	0	$0	0%
Tioga	0	0	$0	0%
Union	40,868	14,670	$3,732,935	91%
Venango	3,888	2,123	$392,527	7%
Warren	0	0	$0	0%
Washington	85,198	36,706	$9,342,059	40%

Table 4.3.13-4 Vulnerability of people and buildings to subsidence or sinkhole development.				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $**	**PERCENT OF COUNTY BUILDING VALUE**
Wayne	0	0	$0	0%
Westmoreland	134,885	58,825	$15,873,998	39%
Wyoming	0	0	$0	0%
York	126,099	49,649	$14,870,277	31%
Total	**2,998,832**	**1,160,954**	**$334,196,792**	**23%**

Using the methodology defined above, 45 counties were identified as having population and buildings vulnerable to subsidence or sinkhole development. Throughout the Commonwealth, nearly million people have been identified as vulnerable to this hazard. The counties with the largest vulnerable populations include Allegheny, Lancaster, Lehigh, and Northampton Counties. In contrast, the counties with the highest percentage of exposed building value are Union, Juniata, Centre, Lehigh, and Northampton Counties.

Subsidence repair or preemptive mitigation can be quite costly for local communities. Areas that have already undergone development have special problems in re-design and re-construction. After-the-fact methods of subsidence repair are often expensive and offer no guarantee that the problem will not re-occur. Sinkhole repair for Vera Cruz Road in Lehigh County cost nearly $80,000, and a new sinkhole opened, just outside the repair area, within six months. Bruhn et al. (1978) reported in a study of the Pittsburgh coal, that annual costs for remedial measures and repairs were $438,000. This estimate does not include the cost of damage to commercial structures, utilities, or transportation rights-of-way, and the cost of engineering and construction measures undertaken to prevent or minimize subsidence damage. In a study of damage from active mining in western Pennsylvania, Bruhn et al. (1982) reported that home repair costs (measured in 1981-dollar values) ranged from a few hundred dollars to more than $100,000. The median repair cost was $6,000 to $10,000 per home.

4.3.14. Tornado, Windstorm

4.3.14.1. Location and Extent

Both tornado and windstorm events can occur throughout Pennsylvania. Tornado events are usually localized. However, severe thunderstorms may result in conditions favorable to the formation of numerous or long-lived tornadoes. Tornadoes can occur at any time during the day or night, but are most frequent during late afternoon into early evening, the warmest hours of the day, and most likely to occur during the spring and early summer months of March through June. Tornado movement is characterized in two ways: direction and speed of spinning winds and forward movement of the tornado, also known as the storm track. Most tornadoes have wind speeds of 110 mph (175 km/h) or less, are approximately 250 feet (75 m) across, and travel a few miles (several kilometers) before dissipating. Some attain wind speeds of more than 300 mph (480 km/h), stretch more than a mile (1.6 km) across, and stay on the ground for dozens of miles (more than 100 km). Some tornadoes never touch the ground and are short-lived, while others may touch the ground several times.

Straight-line winds and windstorms are experienced on a region-wide scale. While such winds usually accompany tornadoes, straight-lined winds are caused by the movement of air from areas of higher pressure to areas of lower pressure. Stronger winds are the result of greater differences in pressure. Windstorms are generally defined with sustained wind speeds of 40 mph or greater lasting for one hour or longer, or winds of 58 mph or greater for any duration. Wind events can vary in spatial size from small microscale events which take place over only a few hundred meters to large-scale synoptic wind events often associated with warm or cold fronts.

4.3.14.2. Range of Magnitude

Each year, tornadoes account for $1.1 billion in damages and cause over 80 deaths nationally (NCAR, 2001). 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 100 mph to more than 250 mph. In addition, the speed of forward motion can range from 0 to 50 mph. 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 miles per hour or more and are capable of causing extreme destruction and turning normally harmless objects into deadly missiles.

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 such as mobile homes. 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,” which was published in 1971. The EF-Scale provides engineered wind estimates and better damage descriptions. It classifies United States tornadoes into six intensity categories, as shown in Table 4.3.14-1, based upon the estimated maximum winds occurring within the wind vortex. 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. F-Scale categories with corresponding EF-Scale wind speeds are also provided since previous tornado occurrences are described based on the F-Scale (FEMA, 2012).

Table 4.3.14-1 Enhanced Fujita Scale (EF-Scale) categories with associated wind speeds and description of damages (FEMA, 2012).

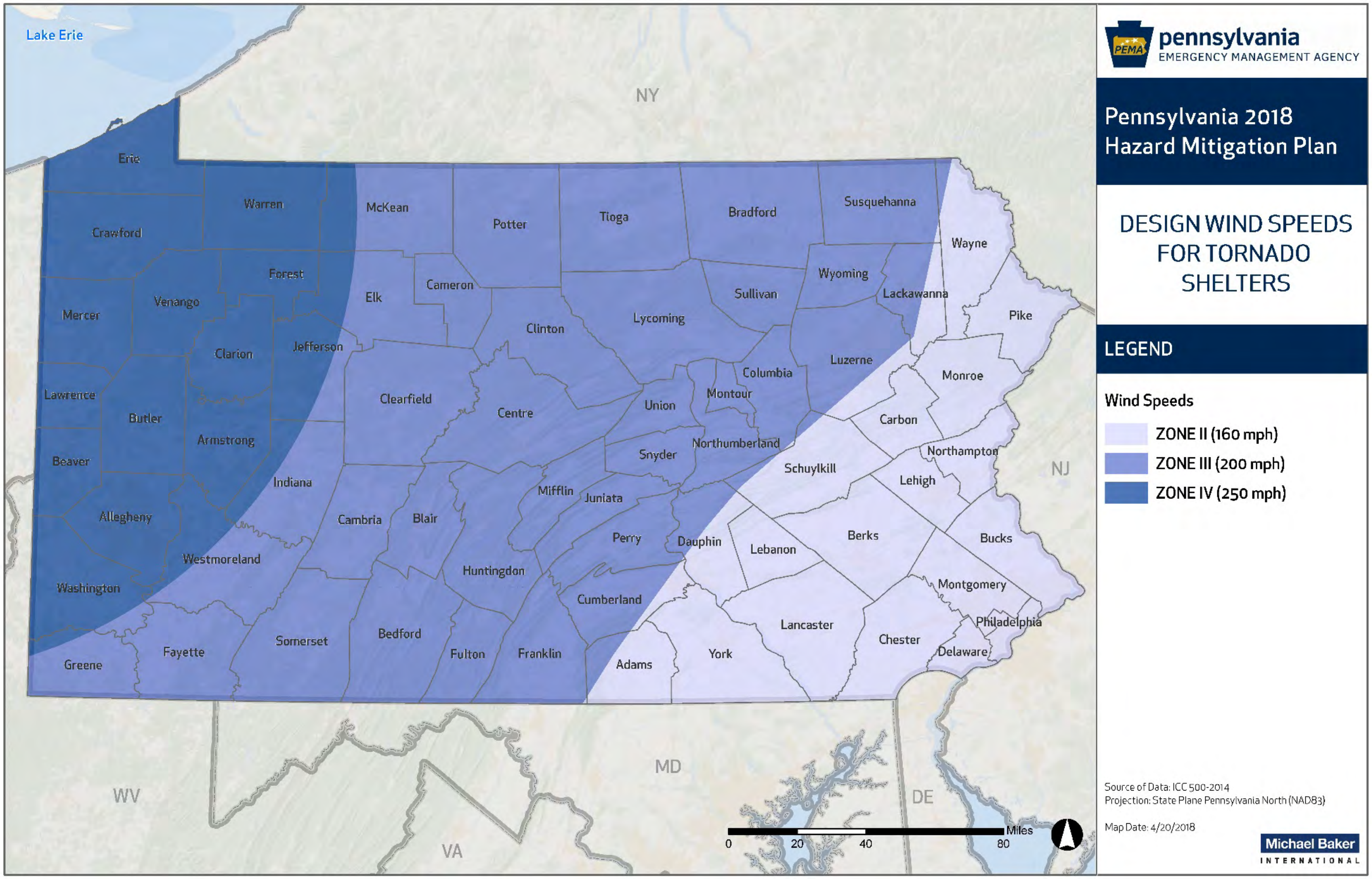
EF-SCALE NUMBER	WIND SPEED (MPH)	F-SCALE NUMBER	TYPE OF DAMAGE POSSIBLE
EF0	65–85	F0-F1	**Light damage**: Chimneys are damaged, tree branches are broken, shallow-rooted trees are toppled.

Table 4.3.14-1 Enhanced Fujita Scale (EF-Scale) categories with associated wind speeds and description of damages (FEMA, 2012).			
EF-SCALE NUMBER	**WIND SPEED (MPH)**	**F-SCALE NUMBER**	**TYPE OF DAMAGE POSSIBLE**
EF1	86-110	F1	**Moderate damage**: Roof surfaces are peeled off, windows are broken, some tree trunks are snapped, unanchored mobile homes are overturned, attached garages may be destroyed.
EF2	111–135	F1-F2	**Considerable damage**: Roof structures are damaged, mobile homes are destroyed, debris becomes airborne, (missiles are generated), large trees are snapped or uprooted.
EF3	136–165	F2-F3	**Severe damage**: Roofs and some walls are torn from structures, some small buildings are destroyed, nonreinforced masonry buildings are destroyed, most trees in forest are uprooted.
EF4	166–200	F3	**Devastating damage**: Well-constructed houses are destroyed, some structures are lifted from foundations and blown some distance, cars are blown some distance, large debris becomes airborne.
EF5	>200	F3-F6	**Extreme damage**: Strong frame houses are lifted from foundations, reinforced concrete structures are damaged, automobile-sized missiles become airborne, trees are completely debarked.

The impact of tornado hazards is ultimately dependent on the population or amount of property (i.e. buildings, infrastructure, agricultural land, etc…) present in the area in which the tornado occurs. Tornado events are often so severe that property loss or human fatality is typically inevitable if evacuation or proper construction standards are not implemented.

Figure 4.3.14-1 shows wind speed zones developed for the design of tornado shelters. It identifies worst-case wind speeds that could occur across the United States to be used as the basis for design and evaluation of the structural integrity of shelters and critical facilities. Eastern Pennsylvania falls within Zone II, meaning design wind speeds for shelters and critical facilities should be able to withstand a 3-second gust of up to 160 mph, regardless of whether the gust is the result of a tornado, hurricane, tropical storm, or windstorm event. Central and parts of western Pennsylvania fall within Zone III, meaning design wind speeds for shelters and critical facilities should be able to withstand a 3-second gust of up to 200 mph. Western and northwestern Pennsylvania are located in Zone IV; design wind speeds for shelters and critical facilities should be able to withstand a 3-second gust of up to 250 mph. Also, it is important to note that eastern and south-central Pennsylvania is within a hurricane-susceptible wind zone. For more information on hurricanes in Pennsylvania, see Section 4.3.7. The wind zones identified in Figure 4.3.14-1 represent the strongest wind speeds anticipated throughout Pennsylvania, not the normal or routine wind speeds expected statewide.

Figure 4.3.14-1 Design wind speeds for tornado shelters (ICC 500, 2014).

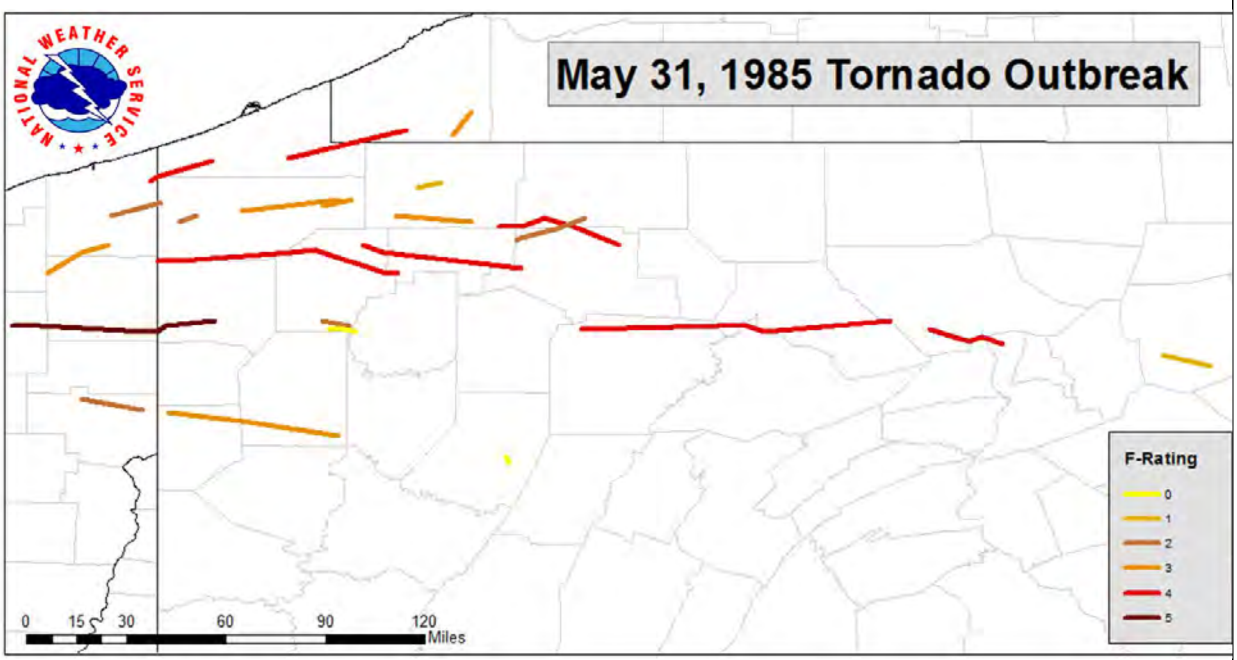


4.3.14.3. Past Occurrence

Tornadoes have occurred throughout Pennsylvania. Western and southeastern sections of the Commonwealth have been struck more frequently. Figure 4.3.14-2 provides a map the maximum number of tornado touchdowns per census tract across the state from 1986 to 2016. The southern central region of the state has recorded the highest number of tornadoes over this time-period.

On May 31, 1985 a very rare outbreak of 43 tornadoes tracked across northwest Pennsylvania, northeast Ohio, southwest New York, and even parts of southern Ontario, Canada. Pennsylvania was the hardest hit with tornados impacting Erie, Warren, Crawford, Forest, Mercer, Venango, Mercer, and Butler counties (Figure 4.3.14-2). One of these tornadoes was rated an F5 while seven were rated F4s on the old Fujita Scale. The deadliest tornado touched down in Wheatland, PA as an F5 on the old Fujita Scale, killing 18 people and injuring 310 as it traversed 47 miles from Ohio into Mercer County, PA. It stayed on the ground for over an hour (NOAA NWS, 2015). According to the National Center for Environmental Information, 65 people died and 526 were injured in Pennsylvania and over $378 million worth of property damage was incurred from these tornadoes (NCEI, 2018).

Figure 4.3.14-2 Map showing tornado tracks during the May 31, 1985 tornado outbreak (NOAA NWS, 2015).



The worst-case single tornado event on record occurred on June 3, 1980 across Allegheny, Armstrong, and Westmoreland Counties. This F4 tornado injured about 140 people and caused $250 million in property damage through its nearly 12-mile track across the three counties (NCEI, 2018).

Maximum number of strong wind events per census tract in Pennsylvania between 1986 and 2016 are provided in Figure 4.3.14-3. Events may be the result of thunderstorms, hurricanes, tropical storms, winter storms, or nor'easters.

Figure 4.3.14-3 Map showing maximum number of strong wind events per census tract in Pennsylvania from 1986-2016 (FEMA NRI, 2018).

4.3.14.4. Future Occurrence

In the United States, tornado activity has increased in variability with a general decrease in the number of days a year with activity but an increase in the number of tornados on those days (increase in tornado outbreaks). The tornado season extent is also increasing with an earlier start of the high activity season. With increases in air temperature and moisture under climate change there is higher risk of extreme convection and favorable tornado conditions (possible increase in frequency and intensity), however, this remains uncertain as confidence in past trends is low. Climate models project conditions conducive to an increase in frequency and intensity of severe thunderstorms, tornados, hail and wind, but confidence is low (Kossin et al. 2017). It is probable that there will be an increased threat of severe convective storms in the future.

4.3.14.5. Environmental Impacts

Since tornado events are typically localized, environmental impacts are rarely widespread. The impacts of windstorms on the environment typically take place over a larger area. In either case, where these events occur, severe damage to plant species is likely. This includes uprooting or total destruction of trees and an increased threat of wildfire in areas where dead trees are not removed. Hazardous material facilities should meet design requirements for the wind zones identified in Figure 4.3.14-1 in order to prevent release of hazardous materials into the environment.

4.3.14.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to tornadoes and windstorms, all structures located within census tracts where maximum number of tornado touchdowns between 1986 and 2016 exceeded 590, as shown in Table 4.3.14-2. Of the 4,460 geolocated state facilities, 1600, or 36 percent, are located within these vulnerable census tracts. These facilities have a combined replacement value of more than $2.6 billion, or approximately 67% of the known value of geolocated state facilities.

Table 4.3.14-2 State facilities vulnerable to tornadoes or windstorms for each department.

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	2	22%
Department of Agriculture	9	56%
Department of Banking and Securities	1	50%
Department of Community and Economic	1	25%
Department of Conservation and Natural	1	50%
Department of Corrections	323	46%
Department of Education	0	0%
Department of Environmental Protection	3	23%
Department of General Services	98	75%
Department of Health	15	31%
Department of Labor and Industry	23	33%
Department of Military and Veterans Affairs	0	0%

Table 4.3.14-2 State facilities vulnerable to tornadoes or windstorms for each department.		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Department of Public Welfare	35	36%
Department of Revenue	4	40%
Department of Transportation	494	29%
Drug and Alcohol Programs	1	100%
Emergency Management Agency	7	88%
Executive Offices	1	50%
Fish and Boat Commission	19	12%
Governor's Office	0	0%
Historical and Museum Commission	14	47%
Insurance Department	2	100%
Liquor Control Board	173	32%
Public School Employees' Retirement System	1	17%
State Civil Service Commission	0	0%
State Department	1	100%
State Employees' Retirement System	1	25%
State Police	14	39%
State System of Higher Education	337	39%
Thaddeus Stevens College of Technology	20	100%
Treasury Department	0	0%
Total	1600	36%

Of the 14,011 geolocated critical facilities 4,718, or 34 percent, located within census tracts where maximum number of tornado touchdowns between 1986 and 2016 exceeded 590 (Table 4.3.14-3). These facilities have a combined replacement value of more than $69 billion, or approximately 36% of the known value of geolocated critical facilities.

Table 4.3.14-3 State critical facilities vulnerable to tornadoes and windstorms by critical facility type		
STATE CRITICAL FACILITY TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	102	37%
Banking	1	33%
Commercial	9	33%
Communication	186	30%
Dam	1,069	31%
Education (colleges and universities)	62	39%
Education (public schools)	1,161	37%
Emergency Operation Center	23	33%
Energy	13	24%
Fire Station	915	34%
Government	20	80%

Table 4.3.14-3 State critical facilities vulnerable to tornadoes and windstorms by critical facility type		
STATE CRITICAL FACILITY TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Hospital	106	31%
National Monument or Icon	2	33%
Nuclear	3	60%
Police Station	420	34%
Transportation	18	24%
Water	608	34%
Total	**4,718**	**34%**

4.3.14.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to tornadoes, all census tracts where the maximum number of tornado touchdowns between 1986 and 2016 exceeded 590 were identified. The population, building counts, and building value of all vulnerable census blocks were then aggregated to the county scale and compiled in Table 4.3.14-4. Across the state, about 4.8 million people are located in census tracts vulnerable to tornadoes or windstorms. There are also over 1.8 million buildings that are vulnerable to tornadoes or windstorms, the total replacement value for which is $553 million, or about 38 percent of the total value for all buildings in the state.

Table 4.3.14-4 Estimated jurisdictional losses due to tornadoes and windstorms.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Adams	101,759	41,876	$10,485,215	100%
Allegheny	0	0	0	0%
Armstrong	0	0	0	0%
Beaver	0	0	0	0%
Bedford	27,588	13,746	$2,504,754	55%
Berks	396,128	147,517	$42,958,724	96%
Blair	12,629	5,023	$1,133,415	9%
Bradford	0	0	0	0%
Bucks	0	0	0	0%
Butler	0	0	0	0%
Cambria	0	0	0	0%
Cameron	0	0	0	0%
Carbon	17,157	8,415	$1,740,175	24%
Centre	5,443	2,932	$507,044	3%
Chester	512,028	178,952	$68,456,575	100%
Clarion	0	0	0	0%
Clearfield	0	0	0	0%

Table 4.3.14-4 Estimated jurisdictional losses due to tornadoes and windstorms.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Clinton	8,263	3,455	$654,118	17%
Columbia	5,615	2,994	$568,820	8%
Crawford	0	0	0	0%
Cumberland	243,838	92,940	$28,208,368	100%
Dauphin	271,962	107,000	$32,485,579	100%
Delaware	562,316	196,456	$68,420,231	100%
Elk	0	0	0	0%
Erie	0	0	0	0%
Fayette	0	0	0	0%
Forest	0	0	0	0%
Franklin	152,707	61,517	$14,391,260	100%
Fulton	14,653	7,423	$1,359,021	100%
Greene	0	0	0	0%
Huntingdon	45,844	22,004	$4,178,057	100%
Indiana	0	0	0	0%
Jefferson	0	0	0	0%
Juniata	24,811	10,842	$2,115,736	100%
Lackawanna	0	0	0	0%
Lancaster	533,110	189,804	$54,619,855	100%
Lawrence	0	0	0	0%
Lebanon	136,950	52,948	$14,293,394	100%
Lehigh	39,685	15,539	$4,051,817	10%
Luzerne	0	0	0	0%
Lycoming	0	0	0	0%
McKean	0	0	0	0%
Mercer	0	0	0	0%
Mifflin	46,585	21,202	$4,370,585	100%
Monroe	0	0	0	0%
Montgomery	567,022	199,725	$81,783,265	72%
Montour	14,464	6,153	$1,583,680	85%
Northampton	6,500	2,933	$621,024	2%
Northumberland	81,813	38,077	$8,424,942	88%
Perry	45,647	20,310	$4,146,443	100%
Philadelphia	270,824	97,699	$27,753,644	17%
Pike	0	0	0	0%
Potter	0	0	0	0%

Table 4.3.14-4 Estimated jurisdictional losses due to tornadoes and windstorms.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Schuylkill	143,105	66,842	$15,354,411	99%
Snyder	40,246	16,013	$3,699,402	100%
Somerset	13,976	6,517	$1,149,301	15%
Sullivan	0	0	0	0%
Susquehanna	0	0	0	0%
Tioga	0	0	0	0%
Union	41,706	16,479	$4,020,814	98%
Venango	0	0	0	0%
Warren	0	0	0	0%
Washington	0	0	0	0%
Wayne	0	0	0	0%
Westmoreland	0	0	0	0%
Wyoming	0	0	0	0%
York	440,604	173,196	$47,895,886	100%
Total	**4,824,978**	**1,826,529**	**$553,935,555**	**38%**

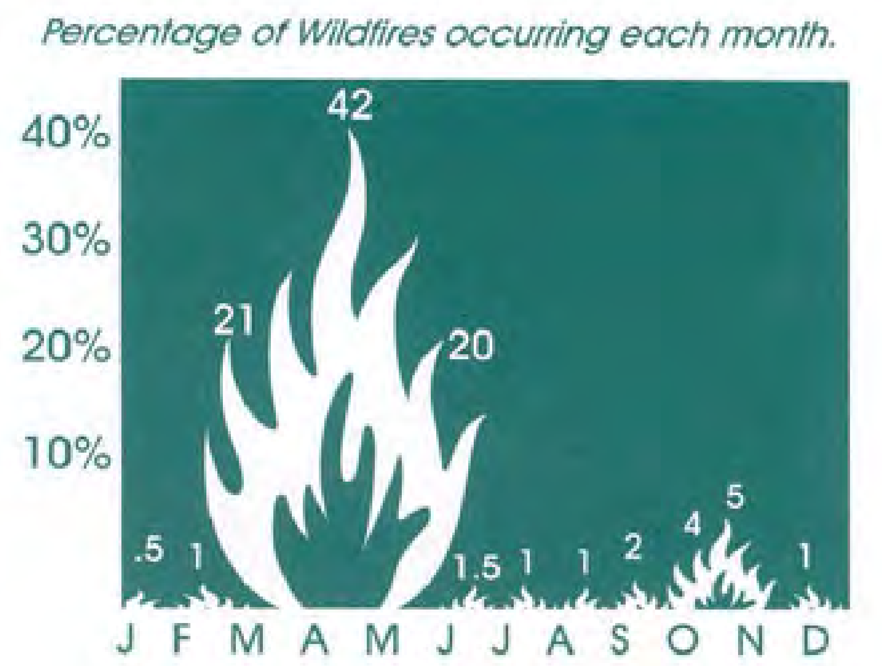
4.3.15. Wildfire

4.3.15.1. Location and Extent

Wildfires occur throughout wooded and open vegetation areas of Pennsylvania. They can occur any time of the year, but mostly occur during long, dry hot spells. Any small fire, if not quickly detected and suppressed, can get out of control. Most wildfires are caused by human carelessness or negligence. However, some are precipitated by lightning strikes and in rare instances, spontaneous combustion.

Open fields, grass, dense brush and forest-covered areas are typical sites for wildfire events. Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands. The greatest potential for wildfires is in the spring months of March, April and May, and, to a lesser extent, 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. In the fall, dried leaves are also fuel for fires. The percentage of wildfires occurring each month is shown in Figure 4.3.15-1.

Figure 4.3.15-1 Percentage of wildfires occurring each month (PA DCNR, 2013).



Most wildfires in Pennsylvania are caused by people, often by debris burns (PA DCNR-BOF, 2010). Table 4.3.15-1 displays the primary causes of wildfires throughout Pennsylvania in 2017. Debris burning accounted for the largest number of wildfires, while incendiary causes accounted for the largest number of acres burned (DCNR, 2017). Several fires have started in a person's backyard and traveled through dead grasses and weeds into bordering woodlands. Ninety-two percent of Pennsylvania wildfires burn less than ten acres and are suppressed within the first burning period.

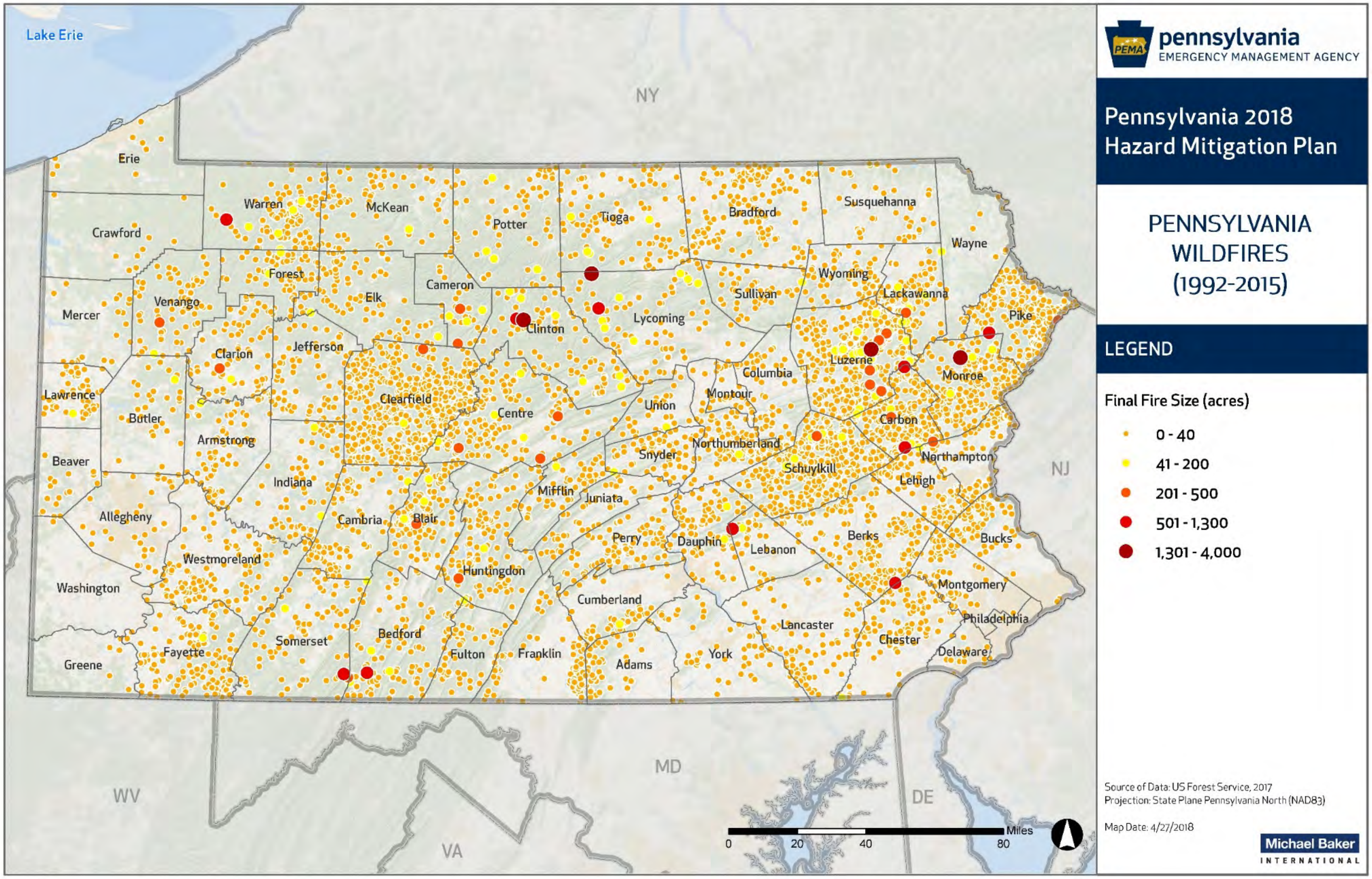
Table 4.3.15-1 Pennsylvania wildfire history (DCNR, 2017).

CAUSE	NUMBER OF FIRES	NUMBER OF ACRES BURNED	PERCENT OF TOTAL FIRES	PERCENT OF ACRES BURNED
Campfire	17	115.0	3.2%	7.0%
Children	8	3.9	1.5%	0.2%
Debris Burning	279	299.7	52.2%	18.2%
Equipment Use	44	37.0	8.2%	2.2%
Fireworks	4	2.6	0.7%	0.2%
Incendiary	71	716.0	13.3%	43.4%
Lightning	2	0.6	0.4%	0.0%
Miscellaneous	45	53.9	8.4%	3.3%
Power Line	29	75.7	5.4%	4.6%
Railroad	26	314.9	4.9%	19.1%
Smoking	5	23.8	0.9%	1.4%
Structure	4	6.4	0.7%	0.4%

Table 4.3.15-1 Pennsylvania wildfire history (DCNR, 2017).				
CAUSE	NUMBER OF FIRES	NUMBER OF ACRES BURNED	PERCENT OF TOTAL FIRES	PERCENT OF ACRES BURNED
TOTAL	**534**	**1,649**	***100%***	***100%***

Figure 4.3.15-2 shows the location and size of wildfires that occurred in Pennsylvania between 1992 and 2015 as compiled by researchers at the U.S. Forest Service (USFS, 2017). The wildfire records were acquired from the reporting systems of federal, state, and local fire organizations. This data, and all the wildfire data in this section, represents the best available data for wildfire hazards. Wildfire are relatively frequent hazard events that involve emergency response from thousands of different jurisdictions at all levels of government. They are therefore known to be underreported. It is estimated that five to ten thousand wildfires occur annual in Pennsylvania. As shown in Figure 4.3.15-2, Clearfield County and the state's eastern counties have experienced the largest number of wildfires in the period of record.

Figure 4.3.15-2 Map showing location of and size of wildfires (US Forest Service, 2017).



Areas of the Commonwealth that have large home developments built in volatile fuel types are at risk for catastrophic wildfires. Many areas of the state are at risk for large wildfires, but Northeastern Pennsylvania is the most at risk for loss of life and/or property due to the number of homes at risk for wildfires. This area has large home developments built in volatile fuel types including scrub oak, mountain laurel, blueberry, and huckleberry. If spring weather conditions were perfect for a fire (i.e. clear sky, high winds, low relative humidity, and a prolonged period of dry weather), it is possible that 10,000 acres could burn in areas of Monroe or Pike Counties. In Monroe County, concerns about ignition of fallen limbs after strong wind storms and winter storms continue.

In locations where homes are at risk for wildfires, the BOF's Wildland/Urban Interface Guidance Document is available to assist homeowners, community associations, local government and developers to assess and mitigation the potential dangers of a wildfire. The guidance also provides information for developing and action plan in coordination with local emergency managers. Communities at risks for wildfires can adopt by local ordinance the ''International Wildland-Urban Interface Code" of the Uniform Construction Code. The actions under Objective 1-9 address Wildland-Urban Interface related mitigation.

4.3.15.2. Range of Magnitude

Wildfire events can range from small fires that can be managed by local firefighters to large fires impacting many acres of land. Large events may require evacuation from one or more communities and necessitate regional or national firefighting support. The impact of a severe wildfire can be devastating. A wildfire has the potential to kill people, livestock, fish and wildlife. They often destroy property, valuable timber, forage and recreational and scenic values.

In addition to the risk wildfires pose to the general public and property owners, the safety of firefighters is also a concern. Although loss of life among firefighters does not occur often in Pennsylvania, it is always a risk. More common firefighting injuries includes falls, sprains, abrasions or heat-related injuries such as dehydration. Response to wildfires also exposes emergency responders to the risk of motor vehicle accidents and can place them in remote areas away from the communities that they are chartered to protect.

The largest wildfire in Pennsylvania in recent years burned 10,000 acres in the north-central area of the Commonwealth. This fire was controlled within a week. It destroyed five cabins, but there was no loss of life. Several other fires have burned over 2,000 acres each and again have been controlled within a week of the reported start. A potential worst-case scenario for a wildfire in Pennsylvania would be if a large fire ignited in/around a secluded but populated area of the Pocono Mountains. This kind of an event could cause damage to homes, threaten lives, and destroy stands of trees with both agricultural and tourism economic value. The seclusion of housing developments along with the strong availability of wildfire fuel could also complicate emergency response and home defense.

4.3.15.3. Past Occurrence

The DCNR Bureau of Forestry (BOF) maintains an inventory of wildfire events dating back to 1913. The inventory shows that the annual number of wildfires peaked in the early 1930s, while the annual number of acres burned had its peak in 1913 and has declined steadily since the

1930s. Table 4.3.15-2 displays wildfire history from 1913 to 2017. Over the entire period of record, the average annual number of wildfires was 1,561, and the average size of wildfires was 36.6 acres. Over the 10 years between 2008 and 2017, in contrast, the average annual number of wildfires was 650, and the average size of wildfires was 7.0 acres (DCNR, 2017).

Table 4.3.15-2 Pennsylvania wildfire history (DCNR, 2017).

YEAR	NUMBER OF FIRES	ACRES BURNED	AVERAGE SIZE	COST OF EXTINCTION ($)
1913	937	386,267	412.2	$ 29,593.56
1914	1,182	360,236	304.8	$ 32,535.83
1915	1,080	340,634	315.4	$ 27,154.94
1916	1,012	143,295	141.6	$ 13,760.86
1917	1,902	286,184	150.5	$ 27,831.28
1918	1,625	227,485	140.0	$ 30,166.12
1919	950	126,626	133.3	$ 15,839.21
1920	1,597	256,158	160.4	$ 55,538.10
1921	2,409	188,536	78.3	$ 60,941.12
1922	3,628	331,566	91.4	$ 185,201.55
1923	3,538	375,737	106.2	$ 158,825.45
1924	1,997	95,792	48.0	$ 85,777.64
1925	2,562	125,150	48.8	$ 63,793.35
1926	2,917	224,256	76.9	$ 177,353.41
1927	1,246	37,680	30.2	$ 28,856.14
1928	2,534	111,631	44.1	$ 99,380.14
1929	2,467	41,929	17.0	$ 59,367.33
1930	6,790	312,300	46.0	$ 675,943.52
1931	4,020	150,140	37.3	$ 200,143.09
1932	4,898	95,141	19.4	$ 171,429.95
1933	2,028	28,598	14.1	$ 43,760.63
1934	4,188	179,727	42.9	$ 146,624.42
1935	3,507	72,551	20.7	$ 92,119.85
1936	2,926	35,328	12.1	$ 76,062.77
1937	2,470	35,364	14.3	$ 54,137.62
1938	3,467	57,590	16.6	$ 104,336.84
1939	4,790	72,287	15.1	$ 195,912.67
1940	2,411	33,972	14.1	$ 71,881.86
1941	4,084	109,116	26.7	$ 204,385.27
1942	2,010	71,386	35.5	$ 101,133.20
1943	2,117	67,826	32.0	$ 118,771.21
1944	1,723	68,001	39.5	$ 84,943.42
1945	865	26,366	30.5	$ 40,960.39
1946	2,171	47,931	22.1	$ 89,413.56
1947	1,495	52,494	35.1	$ 124,148.65
1948	871	13,016	14.9	$ 32,401.30
1949	1,540	32,723	21.2	$ 88,151.34
1951	858	33,959	39.6	$ 65,942.14

Table 4.3.15-2 Pennsylvania wildfire history (DCNR, 2017).				
YEAR	NUMBER OF FIRES	ACRES BURNED	AVERAGE SIZE	COST OF EXTINCTION ($)
1952	1,653	68,823	41.6	$ 228,056.49
1653	1,414	33,148	23.4	$ 274,457.69
1954	947	21,275	22.5	$ 96,405.78
1955	1,258	33,783	26.9	$ 167,187.49
1956	559	6,940	12.4	$ 29,754.95
1957	1,250	37,077	29.7	$ 144,824.45
1958	912	15,537	17.0	$ 64,470.12
1959	984	25,812	26.2	$ 90,650.83
1960	1,257	33,324	26.5	$ 179,476.52
1961	537	3,104	5.8	$ 44,871.66
1962	1,773	44,315	25.0	$ 323,696.69
1963	2,641	44,583	16.9	$ 659,436.01
1964	1,909	27,098	14.2	$ 436,923.45
1965	1,207	12,835	10.6	$ 199,268.69
1966	1,353	13,276	9.8	$ 317,896.12
1967	918	5,264	5.7	$ 178,169.18
1968	1,454	13,039	9.0	$ 197,748.90
1969	1,735	16,507	9.5	$ 194,011.00
1970	907	4,508	5.0	$ 104,303.00
1971	1,607	14,901	9.3	$ 248,867.00
1972	1,000	3,881	3.9	$ 94,655.00
1973	1,000	3,930	3.9	$ 111,662.00
1974	1,446	8,231	5.7	$ 226,315.00
1975	1,323	5,755	4.3	$ 183,637.00
1976	1,781	14,852	8.3	$ 431,470.00
1977	1,630	10,402	6.4	$ 296,390.00
1978	1,149	5,091	4.4	$ 201,401.00
1979	1,544	8,514	5.5	$ 256,363.00
1980	1,864	8,606	4.6	$ 440,971.00
1981	1,827	13,440	7.4	$ 391,466.00
1982	1,536	9,396	6.1	$ 404,841.00
1983	948	4,038	4.3	$ 260,117.00
1984	800	3,886	4.9	$ 175,808.00
1985	1,284	6,537	5.1	$ 329,613.00
1986	1,640	16,192	9.9	$ 471,247.00
1987	1,331	5,290	3.9	$ 253,278.00
1988	1,761	6,803	3.9	$ 657,523.00
1989	1,327	9,527	7.2	$ 371,381.00
1990	829	15,541	18.59	$ 370,287.00
1991	1,330	3,820	2.87	$ 474,286.00
1992	876	1,926	2.20	$ 170,817.00
1993	653	3,318	5.08	$ 244,323.00
1994	903	4,537	5.24	$ 423,484.00
1995	1,034	3,459	3.35	$ 419,194.00
1996	397	1,712	4.30	$ 229,585.00

Table 4.3.15-2 Pennsylvania wildfire history (DCNR, 2017).				
YEAR	**NUMBER OF FIRES**	**ACRES BURNED**	**AVERAGE SIZE**	**COST OF EXTINCTION ($)**
1997	967	4,023	4.16	$ 589,152.00
1998	910	6,013	6.61	$ 736,103.00
2000	744	4,702	6.32	$ 598,394.00
2001	974	7,244	7.47	$ 941,452.00
2002	636	2903	4.56	$ 540,454.00
2003	407	2024	4.97	$ 262,736.52
2004	211	2,780	13.7	$ 169,065.00
2005	804	4,268	5.30	$ 599,910.00
2006	912	7,920	8.03	$ 942,544.00
2007	540	1,140	2.10	$ 299,971.00
2008	689	7,670	11.1	$ 711,229.19
2009	619	6,605	9.80	$ 613,838.48
2010	569	3,399	6.00	$ 638,248.84
2011	202	579	2.90	$ 83,654.69
2012	717	3,186	4.44	$ 677,708.70
2013	632	1790	2.83	$180,825.65
2014	871	4514	5.18	$595,389.29
2015	817	4165	5.1	$756,092.67
2016	853	12,190	14.3	$2,722,738.29
2017	534	1649	3.09	$244,765.77
Total	***163,908***	***5,997,575***	***36.59***	***$28,909,383***

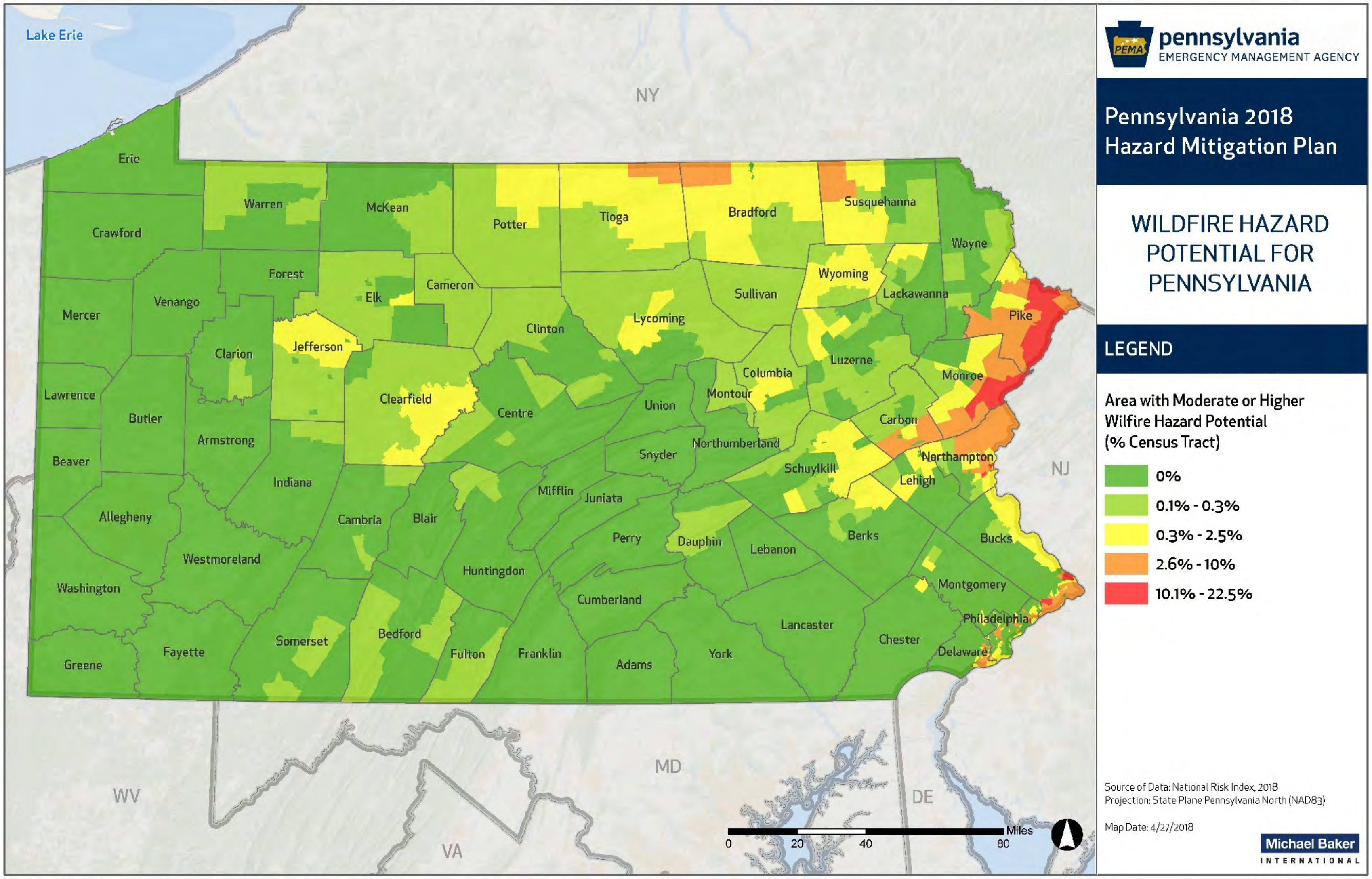
4.3.15.4. Future Occurrence

One guide to the future occurrence of wildfires is the U.S. Forest Service Wildfire Hazard Potential (WHP) map. The latest available WHP map is based on 2010 landscape conditions and evaluates wildfire hazard based on the types of fuels present. Areas with fuels having a higher probability of experiencing torching, crowning, or other forms of extreme fire behavior under conducive weather conditions are assigned higher hazard values. Figure 4.3.15-3 summarizes WHP values at the census tract scale by showing the percent of each census tract with moderate or high wildfire hazard potential. The percentage values were taken from FEMA's National Risk Index (FEMA, 2018). In Pennsylvania, the census tracts with the highest wildfire hazard are located in the state's easternmost and northernmost counties.

Based on past experience, wildfire events will occur in Pennsylvania every year; therefore, annual occurrence should be considered *highly likely* according to the Risk Factor Methodology (see Section 4.1). However, the likelihood of one of those fires attaining significant size and intensity is unpredictable and highly dependent on environmental conditions and firefighting response. Weather conditions, particularly drought events, increase the likelihood of wildfires occurring. Additionally, invasive forest insects can increase the likelihood of wildfires occurring; insects that attack and kill trees increase the total wildfire fuel available in wooded areas. Climate change is also likely to increase the probability of future wildfires. Prolonged periods of drought caused by climate change can potentially increase the length of the wildfire season and provide a more favorable climate for ignition. The key factors in wildfire occurrence and spread is temperature, soil moisture, relative humidity, wind speed, and vegetation (fuel). Decreases in the surface soil moisture due to enhanced evaporation under a warmer climate is likely (Wehner et al. 2017) and could contribute to more dry conditions conducive to wildfire especially in the summer and fall. Warmer, drier summers increase the risk of wildfires and airborne dust (Shortle et al. 2015).

It is important to note that 98% of wildfires in Pennsylvania are human-caused (PA DCNR-BOF, 2010). Thus, there is rationale for including this hazard under the summary of *human-made hazards*. Nonetheless, the critical inference to draw from this statistic is the fact that the occurrence of future wildfire events will strongly depend on patterns of human activity. Events are more likely to occur in wildfire-prone areas experiencing new or additional development.

Figure 4.3.15-3 Wildfire Hazard Potential for Pennsylvania (FEMA National Risk Index, 2018).



4.3.15.5. Environmental Impacts

Vegetation loss is often a concern, but it typically is not a serious impact since natural re-growth occurs with time. The most significant environmental impact is the potential for severe erosion, silting of stream beds and reservoirs, and flooding due to ground-cover loss following a fire event.

Wildfires also have a positive environmental impact in that they burn dead trees, leaves, and grasses to allow more open spaces for new and different types of vegetation to grow and receive sunlight. Another positive effect of a wildfire is that it stimulates the growth of new shoots on trees and shrubs and its heat can open pine cones and other seed pods.

4.3.15.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to wildfires, all structures located in high hazard census tracts were identified. Wildfire hazard was characterized based on the National Risk Index. As described in Section 4.3.15.4, the National Risk Index determined the percent of each census tract with moderate or High Wildfire Hazard Potential (WHP), based on 2010 landscape conditions. For this analysis, all census tracts in which the area of moderate or high WHP exceeded 10 percent of the census tract area were defined as high hazard census tracts, and all structures within these census tracts were identified as vulnerable facilities. Note that the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 85, or 2 percent, are located within census tracts characterized by high wildfire hazard, based on 2010 landscape condition (Table 4.3.15-3). These facilities have a combined replacement value of approximately $7.6 million, or approximately 0.2% of the known value of geolocated state facilities.

Table 4.3.15-3 Vulnerability of state facilities to wildfire.

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	0	0%
Department of Agriculture	0	0%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	0	0%
Department of Education	0	0%
Department of Environmental Protection	0	0%
Department of General Services	0	0%
Department of Health	0	0%
Department of Labor and Industry	0	0%

Table 4.3.15-3 Vulnerability of state facilities to wildfire.		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	1	1%
Department of Revenue	0	0%
Department of Transportation	15	1%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	0	0%
Governor's Office	0	0%
Historical and Museum Commission	0	0%
Insurance Department	0	0%
Liquor Control Board	6	1%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	1	25%
State Police	1	3%
State System of Higher Education	61	7%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	**85**	**1.91%**

Of the 14,011 geolocated critical facilities, 191 or 1.4 percent, are located within census tracts characterized by high wildfire hazard (Table 4.3.15-4). These facilities have a combined replacement value of approximately $1.7 billion, or 0.9% of the known value of geolocated critical facilities.

Table 4.3.15-4 Vulnerability of critical facilities to wildfire.		
TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	1	0%
Banking	0	0%
Commercial	0	0%
Communication	4	1%
Dam	105	3%
Education (colleges and universities)	2	1%
Education (public schools)	30	1%
Emergency Operation Center	2	3%

Table 4.3.15-4 Vulnerability of critical facilities to wildfire.		
TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Energy	0	0%
Fire Station	22	1%
Government	0	0%
Hospital	2	1%
National Monument or Icon	0	0%
Nuclear	0	0%
Police Station	10	1%
Transportation	0	0%
Water	13	1%
Total	**191**	**1.4%**

4.3.15.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to wildfire hazards, the population, building counts, and building value of all high-hazard census tracts were aggregated to the county scale and compiled in Table 4.3.14-4. Based on 2010 landscape condition and the associated Wildfire Hazard Potential, only six counties in Pennsylvania are significantly impacted by wildfire hazards. Across these counties, about 142 thousand people are located in census tracts vulnerable to wildfires. There are also over 57,000 buildings that are vulnerable to wildfires, the total replacement value for which is $16.4 million, or about 1.1 percent of the total value for all buildings in the state.

Table 4.3.15-5 Estimated jurisdictional losses due to wildfires.				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**EXPOSED BUILDING VALUE (THOUSAND $)**	**% OF TOTAL BUILDING VALUE**
Bucks	29,628	10,462	$3,766,542	4.6%
Delaware	3,673	1,343	$329,106	0.5%
Monroe	52,639	21,121	$6,021,164	31.6%
Northampton	15,492	4,519	$1,354,675	4.1%
Philadelphia	15,521	5,412	$1,338,468	0.8%
Pike	24,648	14,327	$3,624,088	42.8%
Total	**141,601**	**57,184**	**$16,434,043**	**1.1%**

Another component of jurisdictional vulnerability involves examining the number of past wildfire occurrences and the respective acres burned. Table 4.3.15-6 displays the number of reported wildfires and acres burned per county. In terms of number of past wildfires, Clearfield County is the most vulnerable with 726 wildfire events. Clinton County is most vulnerable to large-scale wildfires; from 1992-2015 the average fire size in this county was more than 36 acres..

Table 4.3.15-6 Number of reported wildfires and acres burned per county from 1992-2015 (USFS, 2017)

COUNTY	WILDFIRES	ACRES BURNED	COUNTY	WILDFIRES	ACRES BURNED
Adams	42	49.3	Lackawanna	141	1,299.2
Allegheny	54	44.2	Lancaster	106	176.7
Armstrong	83	274.7	Lawrence	76	301.4
Beaver	19	107.5	Lebanon	33	1,076.0
Bedford	104	1,295.2	Lehigh	122	313.6
Berks	251	275.6	Luzerne	586	9,783.6
Blair	113	771.1	Lycoming	52	1,350.3
Bradford	210	416.0	McKean	62	346.0
Bucks	62	124.0	Mercer	21	60.2
Butler	36	192.8	Mifflin	49	133.6
Cambria	104	416.0	Monroe	234	880.5
Cameron	32	1,039.0	Montgomery	61	57.8
Carbon	350	2,178.9	Montour	24	25.1
Centre	233	1,744.2	Northampton	87	168.0
Chester	87	155.9	Northumberland	217	357.4
Clarion	68	676.9	Perry	103	190.4
Clearfield	726	1,147.9	Pike	276	972.2
Clinton	88	3,245.8	Potter	56	493.9
Columbia	58	200.9	Schuylkill	555	1,890.7
Crawford	6	12.0	Snyder	59	78.7
Cumberland	40	239.8	Somerset	98	1,066.4
Dauphin	98	413.1	Steuben	1	2.0
Delaware	10	9.2	Sullivan	44	254.2
Elk	70	329.6	Susquehanna	39	102.6
Erie	9	10.5	Tioga	109	1,476.3
Fayette	187	614.9	Union	35	139.1
Forest	37	320.7	Venango	76	589.1
Franklin	95	241.9	Warren	92	412.6
Fulton	39	65.9	Washington	3	12.0
Greene	5	6.4	Wayne	11	150.5
Hunterdon	2	1.3	Westmoreland	142	314.5
Huntingdon	131	535.5	Wyoming	57	170.2
Indiana	76	622.1	York	54	90.4
Jefferson	63	210.1	**Grand Total**	**7,306**	**54,732.5**
Juniata	37	130.9			

As discussed in Section 4.1.3, the 2018 SHMP recognized the importance of protecting not just lives and property, but sense of place as well. To this end, historic buildings were also included in the assessment of jurisdictional vulnerability to wildfires. The data source and definition of historic buildings is described further in Section 4.1.3. Table 4.3.15-7 shows the number and percent of historic buildings in each county located in census tracts characterized by high wildfire risk. As in the state vulnerability assessment, high risk census tracts were identified based on the hazard values available through FEMA's National Risk Index (FEMA NRI, 2018). A total of 76 historic buildings are located in high hazard census tracts. By far the counties with the largest share of vulnerable historic buildings are Monroe and Pike counties, with 59 percent and 78 percent of their historic buildings located in census tracts vulnerable to wildfires, respectively.

Table 4.3.15-7 Vulnerability of historic buildings to wildfires (PHMC, as of June 14, 2018).

COUNTY	AT-RISK HISTORIC BUILDINGS	% OF COUNTY HISTORIC BUILDINGS
Bucks	5	2%
Monroe	35	59%
Northampton	5	4%
Philadelphia	5	1%
Pike	25	78%
Total	**76**	**1%**

4.3.16. Winter Storm

4.3.16.1. Location and Extent

Winter storms are regional events. An event most often impacts a large swath or all of Pennsylvania. In many cases, surrounding states and even the larger northeastern U.S. region are affected.

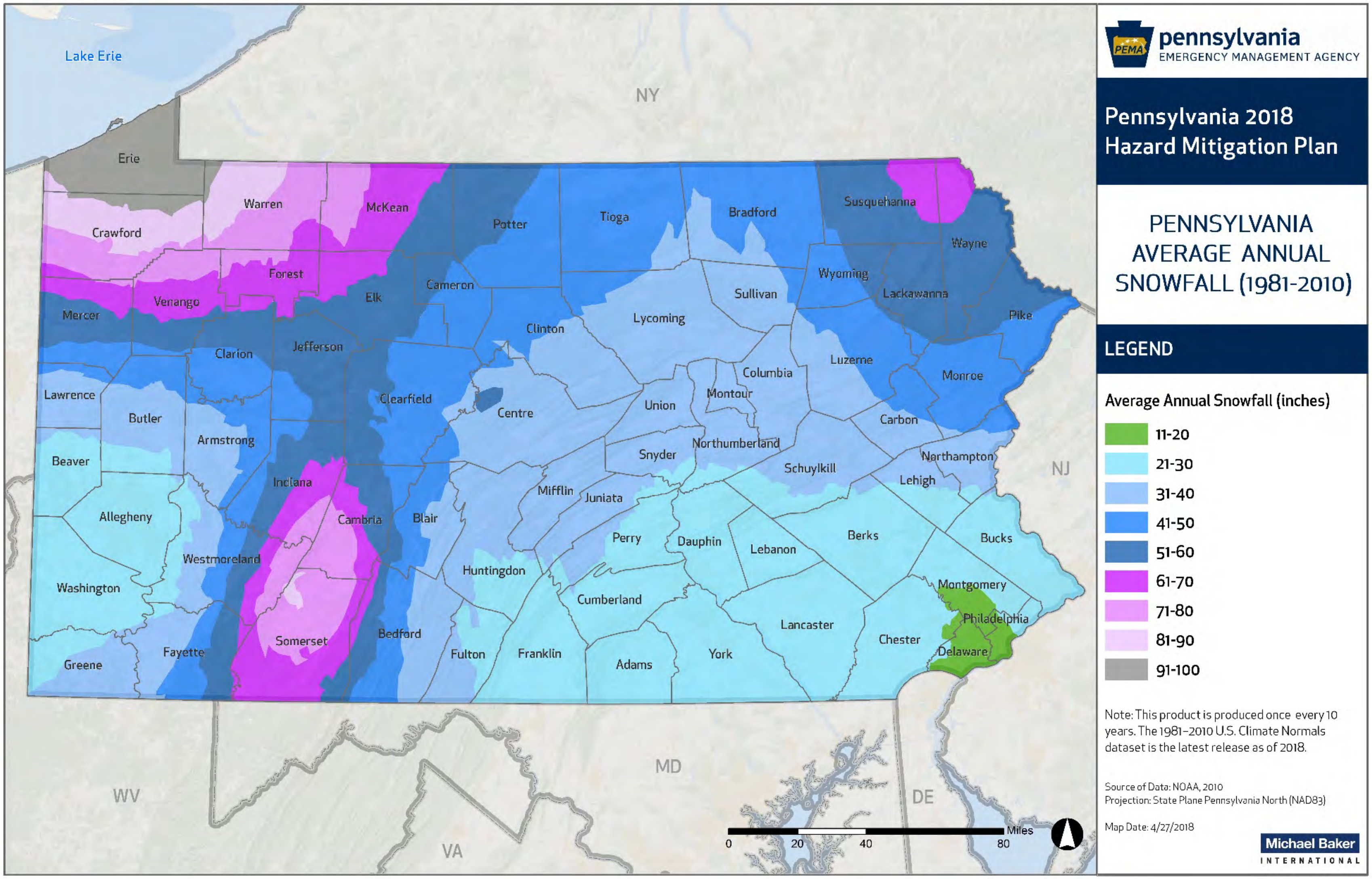
4.3.16.2. Range of Magnitude

Winter storms consist of cold temperatures, heavy snow or ice and sometimes strong winds. They begin as low-pressure systems that move through Pennsylvania usually following the jet stream. Due to their regular occurrence, these storms are considered hazards only when they result in damage to specific structures or cause disruption to traffic, communications, electric power, or other utilities.

A winter storm can adversely affect roadways, utilities, business activities, and can cause loss of life, frostbite and freezing conditions. They can result in the closing of secondary roads, particularly in rural locations, loss of utility services and depletion of oil heating supplies.

Average annual snowfall across Pennsylvania ranges from 11 inches in the southeast to over 100 inches in the northwest (see Figure 4.3.16-1). Storms tracking up the east coast tap into Atlantic moisture, whereas the Great Lakes supply the moisture and instability for heavy snow squalls in the northwest. Orographic lift enhances snowfall over higher elevations (note particularly higher average snowfall in Somerset County in the Allegheny Mountains). The snowfall season is November through April, and amounts are generally below one inch during October and May. The greatest monthly snowfalls occur in March as moisture supply begins to increase with rising temperatures.

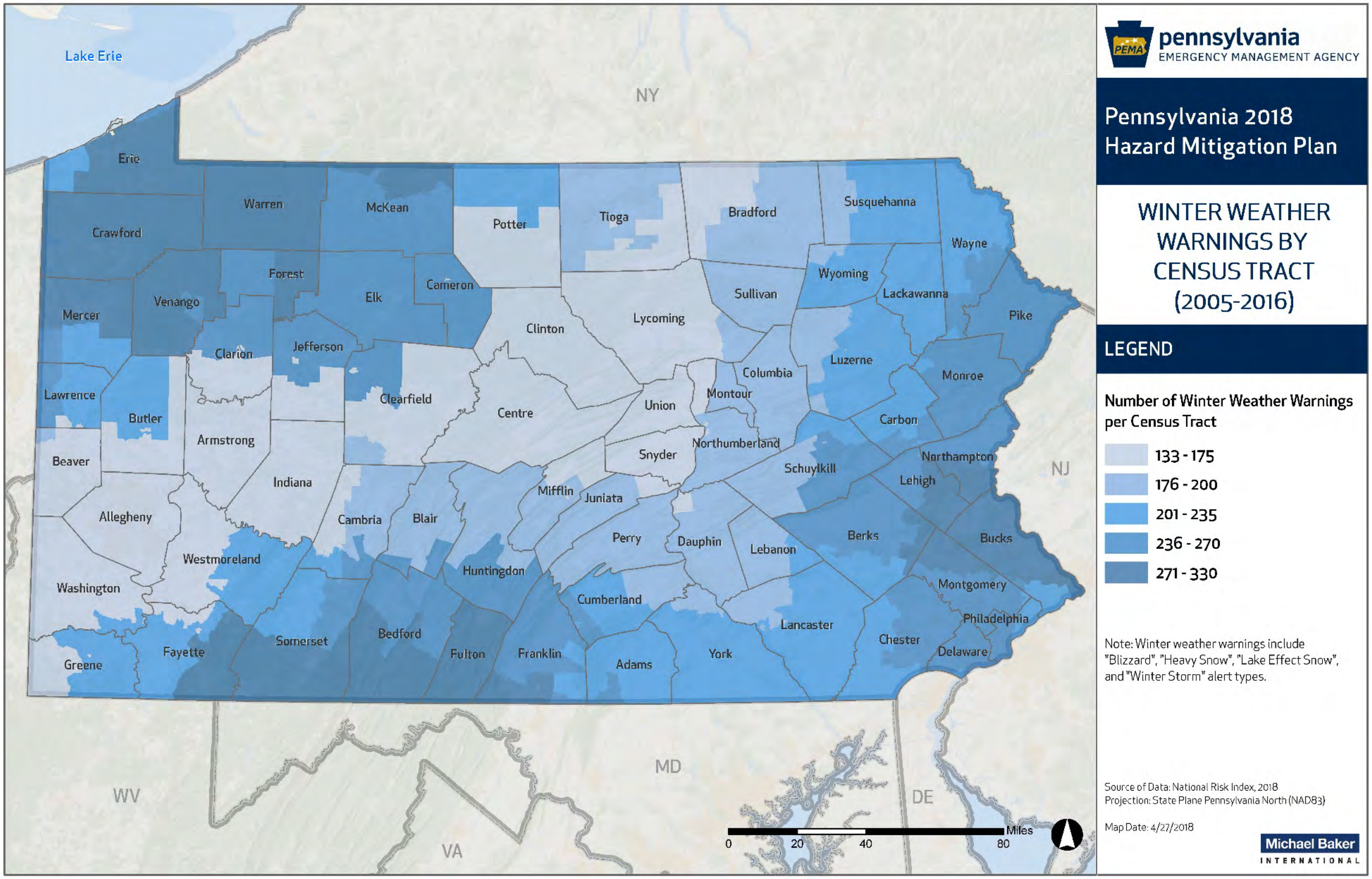
Figure 4.3.16-1 Pennsylvania average annual snowfall (NOAA, 2010).



4.3.16.3. Past Occurrence

Pennsylvania has a long history of severe winter weather. Six of the 59 Presidential Disaster and Emergency Declarations issued in Pennsylvania have been in response to winter storm events (see Table 4.2.1-1). Figure 4.3.16-2 shows the number of winter weather warnings by census tract across Pennsylvania between 2005 and 2016.

Figure 4.3.16-2 Map showing the number of winter weather warnings by census tracts across Pennsylvania (FEMA NRI, 2018).



In the winter of 1993-1994, the Commonwealth 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.

The first of these devastating winter storms occurred in early January 1994 with record snowfall depths in excess of 33 inches across southwest and south-central portions 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, affecting the southeastern portion of the Commonwealth, which closed major arterial roads and downed trees and power lines. Utility crews from a five-state area were called to assist in power restoration repairs. Officials from PP&L stated that this was the worst winter storm in the history of the company; related damage-repair costs exceeded $5,000,000.

Serious power supply shortages continued through mid-January because of record cold temperatures at many places, causing sporadic power generation outages across the Commonwealth. 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 resulted in numerous water-main breaks and interruptions of service to thousands of municipal and city water customers throughout the Commonwealth. Additionally, the extreme cold in conjunction with accumulations of frozen precipitation resulted in acute shortages of road salt. As a result, trucks were dispatched to haul salt from New York to expedite deliveries to Pennsylvania Department of Transportation storage sites.

During January and February 1994, Pennsylvania experienced at least seventeen regional or statewide winter storms. In January 1996, another series of severe winter storms with 27- and 24-inch accumulated snow depths was followed by 50 to 60 degree temperatures resulting in rapid melting and flooding.

Pennsylvania experienced several significant snowstorms in the winter of 2009-2010 resulting in record season-total snowfalls in many areas. Two of the top snowfall events were recorded in Philadelphia, including a snowfall of 23.2” on December 19-20, 2009 and a snowfall of 28.5” on February 5-6, 2010. These storms crippled many areas of Pennsylvania. Additional notable storms from this record-setting winter occurred on February 9-10, 2010 and February 25-26, 2010.

A summary of the most extreme snowfall events as well as the greatest snowfall depth recorded in Pennsylvania is provided in Table 4.3.16-1.

Table 4.3.16-1 Summary of Pennsylvania snowfall and snow depth extremes (NOAA, 2018)				
CATEGORY	**SNOW AMOUNT (INCHES)**	**STATION LOCATION**	**COUNTY**	**ENDING DATE**
Greatest daily snowfall	41	Lakeville 2 NNE	Wayne	2/16/1958
Greatest 2-day snowfall	46	Seven Springs	Somerset	3/14/1993
Greatest 3-day snowfall	52.4	Coatesville 1 SW	Chester	2/14/1899

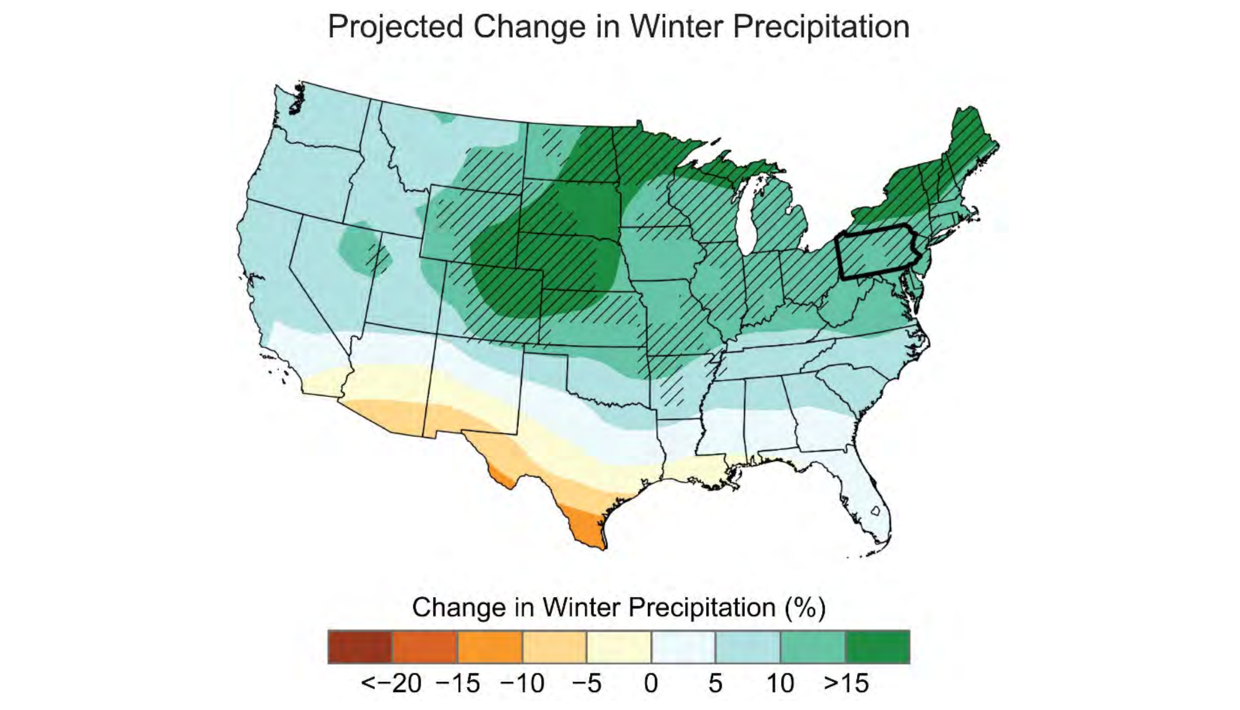
The worst winter storm in the country on record occurred on March 11-14, 1993. This blizzard, often called the *Storm of the Century*, stretched from Canada to the Gulf of Mexico but was worst in the Eastern United States, including all of Pennsylvania. This storm caused widespread blackout conditions; snowfall totals ranged from twelve inches in Philadelphia to 20 inches in Harrisburg and Scranton to 24 inches in the Pittsburgh area. Latrobe, in Westmoreland County, received 36 inches of snow, with 10-foot drifts. This event garnered a Presidential Emergency Declaration; the overall damage estimate for all states in this event was $5.5 billion (NCEI, 2017).

4.3.16.4. Future Occurrence

Winter storms are a regular, annual occurrence in Pennsylvania and should be considered *highly likely* according to the Risk Factor Methodology (see Section 4.1). Extreme snowfall totals for 10%-, 4%-, 2%-, and 1%-annual probabilities vary by location and can be obtained by weather station or county from the NOAA National Climatic Data Center at: https://www.ncdc.noaa.gov/snow-and-ice/snowfall-extremes/. The northwestern part of the state receives lake effect snows and can have more than 100 inches of snow annually due to moist arctic air masses passing over the Great Lakes.

Large snowfall years with frequent and heavier than normal snowfalls have increased in the Northeast (especially with the winters of 2013/2014 and 2014/2015). There has not been a significant trend in ice storm frequency. In recent decades, winter storm tracks in North America have shifted northward by 0.4 degrees latitude and there has been an increase in frequency and intensity since 1950. This trend is projected to continue with the CMIP5 climate model predicting an increase in winter storm frequency over the eastern United States under a high emissions scenario (Kossin et al. 2017). Under a high emissions climate scenario, winter precipitation is expected to increase in Pennsylvania (Figure 4.3.16-3).

Figure 4.3.16-3 The percent change in winter precipitation projected for the middle of the 21st century (relative to the late 20th century) (Frankson et al. 2017).



However, there is uncertainty in the climate model projections, they vary by region and model agreement is low, leading to low confidence in these projections.

Some research and data point to a connection between arctic amplification and frequent, heavy snowfall winter storms, as enhanced arctic warming increases the amplification (waviness) of jet stream patterns and allows cold arctic airmasses to reach the Northeast (Kossin et al. 2017). This leads to a possible counterintuitive increase in intense snowstorms as the climate transitions to a warmer average.

While there may be more occurrences of intense winter storms, the overall snow cover is expected to decline. The number of snow-covered days declined by 1.5 days per decade for January and by 1 day per decade for February in the Northeast and snow totals are expected to decline 20-30% in the northern part of the state and 50-60% in southern parts (PA DCNR 2015). There has also been a trend toward earlier snowmelt and total snowfall has decreased in some counties (Bradford and York) but increased in others (Centre, Franklin and Elk) (Figure 4.3.16-4). Declines in snowfall is notably due to a change in the type of precipitation – from snow to rain. As shown in Figure 4.3.16-5 there is a lower percentage of precipitation as snow for the majority of Pennsylvania, especially in the northern parts of the state (note one exception that Erie is getting more snow than rain). It is *possible* there will be an increase in frequency and intensity of winter storms, and *probable* there will be a decline in total snow cover and an increase in the percentage of precipitation falling as rain instead of snow.

Figure 4.3.16-4 Change in total snowfall from 1930 to 2007. (Kunkel et al., 2009).

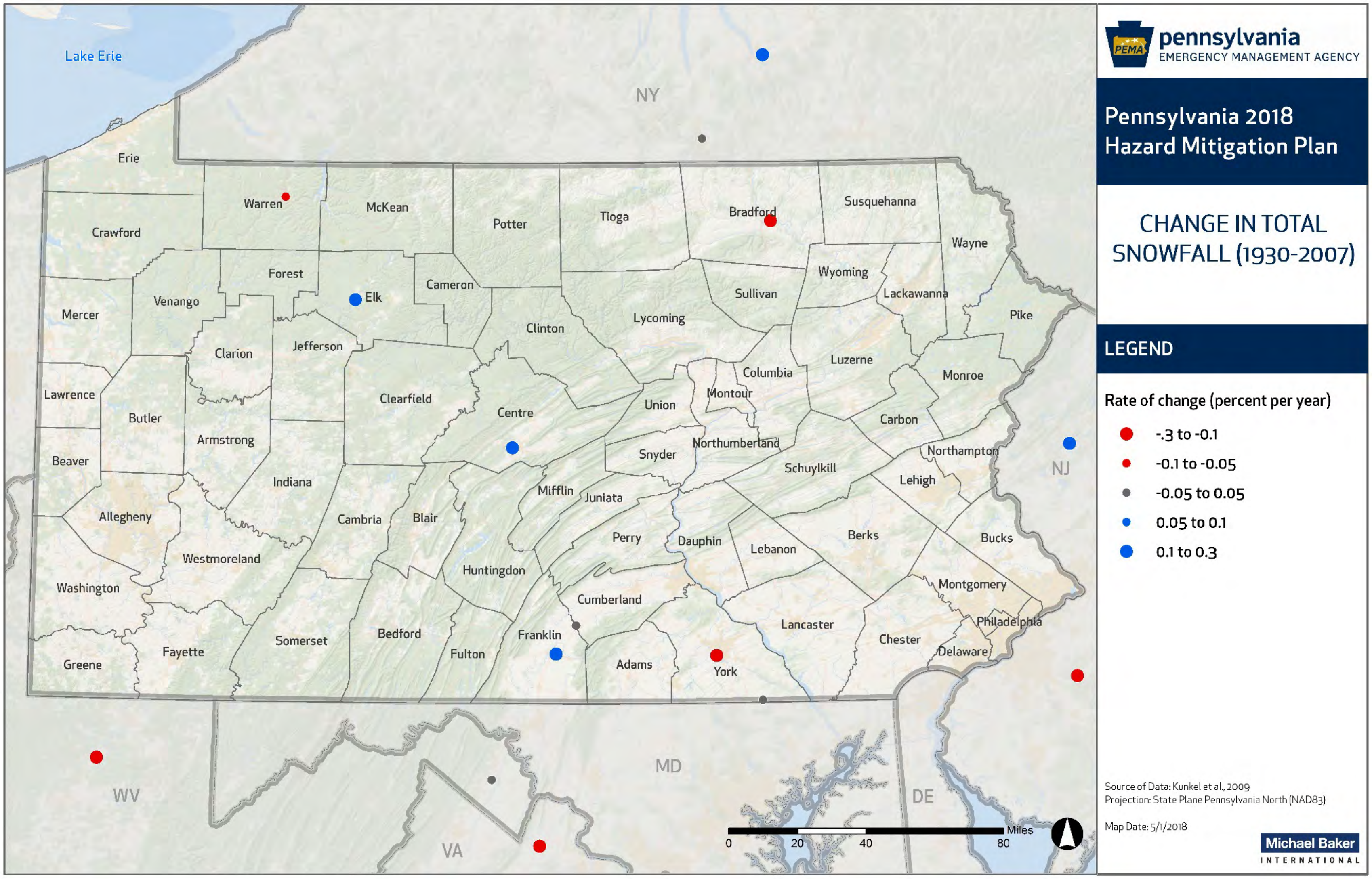
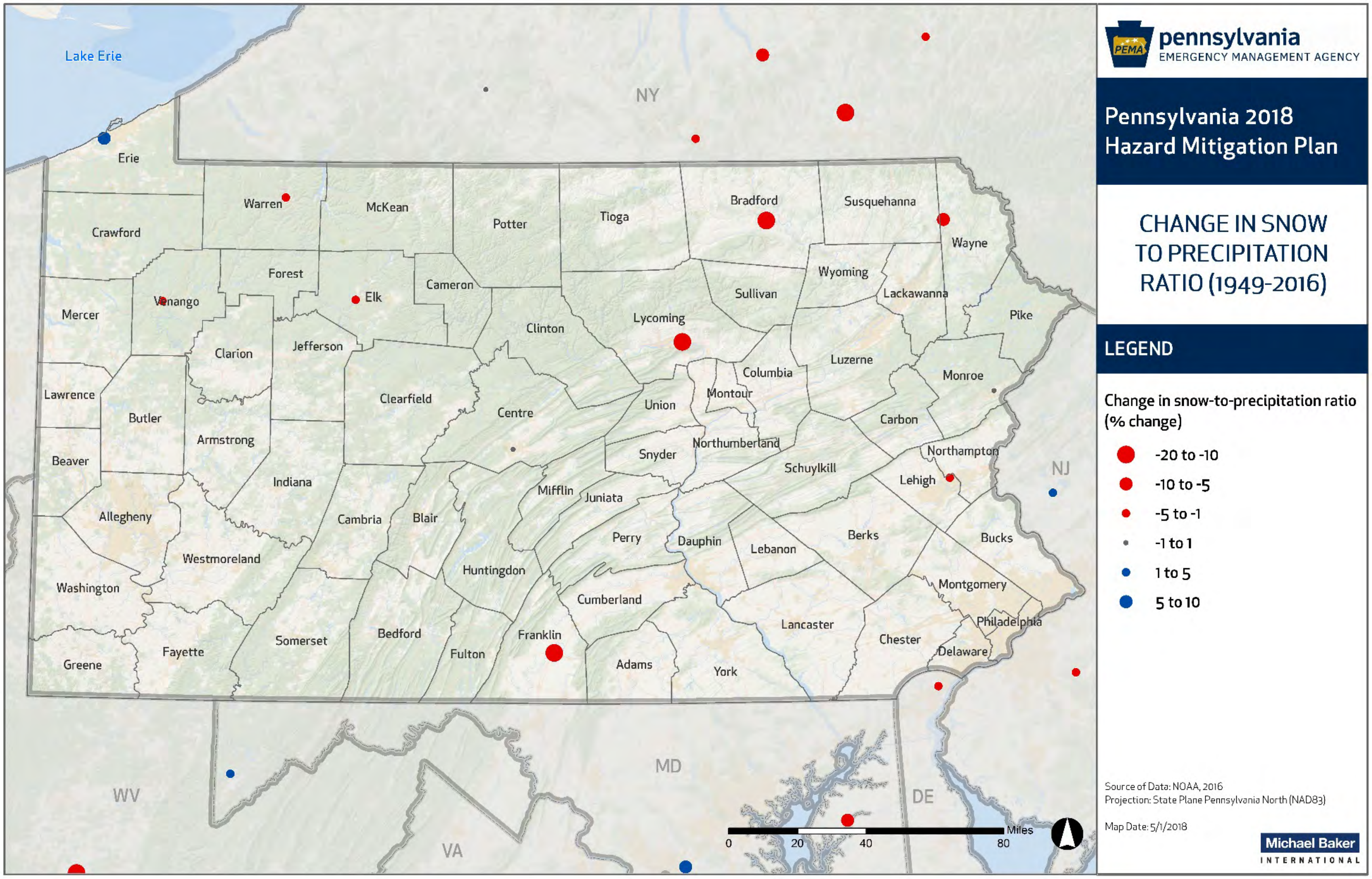


Figure 4.3.16-5 Change in winter snow-to-precipitation ratio from 1949 to 2016. Decreases mean more precipitation is falling as rain instead of snow. (NOAA, 2016).



4.3.16.5. Environmental Impacts

Environmental impacts often include damage 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. An indirect effect of winter storms is the treatment of roadway surfaces with salt, chemicals, and other de-icing materials which can impair adjacent surface and ground waters. This is particularly a concern in highly urban areas such as Philadelphia, Pittsburgh, and Harrisburg. Another important secondary impact for winter storms is building or structure collapses; if there is a heavy snowfall or a significant accumulation over time, the weight of the snow may cause building damage or even collapse.

Winter storms have a positive environmental impact as well; gradual melting of snow and ice provides excellent groundwater recharge. However, abrupt high temperatures following a heavy snowfall can cause rapid surface water runoff and severe flooding.

4.3.16.6. State Facility Vulnerability Assessment and Loss Estimation

In winter storm events, state critical facility buildings are vulnerable to widespread utility disruptions, including loss of heat and electricity, as well as building collapse or damage from downed trees. Structure vulnerability frequently depends on the age of the structure in question and its roof pitch; the older the structure, especially the roof, the less snow load it can handle. Similarly, roofs with a more gradual pitch are less able to have snow and ice slide off of them, increasing the weight of snow and ice sitting on top and thus the potential for damage.

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to winter storms, all structures located within census tracts where the number of winter weather warnings between 2005 and 2017 exceeded 2017, as shown in Figure 4.3.16-2. Of the 4,460 geolocated state facilities, 643, or 14 percent, are located within these vulnerable census tracts (Table 4.3.16-2). These facilities have a combined replacement value of more than $197 million, or approximately 5% of the known value of geolocated state facilities.

Table 4.3.16-2 Vulnerability of state facilities to winter storms.

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	2	22%
Department of Agriculture	1	6%
Department of Banking and Securities	0	0%
Department of Community and Economic	1	25%
Department of Conservation and Natural	0	0%
Department of Corrections	96	14%
Department of Education	0	0%
Department of Environmental Protection	1	8%
Department of General Services	1	1%
Department of Health	8	17%
Department of Labor and Industry	7	10%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	8	8%

Table 4.3.16-2 Vulnerability of state facilities to winter storms.		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Department of Revenue	2	20%
Department of Transportation	323	19%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	51	33%
Governor's Office	0	0%
Historical and Museum Commission	9	30%
Insurance Department	0	0%
Liquor Control Board	63	12%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	0	0%
State Police	6	17%
State System of Higher Education	64	7%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	**643**	**14%**

Winter storms can potentially affect all critical facilities, but of the 14,011 geolocated critical facilities, 1,675, or 12 percent, are located within a census tract that had more than 270 winter weather warnings between 2005 and 2017 (Table 4.3.16-3). These facilities have a combined replacement value of more than $27 billion, or approximately 14% of the known value of geolocated critical facilities.

Table 4.3.16-3 Vulnerability of critical facilities to winter storms.		
STATE CRITICAL FACILITY TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	37	13%
Banking	0	0%
Commercial	2	7%
Communication	73	12%
Dam	404	12%
Education (colleges and universities)	16	10%
Education (public schools)	388	12%
Emergency Operation Center	7	10%
Energy	4	7%
Fire Station	301	11%
Government	0	0%

Table 4.3.16-3 Vulnerability of critical facilities to winter storms.		
STATE CRITICAL FACILITY TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Hospital	40	12%
National Monument or Icon	0	0%
Nuclear	0	0%
Police Station	127	10%
Transportation	4	5%
Water	272	15%
Total	**1,675**	**12%**

4.3.16.7. Jurisdictional Vulnerability Assessment

Areas considered to be at high risk to winter storms were defined as census tracts where the number of winter weather warnings between 2005 and 2017 exceeded 2017, as shown in Figure 4.3.16-2. In these areas, 1,567,026 people and 628,174 buildings may be impacted by winter storms. These buildings have a combined loss estimate of $183.1 billion (Table 4.3.16-4). Of the vulnerable jurisdictions, Bucks County is the most threatened with more than 350,000 vulnerable people, and more than 136,000 potentially impacted buildings worth over $49 billion.

Table 4.3.16-4 Estimated jurisdictional losses due to winter storms.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Adams	0	0	0	0%
Allegheny	0	0	0	0%
Armstrong	0	0	0	0%
Beaver	0	0	0	0%
Bedford	14,566	7,943	$1,292,563	28%
Berks	32,498	13,861	$3,561,881	8%
Blair	0	0	0	0%
Bradford	0	0	0	0%
Bucks	357,551	136,881	$49,321,543	60%
Butler	0	0	0	0%
Cambria	0	0	0	0%
Cameron	0	0	0	0%
Carbon	0	0	0	0%
Centre	0	0	0	0%
Chester	0	0	0	0%
Clarion	0	0	0	0%
Clearfield	0	0	0	0%
Clinton	0	0	0	0%
Columbia	0	0	0	0%
Crawford	87,027	44,439	$9,548,325	100%
Cumberland	0	0	0	0%

Table 4.3.16-4 Estimated jurisdictional losses due to winter storms.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Dauphin	0	0	0	0%
Delaware	0	0	0	0.00%
Elk	0	0	0	0%
Erie	236,708	91,415	$26,050,221	86%
Fayette	15,155	8,203	$1,549,332	12%
Forest	5,584	3,112	$530,537	40%
Franklin	21,773	8,697	$1,996,440	14%
Fulton	14,653	7,423	$1,359,021	100%
Greene	0	0	0	0%
Huntingdon	0	0	0	0%
Indiana	0	0	0	0%
Jefferson	0	0	0	0%
Juniata	0	0	0	0%
Lackawanna	0	0	0	0%
Lancaster	0	0	0	0%
Lawrence	0	0	0	0%
Lebanon	0	0	0	0%
Lehigh	311,620	109,318	$34,350,004	86%
Luzerne	0	0	0	0%
Lycoming	0	0	0	0%
McKean	12,078	5,913	$1,095,014	23%
Mercer	37,982	18,000	$4,170,086	32%
Mifflin	0	0	0	0%
Monroe	0	0	0	0%
Montgomery	138,883	49,962	$17,050,237	15%
Montour	0	0	0	0%
Northampton	176,055	65,466	$19,748,923	60%
Northumberland	0	0	0	0%
Perry	0	0	0	0%
Philadelphia	0	0	0	0%
Pike	0	0	0	0%
Potter	0	0	0	0%
Schuylkill	0	0	0	0%
Snyder	0	0	0	0%
Somerset	24,023	13,343	$2,338,238	30%
Sullivan	0	0	0	0%
Susquehanna	0	0	0	0%
Tioga	0	0	0	0%
Union	0	0	0	0%
Venango	40,221	21,188	$4,404,368	77%

Table 4.3.16-4 Estimated jurisdictional losses due to winter storms.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Warren	40,649	23,010	$4,773,178	100%
Washington	0	0	0	0%
Wayne	0	0	0	0%
Westmoreland	0	0	0	0%
Wyoming	0	0	0	0%
York	0	0	0	0%
Total	**1,567,026**	**628,174**	**$183,139,911**	**12%**

HUMAN-MADE HAZARDS

4.3.17. Building and Structure Collapse

4.3.17.1. Location and Extent

Buildings and other engineered structures, including bridges, may collapse if their structural integrity is compromised, especially due to effects from other natural or human-made hazards. Older buildings or structures, structures that are not built to standard codes, or structures that have been weakened are more susceptible to be affected by these hazards.

Adherence to modern building codes can lower a building's risk to collapse. Building codes – developed by the International Code Council in partnership with FEMA and other federal, state, local, and private authorities – specify the minimum legal design and construction requirements for structural integrity, construction materials, and fire protection (FEMA, 2014). Most buildings constructed after 1961 in the Commonwealth were built under modern building codes as adopted in the Pennsylvania Uniform Construction Code. However, 47.5% of occupied housing units were built before 1960 in Pennsylvania. Figure 4.3.17-1 shows which counties have higher percentages of buildings constructed prior to 1960 in the Commonwealth. As illustrated on the map, Philadelphia County has the highest percentage (70.2%) of housing units built prior to 1960, while Monroe and Pike Counties have the lowest percentages at 19.5 and 15.9, respectively. More than half of all housing units in 21 counties were built prior to 1960.

In addition, the vast majority of historic resources (which are typically considered eligible for listing in the National Register of Historical Places once they past 50 years in age) were constructed prior to 1960. Historic resources are addressed in association with other hazards, but the hazard of building collapse poses a distinct, heightened risk. Based on the historic resources inventory provided by the Pennsylvania State Historic Preservation Office (PA SHPO), the Commonwealth has at least 6,160 historic buildings classified as Eligible, Listed, or National Historic Landmark. Table 4.3.17-1 shows the distribution of Eligible, Listed, and NHL buildings in the Commonwealth by county. The counties with the largest numbers of historic buildings include those in the greater Philadelphia and greater Pittsburgh regions, Lancaster County, and Washington County.

Figure 4.3.17-1 Percent of housing units built prior to 1960 by county (ACS, 2016).

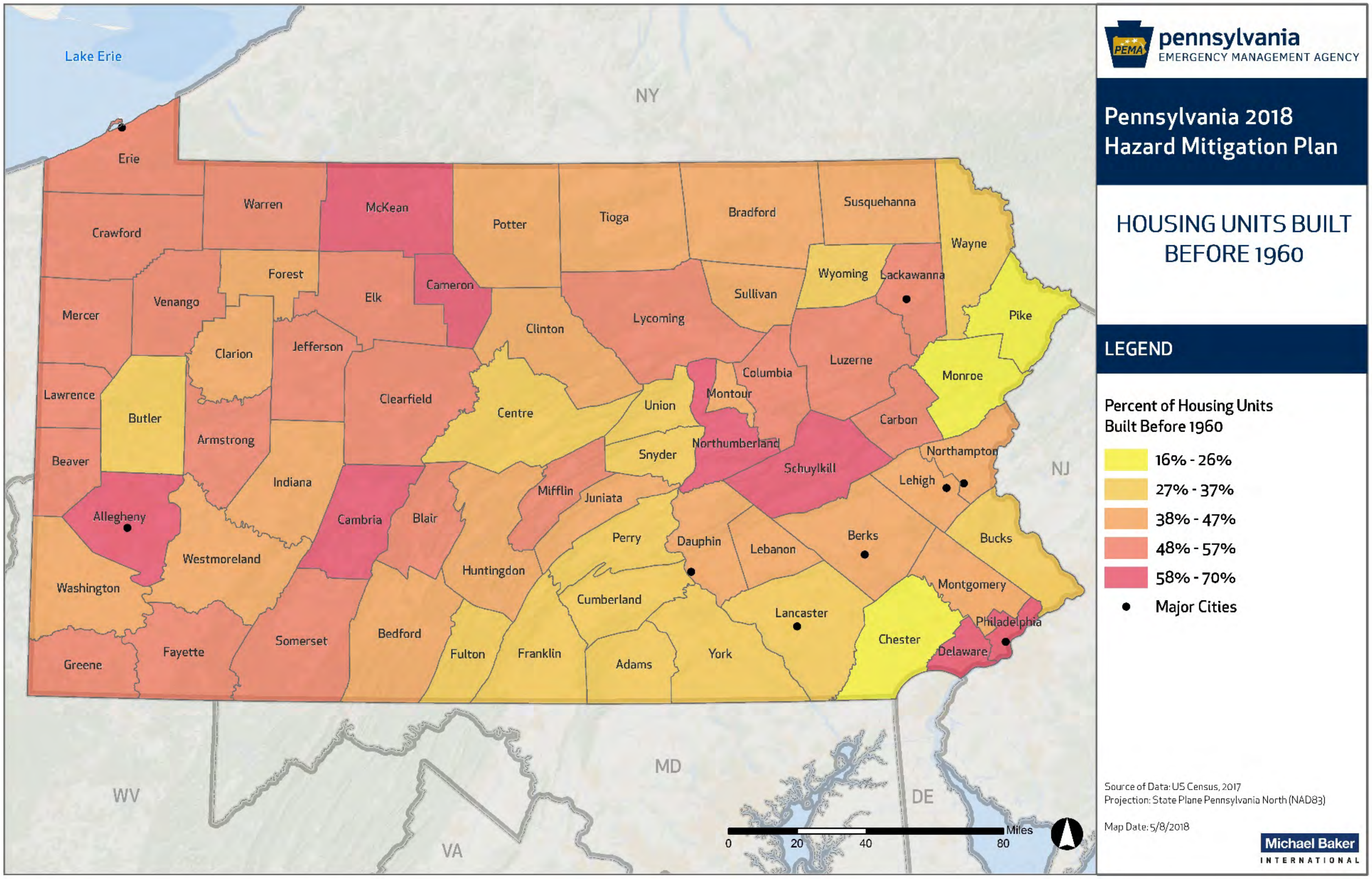


Table 4.3.17-1 Historic buildings in Pennsylvania by county (PHMC, as of June 14, 2018)		
COUNTY	ELIGIBLE, LISTED, AND NHL BUILDINGS	% OF STATE TOTAL
Adams	55	0.9%
Allegheny	490	8.0%
Armstrong	24	0.4%
Beaver	53	0.9%
Bedford	54	0.9%
Berks	252	4.1%
Blair	50	0.8%
Bradford	32	0.5%
Bucks	304	4.9%
Butler	48	0.8%
Cambria	60	1.0%
Cameron	5	0.1%
Carbon	20	0.3%
Centre	80	1.3%
Chester	467	7.6%
Clarion	11	0.2%
Clearfield	20	0.3%
Clinton	17	0.3%
Columbia	25	0.4%
Crawford	35	0.6%
Cumberland	110	1.8%
Dauphin	147	2.4%
Delaware	186	3.0%
Elk	23	0.4%
Erie	116	1.9%
Fayette	129	2.1%
Forest	6	0.1%
Franklin	106	1.7%
Fulton	13	0.2%
Greene	45	0.7%
Huntingdon	50	0.8%
Indiana	45	0.7%
Jefferson	23	0.4%
Juniata	9	0.1%
Lackawanna	94	1.5%
Lancaster	329	5.3%
Lawrence	25	0.4%
Lebanon	68	1.1%

Table 4.3.17-1 Historic buildings in Pennsylvania by county (PHMC, as of June 14, 2018)		
COUNTY	**ELIGIBLE, LISTED, AND NHL BUILDINGS**	**% OF STATE TOTAL**
Lehigh	117	1.9%
Luzerne	95	1.5%
Lycoming	41	0.7%
McKean	21	0.3%
Mercer	23	0.4%
Mifflin	30	0.5%
Monroe	59	1.0%
Montgomery	385	6.3%
Montour	16	0.3%
Northampton	115	1.9%
Northumberland	53	0.9%
Perry	17	0.3%
Philadelphia	631	10.2%
Pike	32	0.5%
Potter	10	0.2%
Schuylkill	54	0.9%
Snyder	39	0.6%
Somerset	63	1.0%
Sullivan	6	0.1%
Susquehanna	16	0.3%
Tioga	32	0.5%
Union	27	0.4%
Venango	21	0.3%
Warren	16	0.3%
Washington	199	3.2%
Wayne	53	0.9%
Westmoreland	137	2.2%
Total	**6,160**	**100%**

Bridges serve to connect both large and small roadways and communities throughout the Commonwealth. Whether they span another roadway or a body of water, bridges are a crucial part of every transportation system. However, many of Pennsylvania's bridge structures are aging and in great need of repair. Pennsylvania has more than 25,000 state-owned bridges, the third-largest number of bridges in the nation, with an average age of over 50 years old (PennDOT, 2018). Inspection and maintenance are necessary to observe and mitigate the extent of the disrepair, especially on older structures.

4.3.17.2. Range of Magnitude

There are different effects of a collapse, depending on the type and cause of the collapse and the type of structure that collapses. A building collapsing in on itself will likely result in a debris field which is dense but has a small footprint. However, if a building collapses in an outward direction, the debris field will be more widely scattered (University of Michigan, 2011). Both types of collapses can cause injury to and endanger the lives of those inside or near to the structure and can result in damages to nearby property, especially if the collapse causes a large amount of debris near a populated area. Though occupied buildings are less likely to collapse since they would generally be maintained, more risk of death or injury would be likely with the sudden collapse of an occupied building.

A worst-case scenario for a building collapse would be for a building with multiple people in it to collapse in a denser area causing injuries and possible death to those in the building as well as around the area.

Disrepair can critically affect the integrity of bridge structures as well. The level of disrepair depends on how much of the structure is damaged and how critical that portion of the structure is to the safety of drivers. Some structures only need deck replacement or a new superstructure, while others have substructure problems and should be entirely replaced. As of April 2018, 3,098 of the 25,396 bridges on state roads and 1,909 of the 6,423 bridges on locally-owned roads were classified as structurally deficient. However, a structurally-deficient rating does not indicate that a bridge is unsafe, only that there is deterioration to one or more of the major components. Should a bride be determined to be unsafe, it would be closed (PennDOT, 2018). As of April 2018, 30 bridges on state roads and 190 bridges on locally-owned roads were closed. Table 4.3.17-1 shows the number of closed and structurally-deficient bridges by county as reported by PennDOT.

Table 4.3.17-2 Total, Closed, and Structurally-Deficient Bridges on State- and Locally-owned Roads by County (PennDOT, 2018)

COUNTY	BRIDGES ON STATE ROUTE SYSTEM, LENGTH 8' OR GREATER			BRIDGES ON LOCAL ROUTE SYSTEM, LENGTH 20' OR GREATER		
	TOTAL COUNT	CLOSED BRIDGES	STRUCT. DEFICIENT COUNT	TOTAL COUNT	CLOSED BRIDGES	STRUCT. DEFICIENT COUNT
Adams	380	0	49	67	0	4
Allegheny	1,182	0	139	391	11	91
Armstrong	370	0	57	65	0	9
Beaver	336	1	42	58	2	10
Bedford	458	0	52	86	0	30
Berks	640	3	77	241	6	83
Blair	321	0	17	112	1	38
Bradford	509	0	23	117	5	46
Bucks	660	1	114	174	2	61
Butler	354	0	56	146	0	37
Cambria	332	0	13	87	2	32

Table 4.3.17-2	Total, Closed, and Structurally-Deficient Bridges on State- and Locally-owned Roads by County (PennDOT, 2018)					
COUNTY	BRIDGES ON STATE ROUTE SYSTEM, LENGTH 8' OR GREATER			BRIDGES ON LOCAL ROUTE SYSTEM, LENGTH 20' OR GREATER		
	TOTAL COUNT	CLOSED BRIDGES	STRUCT. DEFICIENT COUNT	TOTAL COUNT	CLOSED BRIDGES	STRUCT. DEFICIENT COUNT
Cameron	66	0	12	16	1	7
Carbon	135	0	27	30	1	11
Centre	432	0	30	57	1	12
Chester	665	3	102	223	4	61
Clarion	210	0	20	49	2	12
Clearfield	385	1	56	70	4	31
Clinton	249	0	19	19	1	9
Columbia	304	0	9	78	2	31
Crawford	500	0	50	124	5	51
Cumberland	372	0	28	67	2	12
Dauphin	440	0	27	119	3	17
Delaware	374	0	51	96	2	27
Elk	124	0	10	35	0	10
Erie	575	2	25	111	5	38
Fayette	433	0	79	113	7	47
Forest	76	0	6	13	1	7
Franklin	324	0	34	95	1	14
Fulton	181	0	25	25	0	9
Greene	395	1	69	91	6	29
Huntingdon	318	0	30	57	1	16
Indiana	431	0	121	79	4	12
Jefferson	264	0	30	44	2	12
Juniata	254	0	47	36	0	14
Lackawanna	415	2	46	64	2	34
Lancaster	724	4	101	266	8	62
Lawrence	279	0	30	80	5	28
Lebanon	223	0	18	89	2	16
Lehigh	350	0	34	122	2	32
Luzerne	571	1	124	103	8	37
Lycoming	513	0	12	103	0	22
McKean	245	0	53	79	1	34
Mercer	423	0	25	168	5	37
Mifflin	184	0	13	50	3	13
Monroe	368	3	65	61	1	22
Montgomery	640	0	111	261	15	86
Montour	133	0	1	25	2	6

Table 4.3.17-2	Total, Closed, and Structurally-Deficient Bridges on State- and Locally-owned Roads by County (PennDOT, 2018)					
COUNTY	BRIDGES ON STATE ROUTE SYSTEM, LENGTH 8' OR GREATER			BRIDGES ON LOCAL ROUTE SYSTEM, LENGTH 20' OR GREATER		
	TOTAL COUNT	CLOSED BRIDGES	STRUCT. DEFICIENT COUNT	TOTAL COUNT	CLOSED BRIDGES	STRUCT. DEFICIENT COUNT
Northampton	308	1	45	137	2	20
Northumberla	342	1	11	86	3	17
Perry	275	0	44	44	3	11
Philadelphia	420	0	50	167	1	45
Pike	178	0	29	36	1	22
Potter	246	0	40	44	3	18
Schuylkill	343	0	48	156	6	74
Snyder	240	0	3	32	0	7
Somerset	474	0	56	94	4	46
Sullivan	139	0	4	34	6	11
Susquehanna	414	1	106	59	1	12
Tioga	521	0	10	84	3	20
Union	198	0	3	38	2	11
Venango	223	0	18	66	2	26
Warren	267	1	20	63	2	25
Washington	780	1	123	161	3	47
Wayne	316	2	82	64	1	23
Westmorelan	735	1	109	168	4	62
Wyoming	203	0	38	25	1	9
York	657	0	80	203	4	44
TOTAL	**25,396**	**30**	**3098**	**6423**	**190**	**1909**

A total of 17 counties have more than 100 structurally-deficient bridges on both state- and locally-owned roads combined, with Allegheny County having the most at 230. The jurisdiction with the greatest number of closed bridges is Montgomery County, which has 15 closed bridges.

A worst-case scenario for a bridge structure collapse is for a high traffic bridge to collapse during rush hour causing many injuries and several deaths.

4.3.17.3. Past Occurrence

There is no comprehensive list of building or structure collapses in Pennsylvania. However, two recent events with respect to building collapse and structurally-deficient bridges have been widely reported.

In June 2013, a blighted four-story building in Center City Philadelphia that was undergoing demolition collapsed on a neighboring building, which was the location of a thrift store. At the time of the collapse, the store was open. The incident resulted in seven casualties and 12 injuries; more than a dozen were trapped under the rubble. Prior to the collapse, there were no known violations at the site and the building inspector found that proper permits were on file (CNN, 2013). During the subsequent investigation, it was determined that the collapse was the result of improper demolition. This event highlights the significance of the role of building codes and enforcement.

More recently, in January 2017, the Delaware River Turnpike Bridge in Bucks County was determined to be unsafe for travel after inspectors found a crack in the steel support of the bridge. The bride, which reportedly services 42,000 vehicles daily, was initially opened in 1956 and was more than 60 years old. Emergency repairs commenced and the bridge reopened in March 2017. The total cost of repairs was estimated to be $12 million (NJ.com, 2017).

4.3.17.4. Future Occurrence

Structures and buildings can collapse due to deterioration of bridge critical load bearing members and building structural integrity, but external occurrences can also impact bridges and buildings. As discussed, Pennsylvania has the third highest number of bridges in the country with more than 5,000, or 16%, rated as structurally deficient. Consequently, the entire Commonwealth will see an increased focus on prevention of structure collapse. According to PennDOT, within the past five years, the department has spent approximately $370 million to preserve over 1,050 bridges.

As discussed, there is no comprehensive list of building collapse events for the Commonwealth. However, the risk of issues with building structural integrity in the Commonwealth can grow without proper maintenance and code enforcement. Nearly half of all occupied housing in Pennsylvania were constructed prior to 1960 and approximately 250,000 vacant housing units are not for sale, for rent, or seasonally occupied, an indication that these units are not receiving routine maintenance and inspection (U.S. Census, 2012-2016). These structures may be at an increased risk of building collapse. Additionally, other hazard events such as fires, winter storms, and tropical storms could create conditions that would cause buildings or structures to collapse. Information on the future occurrences of such events can be found in their respective hazard profiles.

4.3.17.5. Environmental Impacts

The environmental impacts of building and structure collapse can vary depending on the scale of the event and the type of collapse. A building that collapses within itself results in a smaller debris field than a collapse in an outward direction. As a result of the debris, a building or structure collapse may have an impact air quality. A 2003 study in the *Journal of the Air & Waste Management Association* found that the impact of a 22-story building implosion on air quality was potentially severe, but short-lived and that effective protection includes staying indoors or upwind (Beck et al, 2003). Potential impacts on air quality may also have associated health risks depending on the type of pollutants and particulate matter released in the collapse. With respect to bridge collapses over water bodies, rivers, or streams, environmental impacts can include water flow and habitat disruption and water contamination.

4.3.17.6. State Facility Vulnerability Assessment and Loss Estimation

The vulnerability of state-owned or leased facilities and critical facilities to building or structure collapse is dependent on a wide variety of factors that can include age, condition, or vulnerability to other natural hazards such as fires, flooding, or severe and winter storms. State and critical facility data used to conduct the vulnerability assessments do not include detailed information on building characteristics. Therefore, an analysis of the vulnerability of these facilities based on structure age or condition was not possible. For more information on the vulnerability of state and critical facilities to other hazards that may impact building or structure collapse, please see Sections 4.3.5, 4.3.7, 4.3.16, and 4.3.33 profiling flooding, hurricanes, winter storms, and urban fires, respectively.

4.3.17.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To determine jurisdictional vulnerability to building and structure collapse, GIS analysis was conducted to identify all census tracts characterized by high risk of building and structure collapse. Census tracts in which more than 75 percent of all occupied housing units were built prior to 1960 were defined as high risk areas. A threshold of 75 percent was identified based on the range of the percent of units built prior to 1960 as identified in Figure 4.3.17-1. It should be noted that this analysis of jurisdictional vulnerability only accounts for the age of housing units, not all buildings and structures within a census tract. For example, counties with high percentages of structurally-deficient bridges may also be considered vulnerable to structure collapse. In Pennsylvania, 17 counties have more than 20 percent of their bridges classified as deficient. Further, it does not account for other factors that may lead to building collapse such as condition, vacancy status, or vulnerability to fires. The total population, building count, and building value within these census tracts were aggregated by county to determine the relative vulnerability of each county (Table 4.3.17-2).

Table 4.3.17-3 Vulnerability of people and buildings to structure collapse.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Adams	4,198	1,895	$677,533	6%
Allegheny	369,555	163,796	$41,048,128	25%
Armstrong	4,697	2,262	$511,254	8%
Beaver	40,611	17,871	$5,271,090	27%
Bedford	2,763	1,355	$379,390	8%
Berks	75,749	25,566	$7,239,915	16%
Blair	20,032	8,636	$1,870,206	14%
Bradford	2,848	1,237	$312,291	5%
Bucks	27,239	10,474	$3,289,125	4%
Butler	7,499	3,346	$878,210	4%
Cambria	27,328	14,320	$3,745,044	24%
Cameron	0	0	$0	0%
Carbon	14,524	6,499	$1,536,899	21%

Table 4.3.17-3 Vulnerability of people and buildings to structure collapse.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Centre	2,711	18	$42,911	0%
Chester	10,523	3,358	$1,040,636	2%
Clarion	0	0	$0	0%
Clearfield	6,175	3,034	$754,812	10%
Clinton	0	0	$0	0%
Columbia	10,293	3,663	$1,337,415	19%
Crawford	7,393	2,947	$748,414	8%
Cumberland	7,291	2,985	$992,567	4%
Dauphin	39,201	15,576	$3,853,345	12%
Delaware	227,960	81,222	$24,177,243	35%
Elk	6,395	3,357	$822,879	20%
Erie	52,632	18,805	$4,557,468	15%
Fayette	8,823	3,619	$827,523	7%
Forest	0	0	$0	0%
Franklin	3,110	907	$213,578	1%
Fulton	0	0	$0	0%
Greene	0	0	$0	0%
Huntingdon	0	0	$0	0%
Indiana	0	0	$0	0%
Jefferson	0	0	$0	0%
Juniata	0	0	$0	0%
Lackawanna	54,501	20,713	$6,191,428	24%
Lancaster	58,036	18,666	$5,227,666	10%
Lawrence	20,705	9,787	$2,115,569	23%
Lebanon	3,965	1,317	$287,400	2%
Lehigh	56,718	18,494	$5,185,812	13%
Luzerne	60,726	25,890	$6,332,319	18%
Lycoming	17,125	6,263	$1,917,735	16%
McKean	10,832	4,926	$1,352,598	29%
Mercer	23,805	10,358	$2,847,412	22%
Mifflin	5,600	2,662	$624,426	14%
Monroe	0	0	$0	0%
Montgomery	124,912	44,450	$15,984,743	14%
Montour	0	0	$0	0%
Northampton	62,875	21,351	$6,247,488	19%
Northumberland	30,361	14,317	$3,064,431	32%

Table 4.3.17-3 Vulnerability of people and buildings to structure collapse.				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $**	**PERCENT OF COUNTY BUILDING VALUE**
Perry	0	0	$0	0%
Philadelphia	902,987	334,443	$82,371,302	50%
Pike	0	0	$0	0%
Potter	0	0	$0	0%
Schuylkill	58,745	28,657	$6,549,931	42%
Snyder	1,832	98	$153,156	4%
Somerset	5,886	2,928	$621,826	8%
Sullivan	0	0	$0	0%
Susquehanna	2,092	837	$186,757	4%
Tioga	0	0	$0	0%
Union	5,241	75	$118,286	3%
Venango	9,516	4,230	$959,965	17%
Warren	9,407	4,074	$1,295,393	27%
Washington	30,125	14,342	$3,598,330	15%
Wayne	0	0	$0	0%
Westmoreland	32,537	15,248	$3,705,958	9%
Wyoming	0	0	$0	0%
York	45,737	16,533	$4,728,072	10%
Total	**2,613,816**	**1,017,407**	**$267,795,879**	**18%**

A total of 48 counties were identified as having areas at high risk to building and structure collapse. The assessment found that more than 2.6 million people and one million buildings are located within census tracts in which more than 75 percent of housing units were built prior to 1960. The largest concentrations of vulnerable people and buildings are in Philadelphia and Allegheny Counties, which include dense urban areas with older housing stocks. In Philadelphia, half of the total building value is located in high risk census tracts. The total estimated value of all vulnerable buildings in high risk census tracts is $267.8 billion, which is 18 percent of the total value of all buildings in the Commonwealth.

4.3.18. Civil Disturbance

4.3.18.1. Location and Extent

Civil disturbance is a broad term that is typically used by law enforcement to describe one or more forms of disturbance caused by a group of people. Civil disturbances are typically a symptom of and a form of protest against major socio-political problems. Civil disturbance hazards include the following:

- ***Famine:*** Involves a widespread scarcity of food leading to malnutrition, increased mortality, and a period of psychosocial instability associated with the scarcity of food, such as riots, theft of food, and the fall of governments caused by political instability borne of an inability to deal with the crisis caused by famine.

- ***Economic Collapse or Recession:*** Very slow or negative growth.
- ***Misinformation:*** Erroneous information spread unintentionally.
- ***Civil Disturbance, Public Unrest, Mass Hysteria, and Riot:*** Group acts of violence against property and individuals, for example.
- ***Strike or Labor Dispute:*** Controversies related to the terms and conditions of employment, for example.

Typically, the severity of the action coincides with the level of public outrage. In addition to a form of protest against major socio-political problems, civil disturbances can also arise out of union protest, institutional population uprising, or from large celebrations that become disorderly.

The scale and scope of civil disturbance events varies widely. However, government facilities, landmarks, prisons, and universities are common sites where crowds and mobs may gather. The concentration of federal buildings in Philadelphia and state government buildings in Harrisburg may be targets of civil disturbance. Furthermore, Pennsylvania has 26 state correctional facilities, one motivational boot camp, 14 community corrections centers, 40 contract facilities and a training academy. In addition, Pennsylvania is home to eight federal prison facilities as well as local and private facilities that may be targets for civil unrest.

4.3.18.2. Range of Magnitude

Civil disturbances can take the form of small gatherings or large groups blocking or impeding access to a building, or disrupting normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot, in which a mob burns or otherwise destroys property and terrorizes individuals. Even in its more passive forms, a group that blocks roadways, sidewalks, or buildings interferes with public order. Often that which was intended to be a peaceful demonstration to the public and the government can escalate into general chaos. There are two types of large gatherings typically associated with civil disturbances: a crowd and a mob. A crowd may be defined as a casual, temporary collection of people without a strong, cohesive relationship. Crowds can be classified into four categories:

- ***Casual Crowd:*** A casual crowd is merely a group of people who happen to be in the same place at the same time. Violent conduct does not occur.
- ***Cohesive Crowd:*** A cohesive crowd consists of members who are involved in some type of unified behavior. Members of this group are involved in some type of common activity, such as worshipping, dancing, or watching a sporting event. Although they may have intense internal discipline, they require substantial provocation to arouse to action.
- ***Expressive Crowd:*** An expressive crowd is one held together by a common commitment or purpose. Although they may not be formally organized, they are assembled as an expression of common sentiment or frustration. Members wish to be seen as a formidable influence. One of the best examples of this type is a group assembled to protest.
- ***Aggressive Crowd:*** An aggressive crowd is comprised of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse

the members or motivate them to action. Members are noisy and threatening and will taunt authorities. They may be more impulsive and emotional, and require only minimal stimulation to arouse violence. Examples of this type of crowd could include demonstrators and strikers, though not all demonstrators and strikers are aggressive.

A mob can be defined as a large disorderly crowd or throng. Mobs are usually emotional, loud, tumultuous, violent and lawless. Similar to crowds, mobs have different levels of commitment and can be classified into four categories (Alvarez and Bachman, 2008):

- **Aggressive Mob:** An aggressive mob is one that attacks, riots and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity. Examples of aggressive mobs are the inmate mobs in prisons and jails, mobs that act out their frustrations after political defeat, or violent mobs at political protests or rallies.
- **Escape Mob:** An escape mob is attempting to flee from something such as a fire, bomb, flood, or other catastrophe. Members of escape mobs are generally difficult to control can be characterized by unreasonable terror.
- **Acquisitive Mob:** An acquisitive mob is one motivated by a desire to acquire something. Riots caused by other factors often turn into looting sprees. This mob exploits a lack of control by authorities in safeguarding property.
- **Expressive Mob:** An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration. Members experience a release of pent up emotions in highly charged situations.

The worst-case scenario for a civil disturbance event would be riots akin to the 1967 Newark Riots, an event fueled by police brutality, political exclusion of African Americans, urban renewal, inadequate housing, unemployment, and poverty. In this event, the arrest and subsequent treatment of a cab driver sparked violence and looting in downtown Newark, NJ. The National Guard was called in, but their presence only served to intensify the violence. The riots lasted six days, after which 23 people were dead, 725 were injured, and nearly 1,500 were arrested. A similar event could occur in one of Pennsylvania's major cities and have a comparable impact.

4.3.18.3. Past Occurrence

Over the past 265 years, Pennsylvania has had about dozen civil disorders take place which were notable enough to be recorded in the state's history (Klein, 1973). The following list includes these events as well as more recent civil disturbance events that received widespread media coverage across the state:

- 1742 – Philadelphia Election Riot
- 1764 – Paxton Riots
- 1775 – Philadelphia Anti-Loyalist Riot
- 1794 – Whiskey Rebellion
- 1844 – Philadelphia Nativist Riots
- 1851 – Christiana Riot

- 1877 – Pennsylvania Railroad Strike
- 1892 – Homestead Steel Riot
- 1919 – Pennsylvania Steel Strike
- 1964 – Philadelphia race riot (August 28-30)
- 1969 – York Race Riot (1969)
- 1998 – State College (1998)
- 2011 – State College Paterno Riots
- 2011 – Occupy Philadelphia protests
- 2012 – Fans riot in Bethel Park after a win at home against Upper St. Clair
- 2018 – Philadelphia Eagles Won the Super bowl

While there have been some civil disturbances in the Commonwealth, they have largely not been catastrophic or widespread. Civil disturbance events of some kind occur every day with minimal impact on the Commonwealth, often in relation to politics, elections, economic stagnation, inflation, unemployment, oppression, disruption of services, or political scandal. From 2001 to 2009, events of this kind reported to the Pennsylvania Emergency Incident Reporting System (PEIRS). Between January 2001 and June 2009, there was an average of 19 civil disturbance events reported to PEIRS, as shown in Table 4.3.18-2 below. After 2012, PEMA migrated to a new incident management system, PEMA-KC. Between 2012 and April 2018, a total of 463 civil disorder events were recorded in PEMA-KC. From 2012 to 2017, the Commonwealth experienced an average of 74 civil disturbance events each year (Table 4.3.18-3).

Table 4.3.18-1 Civil disturbance events reported to PEIRS, 2001-2009 (PEMA, 2010).

EVENT TYPE	2001	2002	2003	2004	2005	2006	2007	2008	2009*
Demonstration	6	1	4	0	0	1	8	3	1
Juvenile Detention Center	0	0	0	1	0	2	3	0	1
Prison Disturbance	1	4	2	0	3	2	3	1	1
Prison Escape	6	1	9	8	4	8	4	1	5
Protest	0	4	3	6	7	9	8	4	3
Riot	6	2	4	2	0	3	6	6	1
Civil Disorder - totals	***19***	***12***	***22***	***17***	***14***	***25***	***32***	***15***	***12***
***Events totaled through June 2009**									

Table 4.3.18-2 Civil disturbance events reported to PEMA-KC, 2012-2018 (PEMA, 2018).

EVENT TYPE	2012	2013	2014	2015	2016	2017	2018
Demonstration	1	3	9	3	3	3	3
Juvenile Detention Center	0	0	0	0	0	0	1

Prison Disturbance	0	2	0	0	0	1	0
Detainee Escape	2	4	3	4	0	2	1
Protest	4	24	49	35	64	78	13
Large Crowd Gathering	0	1	0	4	2	3	2
Riot	0	0	0	1	0	0	0
School Threat	1	2	0	2	0	2	0
Assault	2	8	2	2	3	4	0
Gun/Bomb Incident	3	15	3	7	2	3	0
Civil Disorder - totals	***13***	***59***	***66***	***58***	***74***	***96***	***20***
Events totaled through 2018							

4.3.18.4. Future Occurrence

Minor civil disturbances will continue to occur throughout the state, but it is not possible to accurately predict the probability and triggers for a large-scale civil disturbance event over the long-term. Civil disturbance is always a possibility as long as there is discrimination or other perceived social or economic injustices.

The location of civil disturbance events is unpredictable, yet spatial distribution patterns of riots in the past suggest that cities, universities, sporting events, and where large crowds gather are probable areas for a civil disturbance event to ensue. Local law enforcement should continue to anticipate these types of events and be prepared to handle a crowd so that peaceful gatherings are prevented from turning into unruly public disturbances. Overall, the probability of future civil disturbance events can be considered *likely* as defined by the Risk Factor Methodology (See Section 4.1).

4.3.18.5. Environmental Impacts

The impacts of civil disturbance events are contingent upon numerous factors including issues, politics, and method of response. Generally, the impact of civil disturbance events is nominal and short-lived unless acts of sabotage are performed. There may be minor injuries to first responders or participants from physical confrontations, and vandalism may cause minimal damage to property, facilities, and infrastructure. Adequate law enforcement at planned civil disturbance events and around likely target locations like the offices of state agencies minimizes the chances of a small assembly of individuals turning into a significant disturbance.

4.3.18.6. State Facility Vulnerability Assessment and Loss Estimation

The vulnerability of state facilities depends on the type and function of each individual entity as well as the greater geographic context of the facility. As visible symbols of government, government facilities and national monuments are more vulnerable to civil disturbance events, but the vulnerability of each facility may change based on hot-button issues. Table 4.3.18-3 illustrates the number of critical facilities in Pennsylvania that fall into these more vulnerable types. To a certain extent, though, any facility deemed critical may be a target for civil disturbance.

The maximum threat of civil disturbance is hard to project. It has the potential (in terms of injuries, loss of life, and economic, property, and infrastructure damage) to inflict tremendous loss. The critical facilities listed have a total replacement value exceeding $1.7 billion. Please note, though, that national monuments and icons do not have a replacement value, so potential losses should be considered an underestimation. More broadly, in the case of large civil disturbance events, the Commonwealth may incur losses related to work stoppages in addition to any acts of vandalism that might occur. Failure to pursue a program of civil disturbance awareness may result in increased loss of lives and property. Table 4.3.18-3 below shows the total state-owned or leased critical facilities susceptible to civil disturbance events.

Table 4.3.18-3 Vulnerability of critical facilities to civil disturbance events

STATE CRITICAL FACILITY TYPE	NUMBER OF IMPACTED FACILITIES
Government Facilities	41
National Monuments & Icons	6
Total	**47**

4.3.18.7. Jurisdictional Vulnerability Assessment

The vulnerability of individual jurisdictions is difficult to determine because civil disturbance hazards are tied to the current political and economic climate. A jurisdiction that is very vulnerable one month may be less vulnerable the next. However, in general, Philadelphia, Dauphin, and Allegheny Counties and individual county seats may have higher vulnerabilities due to higher concentrations of local, state, and federal facilities.

Losses for civil disturbance events are difficult to predict and can vary significantly in range. For example, the State College Riot in July 1998, fueled by alcohol consumption, resulted in approximately $150,000 in damages. Because of its national, state, and regional importance, Philadelphia is the most threatened jurisdiction for civil disturbances. Philadelphia, Allegheny, and Dauphin Counties, the most vulnerable jurisdictions, have total estimated losses of approximately $360 billion, as shown below. This total includes only building value, and not content or inventory value.

Table 4.3.18-4 Vulnerability of people and buildings to civil disturbance events

COUNTY	NUMBER OF IMPACTED BUILDINGS	NUMBER OF BUILDINGS	BUILDING REPLACEMENT VALUE (THOUSANDS)
Allegheny	1,230,360	501,670	$162,158,360
Dauphin	271,962	107,000	$32,485,579
Philadelphia	1,559,938	534,077	$165,970,513
Total	**3,062,260**	**1,142,747**	**$360,614,452**

4.3.19. Cyber-Terrorism

4.3.19.1. Location and Extent

Cyberterrorism is a broad term that refers to acts associated with the convergence of terrorism and cyberspace. Generally, cyberterrorism involves unlawful attacks or threats against computers, networks, and the information stored therein to intimidate or coerce a government or its people to achieve political or social objectives (Denning, 2000). These acts can range from taking control of a host website, to using networked resources to directly cause destruction and harm. The Pennsylvania Department of Homeland Security defines the following types and methods of cyberattacks:

Table 4.3.19-1 Methods of Cyberattacks (PA Department of Homeland Security, 2017)

THREAT	DESCRIPTION
Botnet (also zombies)	A collection of computers subject to control by an outside party, usually without the knowledge of the owners, using secretly installed software robots. The robots are spread by trojan horses and viruses. The botnets can be used to launch denial-of-service attacks and transmit spam.
Card Skimming	The act of using a skimmer to illegally collect data from the magnetic stripe of a credit, debit or ATM card. This information, copied onto another blank card's magnetic stripe, is then used by an identity thief to make purchases or withdraw cash in the name of the actual account holder. Skimming can take place at an ATM and can occur at restaurants, taxis, or other places where a user surrenders his or her card to an employee.
Denial-of-service attack	Flooding the networks or servers of individuals or organizations with false data requests so they are unable to respond to requests from legitimate users.
Malicious code (also malware)	Any code that can be used to attack a computer by spreading viruses, crashing networks, gathering intelligence, corrupting data, distributing misinformation and interfering with normal operations.
Pharming	The act of sending an e-mail to a user falsely claiming to be an established legitimate enterprise in an attempt to scam the user into surrendering private information that will be used for identity theft. The e-mail directs the user to visit a website where they are asked to update personal information, such as passwords and credit card, social security, and bank account numbers that the legitimate organization already has. The website, however, is bogus and set up only to steal the user's information.
Phishing	Using fake e-mail to trick individuals into revealing personal information, such as Social Security numbers, debit and credit card account numbers and passwords, for nefarious uses.
Spam	Unsolicited bulk e-mail that may contain malicious software. Spam is now said to account for around 81 percent of all e-mail traffic.

Table 4.3.19-1 Methods of Cyberattacks (PA Department of Homeland Security, 2017)

THREAT	DESCRIPTION
Spear Phishing	A type of phishing attack that focuses on a single user or department within an organization, addressed from someone within the company in a position of trust and requesting information such as login IDs and passwords. Spear phishing scams will often appear to be from a company's own human resources or technical support divisions and may ask employees to update their username and passwords. Once hackers get this data, they can gain entry into secured networks. Another type of spear phishing attack will ask users to click on a link, which deploys spyware that can thieve data.
Spoofing	Making a message or transaction appear to come from a source other than the originator.
Spyware	Software that collects information without a user`s knowledge and transfers it to a third party.
Trojan horse	A destructive program that masquerades as a benign application. Unlike viruses, Trojan horses do not replicate themselves but they can be just as destructive. One of the most insidious types of Trojan horse is a program that claims to rid your computer of viruses but instead introduces viruses onto your computer.
Virus	A program designed to degrade service, cause inexplicable symptoms or damage networks.
Worm	Program or algorithm that replicates itself over a computer network and usually performs malicious actions, such as using up the computer's resources and possibly shutting the system down. A worm, unlike a virus, has the capability to travel without human action and does not need to be attached to another file or program.

Cyberattacks may not always constitute acts of cyberterrorism because some acts may have relatively small impacts and only produce annoyances. A cyberattack is generally considered an act of cyberterrorism when the following motivations are present:

- **Effects-based:** When computer attacks result in effects that are disruptive enough to generate fear comparable to a traditional act of terrorism.
- **Intent-based:** When unlawful or politically motivated computer attacks are done to intimidate or coerce a government or people to further a political objective, or to cause grave harm or severe economic damage (Rollins and Clay, 2007).

Cyberattacks can be further divided into the following categories based on the complexity of the attack:

- **Simple-Unstructured:** Simple-unstructured attacks are the most common. These are amateurish attacks with relatively minimal consequences.
- **Advanced-Structured:** Advanced-structured attacks are more sophisticated and consequential, and have a greater emphasis on targeting victims prior to an attack, resulting in a more debilitating effect.

- **Complex-Coordinated:** Complex-coordinated attacks are the most advanced and most troublesome type of attack where success could mean a network shutdown (Denning, 2000).

Cyberterrorism can cause severe disruptions to transportation, public safety, and utility services, all of which are critical infrastructure that are highly dependent on information technology. Cyberterrorism can take many forms, including attacks through physical means, electronic means, and use of malicious code. Cyberterrorists can also have a wide range of personal, political, or cultural agendas. All state agencies, as well as individuals, businesses, and other institutions in the Commonwealth, are potential targets for cyberterrorism. Potential threats include identify theft, loss of sensitive information, disruption of services, and other malicious activity.

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. Cyber attacks are also unpredictable and typically occur without warning.

4.3.19.2. Range of Magnitude

In recent years, cyberterrorism has become a significant threat and can impact people, businesses, institutions, local governments, and state agencies to varying degrees. Impacts from a large-scale cyberterrorism event could disrupt the state's economy and potentially threaten its economic stability. The magnitude of a cyberterrorism attack will vary greatly based on the extent of systems affected and duration of the impact. Additionally, the magnitude will vary based upon which specific system is affected by an attack, the ability to preempt an attack, and an attack's effect on continuity of operations. The largest threat to institutions from cyberterrorism comes from any processes that are networked and controlled via computer. The state should address and take measures to reduce any vulnerabilities that could allow access to sensitive data or processes.

4.3.19.3. Past Occurrence

Since 2012, the following four cyberterrorism related incidents have been reported to PEMA-KC.

Table 4.3.19-2 Past occurrences of cyber-attacks, 2012-2018 (PEMA-KC, 2018)

INCIDENT	YEAR	LOCATION
Cyber threat	2016	York
International cyber attack	2017	Statewide
Cyber attack	2017	Northampton, Bethlehem City
Cyber Incident	2018	Statewide

Another large-scale attack was the Equifax data breach in 2017, which was estimated to potentially impact over 5.5 million residents of Pennsylvania and over 145.5 million nationally. The information accessed included names, Social Security numbers, birthdates, addresses, and driver's license numbers (PA Office of the Attorney General, 2017). Additionally, in 2014 the largest data breach in history impacted over 3 billion Yahoo user accounts, including the names, email address, date of birth, and telephone numbers of over 500 million users (CSO, 2018). In terms of a data breach cyber attack, this could be considered a worst-case scenario event. Other large-scale data breach events have also occurred in recent years and are becoming more common.

In addition to large-scale acts of cyberterrorism, smaller cyberattacks occur on a daily basis. Billions of emails are sent each day, and spam and phishing emails account for a significant share of all email traffic. Additionally, brute force attacks, which area trial and error attempts to obtain user passwords and pins, are frequently used by criminals to attempt to crack encrypted data or gain access to private accounts. Firewalls can be effective at keeping security threats such as these out, but once a cyber criminal gains access to a system, they can attack from within. For example, gaining access to a state employees email account would allow a hacker to send additional phishing emails from within the network, which may not be as monitored as closely as attacks from outside the system. This is known as spear phishing.

4.3.19.4. Future Occurrence

Cyberterrorism is an emerging hazard that has the potential to impact the state's computer infrastructure and the systems and services that are provided to the public. Concerns about cyberterrorism throughout the United States is growing as its impacted could have potentially crippling effects. Security experts describe the threat of cyberterrorism as eminent and *highly likely* to occur in any given year in Pennsylvania.

The Commonwealth of Pennsylvania is a leader among states in cybersecurity and takes many steps to prevent and defend against cyberattacks, reduce vulnerability, minimize damage, reduce recovery time, and promote education and awareness. This includes employing multiple layers of security, advanced monitoring, vulnerability testing, data protection, antivirus, spam blocking, mobile device encryption, and other means to protect state systems and data. The Commonwealth also promotes a cultural of cyber awareness throughout its workforce by providing training, assessments, benchmarking, and exercises. One method that the Commonwealth uses to reduce the success rate of future phishing attacks is utilizing PhishMe software, which distributes simulated phishing scenarios to help state employees better identify and know when to report phishing attacks. When a user successfully reports a fake phishing email sent from PhishMe, they are notified. The Office of Administration also provides cybersecurity information for people, businesses, Commonwealth agencies and employees, and local governments on its website (PA Office of Administration, 2018). Pennsylvania also participates in IT strategic planning and has a cyber incident annex as part of its emergency operations plan. The level of success of an attack and the subsequent damage it can create will vary greatly, but these initiatives help reduce the Commonwealth's vulnerability to cyberterrorism.

4.3.19.5. Environmental Impacts

Generally, cyberterrorism has no direct effect on the environment; however, the environment may be affected if a hazardous materials release occurred because of critical infrastructure failure as a result of cyberterrorism. Similarly, an act of cyberterrorism on a nuclear power plant could have devastating environmental consequences if the plant suffered an intentional catastrophic failure.

4.3.19.6. State Vulnerability Assessment and Loss Estimation

All state-owned and leased facilities are vulnerable to cyberterrorism. While the physical structures of these buildings are generally not at risk, information systems and data stored within them are vulnerable. State computer networks contain sensitive information that is integral to the security of the Commonwealth and could be the target of a cyber attack. The state is also entrusted with many forms of personal and financial information, including tax filings, birth and death records, Social Security numbers, medical information, and more. Additionally, many critical facilities that are essential to state operations are reliant upon computer networks to monitor and control critical functions. For example, an attack on a nuclear power plant or the power grid could have detrimental impacts on state services and functions. Additionally, a large-scale computer breach would likely lead to significant economic costs in lost productivity to the impacted state agencies and potentially related businesses and industries. However, lost revenues and productivity would depend on the type and magnitude of the cyberterrorism event.

4.3.19.7. Jurisdictional Vulnerability Assessment

All communities in the Commonwealth are vulnerable on some level, directly or indirectly, to a cyberterrorism attack. However, in general, Philadelphia, Harrisburg, Dauphin County, Pittsburgh, Allegheny County, and individual county seats may have higher vulnerabilities due to higher concentrations of local, state, and federal facilities. Larger cities like Philadelphia and Pittsburgh are also more vulnerable to terrorist attacks because of the higher concentrations of people, businesses, and critical infrastructure.

4.3.20. Dam Failure

The Dam Failure profile can be found in *Appendix H*.

4.3.21. Environmental Hazard – Coal Mining

4.3.21.1. Location and Extent

Mining, including surface, underground, and open-pit operations, has been an important economic activity in Pennsylvania since before the 1860s and was instrumental in the Commonwealth's development. Coal mining is the most prominent of Pennsylvania's mining activities and continues to be a major industry. Pennsylvania produces two types of coal: bituminous and anthracite. Bituminous coal is typically used for electricity generation and metal production. Anthracite coal, which is rarer than bituminous coal and can reach a high heating point that burns blue flame, is typically used for heating and metal production (PA DEP, 2018).

While resources other than coal are also mined in Pennsylvania - including metal ores, clay and shale, and limestone - most of these deposits are of limited extent. Coal, in contrast, has been mined under large areas of the state. Counties underlain by coal deposits are at highest risk of environmental hazards resulting from coal mining activities. This area includes the majority of southwest Pennsylvania, situated over the Commonwealth's main bituminous field, as well as the jurisdictions in northeast Pennsylvania located over the anthracite fields, particularly in Lackawanna, Luzerne, and Schuylkill Counties (Figure 4.3.21-1).

Figure 4.3.21-2 shows the location of active and abandoned coal mining operations in Pennsylvania. Note that the active and abandoned coal mines are primarily located on the coal fields shown in Figure 4.3.21-1, however there are mines located outside the field areas. Table 4.3.21-1 lists the number of active and abandoned coal mines in each county. Statewide, 48 counties contain at least one active or abandoned coal mine. However, the highest concentration of mines is in western Pennsylvania which is underlain by coal seams. Two western Pennsylvania counties, Jefferson County and Somerset County, contain the highest number of coal mines in the state with 1,393 and 1,694 mines respectively.

Figure 4.3.21-1 Distribution of Pennsylvania Coals (PA DMCR, 2018).

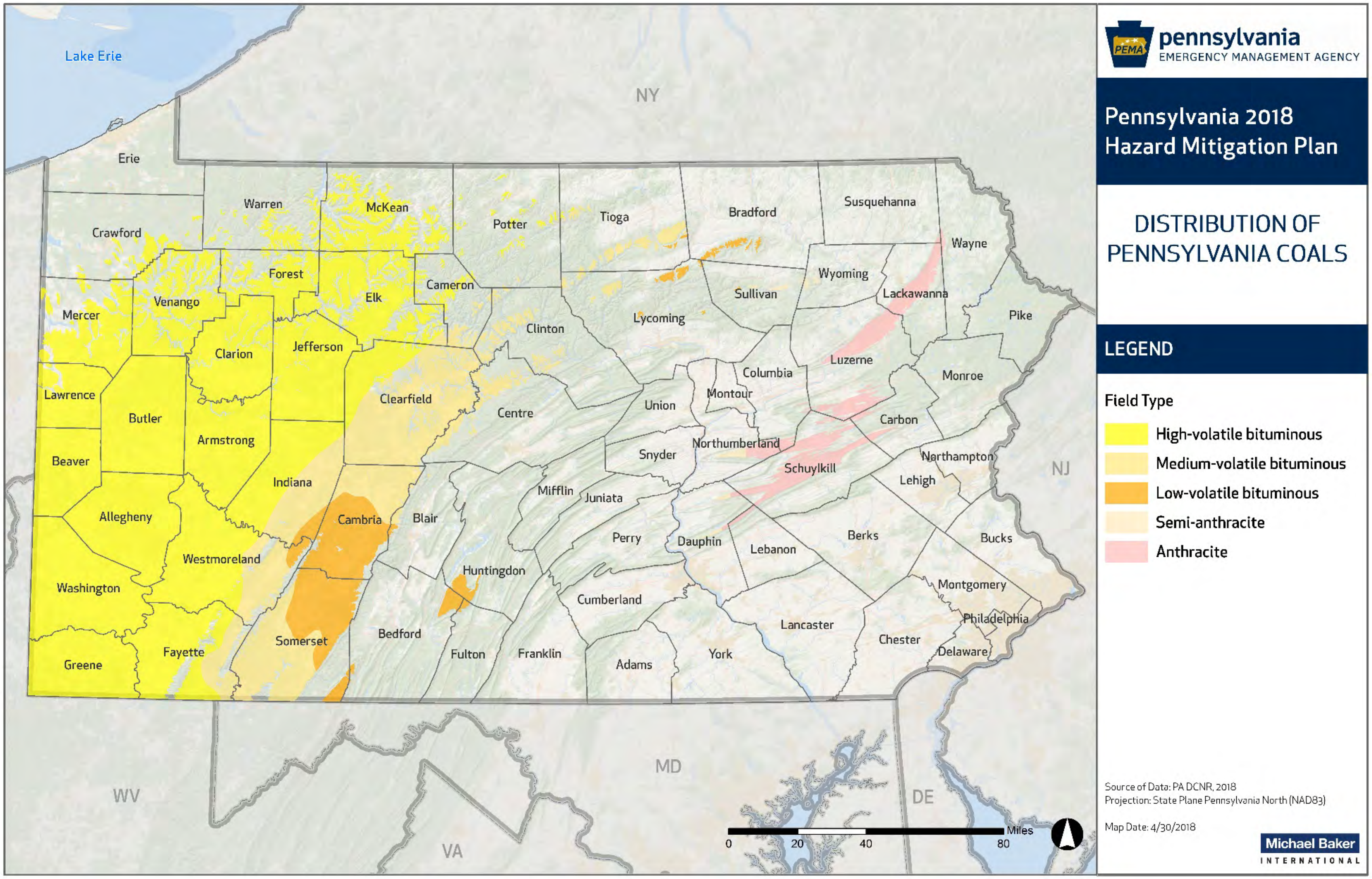


Figure 4.3.21-2 Coal Mining Operations in Pennsylvania (PA DEP, 2018).

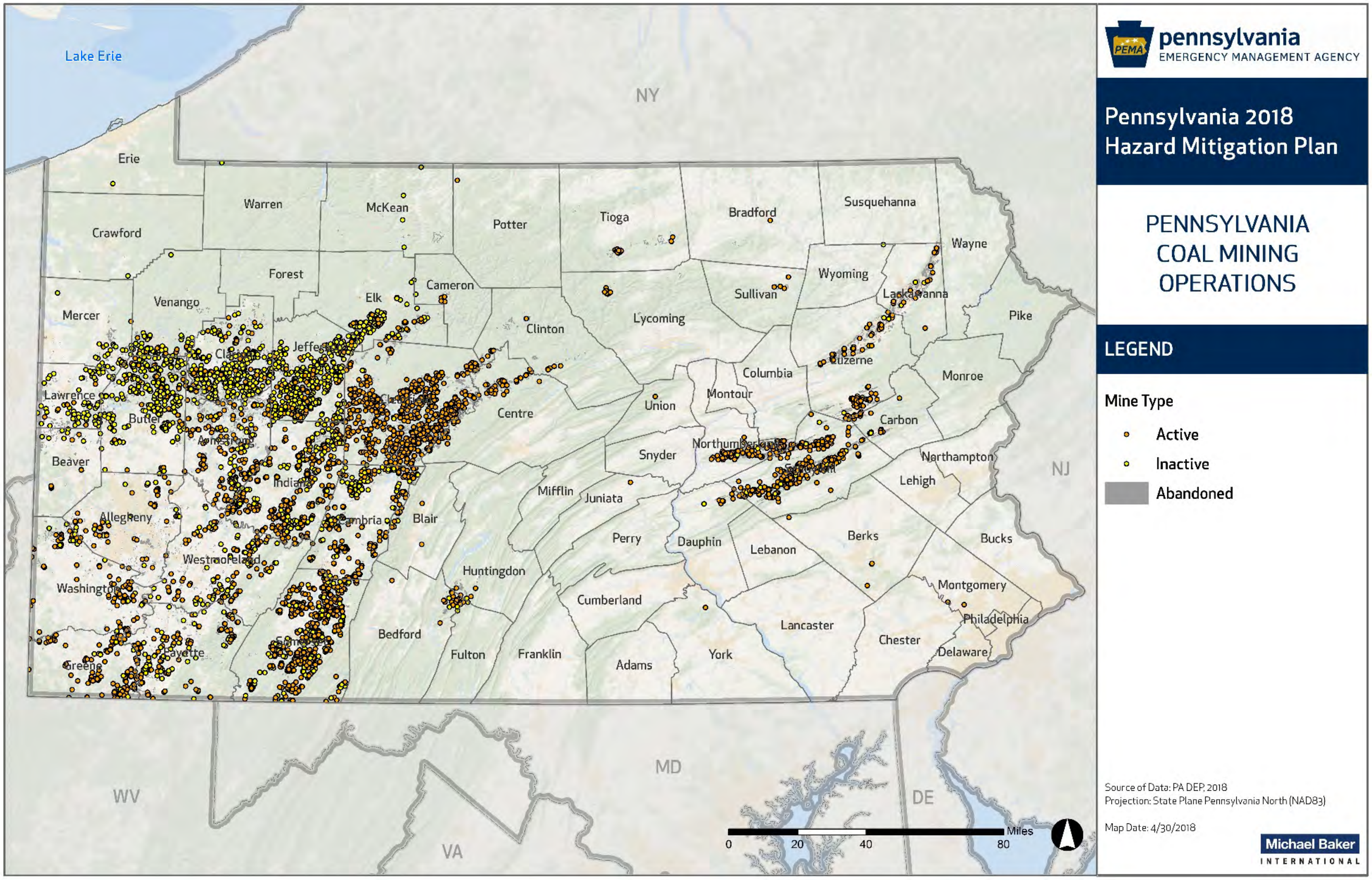


Table 4.3.21-1 Number of Active and Abandoned Coal Mines in Pennsylvania Counties (PASDA, 2018)			
COUNTY	NUMBER OF MINES	COUNTY	NUMBER OF MINES
Adams	0	Lackawanna	40
Allegheny	179	Lancaster	0
Armstrong	640	Lawrence	242
Beaver	59	Lebanon	0
Bedford	46	Lehigh	0
Berks	9	Luzerne	250
Blair	36	Lycoming	12
Bradford	1	McKean	7
Bucks	0	Mercer	76
Butler	771	Mifflin	0
Cambria	802	Monroe	0
Cameron	16	Montgomery	5
Carbon	28	Montour	0
Centre	107	Northampton	0
Chester	0	Northumberland	157
Clarion	1,117	Perry	0
Clearfield	1,303	Philadelphia	0
Clinton	30	Pike	0
Columbia	44	Potter	1
Crawford	2	Schuylkill	655
Cumberland	0	Snyder	0
Dauphin	19	Somerset	1,694
Delaware	0	Sullivan	14
Elk	320	Susquehanna	1
Erie	2	Tioga	18
Fayette	480	Union	1
Forest	0	Venango	216
Franklin	0	Warren	2
Fulton	7	Washington	259
Greene	310	Wayne	0
Huntingdon	18	Westmoreland	463
Indiana	1,266	Wyoming	1
Jefferson	1,393	York	1
Juniata	2	**TOTAL**	**13,122**

Pennsylvania was one of the first states to initiate, promulgate, and enforce environmental regulations related to mining, including mine reclamation. However, there remains a legacy of abandoned mines, waste piles, and degraded groundwater and surface water in the Commonwealth. The EPA estimates that over 3,000 miles of streams in Pennsylvania have been contaminated by acid mine drainage which occurs when metal sulfides in rock oxidize and generate acidity in nearby waterways.

Table 4.3.21-2 shows coal slurry ponds in the Commonwealth including impoundment name, Mine Safety and Health Administration (MSHA) ID number and the county in which the pond is located. A slurry pond is an impoundment used to store waste created during coal preparation also known as washing. The waste contained in the impoundment consists of silt, dust, water, coal fines and washing/treatment chemicals. Coal slurry impoundments are considered dams and classified accordingly by the PA DEP.

The greatest hazard associated with coal slurry ponds is impoundment failure due to seepage, embankment weakness and undermining and resulting in flooding. Breakthroughs associated with deep mining have also led to flooding of underground mine operations. The slurry holding capacity of impoundments in the Commonwealth ranges from tens of millions to billions of gallons. According to Coal Impoundment Location & Information System, there are 41 coal slurry impoundments in Pennsylvania with Washington County having the most at 17 impoundments. This system has not been updated since 2012.

Table 4.3.21-2 Summary of Coal Slurry Impoundments in the Commonwealth. (Coal Impoundment LIS, 2012).

IMPOUNDMENT NAME	MSHA ID NO.	COUNTY
Harmar Refuse Bank Slurry Pond Tailings	1211-PA02-00375-01	Allegheny
Harmar Storage Pond #4 Slurry Impoundement	1211-PA02-00375-04	Allegheny
Slurry-Bald Knob Prep Plant	1211-PA02-00194-03	Allegheny
Treatment Pond 14-North Impoundment	1211-PA02-00049-05	Allegheny
Treatment Pond Cleaning Plant	1211-PA02-00047-03	Armstrong
Cambria Slurry Pond #4	1211-PA02-00254-03	Cambria
Isabella Fresh Water Pond	1211-PA02-00001-03	Fayette
Isabella Slurry Pond	1211-PA02-00001-06	Fayette
LaBelle Slurry Pond #3 Tailings	1211-PA02-00003-04	Fayette
SLURRY POND	1211-PA02-00363-02	Fayette
Slurry Pond #2 La Belle Site	1211-PA02-00003-03	Fayette
Bailey Mine Complex Fresh Water Impoundment	1211-PA02-00107-01	Greene
Bailey Mine Slurry Impoundment Dam	1211-PA02-00107-02	Greene
Bailey Sedimentation Pond No 1	1211-PA02-00107-04	Greene
Bailey Sedimentation Pond No 2	1211-PA02-00107-05	Greene
Cumberland Mine No 1 Refuse-Slurry Pond	1211-PA02-00057-02	Greene
Emerald-Sedimentation Pond 11	1211-PA02-00012-04	Greene
Emerald-Slurry Pond #1	1211-PA02-00012-02	Greene
Robena #4 Slurry	1211-PA02-00063-04	Greene

Table 4.3.21-2 Summary of Coal Slurry Impoundments in the Commonwealth. (Coal Impoundment LIS, 2012).

IMPOUNDMENT NAME	MSHA ID NO.	COUNTY
Robena #6 Refuse	1211-PA02-00063-11	Greene
Robena Sedimentation Pond	1211-PA02-00063-01	Greene
Robena-Colvin Shaft Sedimentation Pond	1211-PA02-00063-12	Greene
Weisner Hollow Sediment Pond	1211-PA02-00190-03	Jefferson
Weisner Hollow Slurry Impoundment	1211-PA02-00190-02	Jefferson
Champion Impoundment	1211-PA02-00193-05	Washington
Champion Slurry	1211-PA02-00193-04	Washington
Champion Slurry Duck Pond	1211-PA02-00193-03	Washington
Eighty Four Pond 5 Abandoned Slurry Tailings	1211-PA02-00055-03	Washington
Eighty Four Pond 7 Debris Control	1211-PA02-00055-06	Washington
Eighty Four Steel Pond at the Prep Plant	1211-PA02-00055-04	Washington
Maple Creek Mine Water Treatment Pond	1211-PA02-00058-02	Washington
Maple Creek Silt Pond A	1211-PA02-00058-07	Washington
Maple Creek Slurry Pond #2	1211-PA02-00058-05	Washington
Maple Creek Slurry Pond#1-Old	1211-PA02-00058-01	Washington
Maple Creek Slurry Pond#3	1211-PA02-00058-06	Washington
Marianna Sediment Pond Marianna Mine #58	1211-PA02-00018-05	Washington
Marianna Slurry Home No. 5	1211-PA02-00018-02	Washington
Mathies Mine Main Slurry Pond Refuse Area Pond #2	1211-PA02-00059-02	Washington
Mathies Refuse Area Sediment Pond #2 Slurry	1211-PA02-00059-05	Washington
Mine No. 84-Slurry Pond #6 Tailings	1211-PA02-00055-05	Washington
Silt Pond B Sediment Basin	1211-PA02-00058-08	Washington

4.3.21.2. Range of Magnitude

Major impacts from mining include surface-elevation changes and subsidence, modification of vegetation, the chemical degradation and flow redistribution of surface water and groundwater, the creation of mine voids and entry openings, adverse aesthetic impacts, and changes in land use.

In addition, active and abandoned mines can also result in injury and loss of human life. This can occur in active mines where workers are injured or killed by mine collapse, entrapment, poisonous gases, inundation, explosions, fires, equipment malfunction, and improper ventilation. Injuries and death, such as All-Terrain Vehicle (ATV) accidents, falling, and drowning, can also occur in abandoned mines.

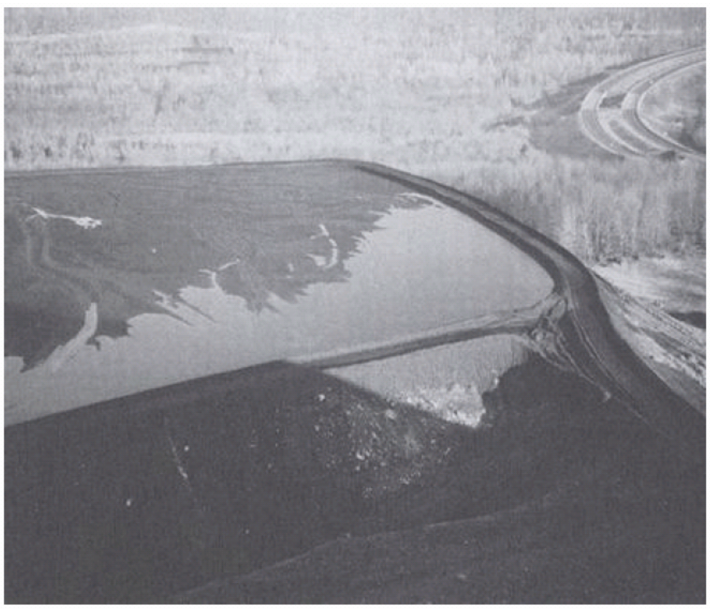
Recently, Pennsylvania, has seen an increase in quarry trespassing due to social media posts on sites like Instagram and YouTube (The Morning Call, 2015). Local officials warn that quarries contain sharp and unpredictable edges, discarded machinery under water, strong currents, and extreme changes in water temperature just below in the surface. In addition to injuries and arrests, deaths from falls and drowning have also resulted from quarry trespassing. The U.S.

Department of Labor reported that 20 people drowned in a quarry in Pennsylvania between the years 1999 to 2013. Between 2014 to 2016, the PA DEP reported four people died while trespassing at a quarry (PA DEP, 2018). In April 2018, police in Berks County reported that a woman died from falling more than 300 feet off a quarry ledge.

The mineral-waste disposal from coal mining also is a hazard. Past disposal practices have dotted Pennsylvania's landscape with unsightly refuse piles. Many of the refuse piles contain combustible materials that cause long-term air-quality problems if ignited. Burning refuse piles have also been linked to major underground coal fires, such as those at Centralia and Shamokin in the Anthracite region of Pennsylvania.

Slurry ponds and tailings dams are also potentially dangerous (Figure 4.3.21-3). Mineral byproducts from coal mining are pumped to slurry or tailings dams for removal by sedimentation. If the dams or structures supporting the slurry ponds fail, they pose hazards similar to dam failure (see Appendix I – Dam Failure Profile).

Figure 4.3.21-3 Typical slurry or tailing (coal-fines) impoundment in Pennsylvania's Anthracite region.



Reject wastes from coal mining that contain sulfide minerals can also degrade groundwater and surface water. Coal refuse piles have historically been prolific sources of acid mine drainage which has impaired many streams in Pennsylvania.

Pennsylvania has a long history of mining and there have been numerous mining accidents. The worst-case scenario event in Pennsylvania mining history occurred in 1962 in Centralia, Pennsylvania when an underground fire began in the coal mines underneath the town and continues to burn today. The federal government offered buyouts of homes of residents so they could relocate from the Centralia, resulting in a cost of over $40 million. In 1992, Pennsylvania claimed eminent domain on all properties in the town and condemned all the buildings. In 1981 the town had over 1,000 residents, but as of 2016, only five people still reside in the borough (U.S. Census, 2016).

In Somerset County, the Quecreek Mine accident nearly became Pennsylvania's worst case scenario when 7 million tons of water flooded into the mine. The accident was the result of a breach in the wall between Quecreek Mine and an abandoned, flooded adjacent mine. Nine miners were trapped for 77 hours; however the accident ended with the safe rescue of all the trapped workers (Pittsburgh Post-Gazette, 2002).

One of the worst mining accidents in the United States since 1950 occurred in nearby West Virginia. On April 5, 2010 twenty-nine miners were killed at the Upper Big Branch Mine by an explosion.

4.3.21.3. Past Occurrence

Although state and federal (U.S. Department of Labor, EPA, and the Office of Surface Mining and Reclamation) laws require occupational health, safety, and environmental protection in all mining activities, mining accidents still occur. The U.S. Department of Labor Mine Safety and Health Administration (MSHA) tracks mining accidents and injuries. Since 2011, there have been seven deaths in Pennsylvania resulting from surface and underground coal mining activities (MSHA, 2018). Although there have been many mining accidents in Pennsylvania's early mining history of the 1800's, there is no comprehensive database that tracks the data. Beyond operator accidents, there can be incidents that are a result of falls, drowning, electrocution, and ATV crashes.

The DEP Bureau of Mine Safety is required by law to investigate all fatal and serious accidents that occur at underground Commonwealth mines. According to the Bureau, there have been four major mine emergencies in Pennsylvania coal mines. They define a mine emergency as a serious situation or occurrence that happens unexpectedly and demands immediate action or a condition of urgent need for action or assistance such as a state of emergency. Two of these were mine fires and two were inundations (PA DEP, 2010).

4.3.21.4. Future Occurrence

It is difficult to forecast the severity and frequency of coal mining accidents and environmental damage in Pennsylvania. Although throughout time, the government has strengthened mining and reclamation operation and environmental regulations, permitting, and inspection criteria, this has not prevented mining accidents and environmental damage from occurring.

Surface subsidence resulting from underground mining continues to be a major concern of those impacted by the mining industry (see Section 4.3.13). Despite the use of deep mine roof-support methods, some subsidence will eventually occur.

It is likely that Pennsylvania will continue to modify its laws to reflect additional environmental awareness. Stricter controls on reclamation, perhaps specifically addressing the disposal of mining residuals, are likely. State and federal laws and programs have historically placed an emphasis on environmental preservation and reclamation. As in the past, it seems likely that Pennsylvania will be at the forefront of these programs and future occurrence will decrease.

However, until then a 100 percent annual probability is anticipated for coal mining hazards as incidents occur annually in the Commonwealth.

4.3.21.5. Environmental Impacts

The environmental impacts of coal mining are many. Mining activities and acid mine drainage can contaminate surface and groundwater, create acid mine drainage, cause changes in water temperature and damage to streams, lakes, ponds, estuaries, and wetland ecosystems. Mine explosions or burning refuse piles can cause air quality problems. Although mine reclamation is required for much surface mining activity, there is still a loss of quality in landscape, damage to vegetation, and degradation of habitat.

Additionally, jurisdictions where longwall mining has taken place face added risks to domestic water wells. Longwall mines involve the extraction of entire coal seams leaving caverns of up to five feet tall that are left to planned subsidence. However, this earth movement can disrupt aquifers and reduce or eliminate water sources.

4.3.21.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to environmental hazards related to coal mining activities, all structures located within 1.5 miles the active or abandoned coal mile shown in Table 4.3.21-3. The area impacted by a coal mine incident will depend on the coal mine and atmospheric conditions. For this assessment, however, 1.5 miles was selected as a representative distance within which death, injury, or significant property damage could occur. In addition, the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 1,026, or 23 percent, are located within 1.5 miles of an active or abandoned coal mine. These facilities have a combined replacement value of more than $547 million, or approximately 14 percent of the known value of geolocated state facilities.

Table 4.3.21-3 Vulnerability of state facilities to environmental hazards related to coal mining.

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	3	33%
Department of Agriculture	1	6%
Department of Banking and Securities	0	0%
Department of Community and Economic	2	50%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	209	30%
Department of Education	0	0%
Department of Environmental Protections	7	54%
Department of General Services	2	2%
Department of Health	10	21%

Table 4.3.21-3 Vulnerability of state facilities to environmental hazards related to coal mining.		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Department of Labor and Industry	17	25%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	14	14%
Department of Revenue	1	10%
Department of Transportation	441	26%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	3	2%
Governor's Office	0	0%
Historical and Museum Commission	3	10%
Insurance Department	0	0%
Liquor Control Board	123	23%
Public School Employees' Retirement System	2	33%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	1	25%
State Police	8	22%
State System of Higher Education	177	21%
Thaddeus Stevens College of Technology	0	0%
Treasury	1	50%
Total	**1,026**	**23%**

Of the 14,011 geolocated critical facilities, 3,334, or 24 percent are located in high environmental hazards related to coal mining activities (Table 4.3.21-4). These facilities have a combined replacement value of approximately $45.3 million, or 23 percent of the known replacement value of geolocated critical facilities.

Table 4.3.21-4 Vulnerability of critical facilities to environmental hazards related to coal mining.		
TYPE	# OF VULNERABLE STRUCTURES	% OF TOTAL STRUCTURES BY TYPE
Agricultural	58	21%
Banking	0	0%
Commercial	0	0%
Communication	147	24%
Dam	651	19%
Education (colleges and universities)	25	16%

Table 4.3.21-4 Vulnerability of critical facilities to environmental hazards related to coal mining.		
TYPE	# OF VULNERABLE STRUCTURES	% OF TOTAL STRUCTURES BY TYPE
Education (public schools)	614	19%
Emergency Operation Center	14	20%
Energy	13	24%
Fire Station	845	31%
Government	1	4%
Hospital	81	24%
National Monument or Icon	1	17%
Nuclear	1	20%
Police Station	346	28%
Transportation	11	15%
Water	536	30%
Total	**3,344**	**24%**

4.3.21.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to environmental hazards related to coal mining activities, all census blocks with centers located within 1.5 miles of an active or abandoned coal mine were identified. The population, building counts, and building value of all vulnerable census blocks were then aggregated to the county scale (Table 4.3.21-5). The counties with the highest percentage of exposed building value are Clarion, Clearfield, and Schuylkill counties. For each of these counties, more than three quarters of the total building value is vulnerable to environmental hazards related to coal mining activities. The counties with the most people exposed to this hazard, in contrast, are Allegheny, Westmoreland, and Luzerne counties.

Table 4.3.21-5 Vulnerability of people and buildings to environmental hazards related to coal mining.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Adams	0	0	$0	0%
Allegheny	556,789	238,286	$69,263,952	43%
Armstrong	45,198	20,878	$4,158,524	63%
Beaver	56,496	24,595	$6,744,254	35%
Bedford	3,036	1,528	$268,803	6%
Berks	8,538	3,381	$975,157	8%
Blair	3,171	1,318	$244,382	2%
Bradford	1,377	700	$132,165	2%
Bucks	0	0	$0	0%
Butler	76,203	31,575	$7,612,191	36%

Table 4.3.21-5 Vulnerability of people and buildings to environmental hazards related to coal mining.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Cambria	105,706	47,325	$11,670,424	73%
Cameron	72	169	$27,544	3%
Carbon	15,891	7,862	$1,616,918	22%
Centre	9,758	5,047	$1,332,335	8%
Chester	2,759	936	$408,442	1%
Clarion	38,197	18,068	$3,908,393	94%
Clearfield	72,895	33,645	$6,531,569	85%
Clinton	962	903	$148,646	4%
Columbia	1,194	632	$132,140	2%
Crawford	468	159	$24,290	0%
Cumberland	0	0	$0	0%
Dauphin	6,537	3,012	$603,679	2%
Delaware	0	0	$0	0%
Elk	14,513	7,691	$1,604,177	39%
Erie	0	0	$0	0%
Fayette	99,651	43,585	$8,492,111	68%
Forest	76	129	$14,431	1%
Franklin	0	0	$0	0%
Fulton	68	34	$4,871	0%
Greene	25,676	10,471	$2,306,782	68%
Huntingdon	2,361	1,298	$177,769	4%
Indiana	50,027	22,629	$4,372,120	53%
Jefferson	34,247	15,841	$3,233,556	71%
Juniata	830	318	$47,418	2%
Lackawanna	156,542	61,673	$18,354,133	72%
Lancaster	0	0	$0	0%
Lawrence	56,923	25,728	$5,538,027	60%
Lebanon	0	0	$0	0%
Lehigh	0	0	$0	0%
Luzerne	222,759	96,421	$25,131,191	71%
Lycoming	209	131	$19,174	0%
McKean	828	727	$108,839	2%
Mercer	21,616	8,426	$2,219,312	17%
Mifflin	0	0	$0	0%
Monroe	0	0	$0	0%
Montgomery	25,110	9,381	$3,960,909	3%

Table 4.3.21-5 Vulnerability of people and buildings to environmental hazards related to coal mining.				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $**	**PERCENT OF TOTAL COUNTY BUILDING VALUE**
Montour	0	0	$0	0%
Northampton	0	0	$0	0%
Northumberland	36,066	17,460	$3,404,450	36%
Perry	0	0	$0	0%
Philadelphia	0	0	$0	0%
Pike	0	0	$0	0%
Potter	82	58	$7,500	0%
Schuylkill	112,613	51,803	$11,855,146	76%
Somerset	61,404	27,508	$5,634,759	72%
Sullivan	687	551	$82,175	8%
Susquehanna	2,276	981	$212,822	5%
Tioga	2,856	1,777	$300,532	7%
Union	149	91	$11,664	0%
Venango	8,384	4,467	$832,693	15%
Warren	170	122	$16,385	0%
Washington	112,497	51,029	$13,084,911	55%
Wayne	764	373	$61,232	1%
Westmoreland	247,248	109,905	$28,087,686	68%
Wyoming	0	0	$0	0%
York	1,624	735	$190,539	0%
Total	**2,303,503**	**1,011,362**	**$255,171,122**	**17%**

4.3.22. Environmental Hazard – Conventional Oil and Gas Wells

4.3.22.1. Location and Extent

There are approximately 130,000 conventional oil and gas wells drilled in Pennsylvania (PASDA, 2018). Conventional wells are defined as traditional vertical wells. There are active and abandoned oil and gas wells exist in 55 of Pennsylvania's 67 counties with the majority of activity occurring western portion of the Commonwealth as shown in Figure 4.3.22-1. Pennsylvania also has unconventional oil and gas wells, which are typically horizontally drilled wells commonly associated with the Marcellus Shale, a natural gas formed from fracking. See Section 4.3.23 for more detail.

Data on conventional oil and gas wells obtained from Pennsylvania Spatial Data Access (PASDA), provided in Table 4.3.22-1 below, shows that over 40 percent of existing oil and gas wells are located in only four counties—McKean, Warren, Indiana, and Venango. These four counties have more than 9,000 wells each within their political boundaries totaling over 55,000 oil and gas wells combined.

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 hazard. Private drinking water is largely unregulated and therefore the existing data is largely incomplete and/or inaccurate. Some information is submitted to the Pennsylvania Topographic and Geologic Survey by water well drillers via the PaGWIS system, but this data is voluntarily reported.

Figure 4.3.22-1 Conventional Oil and Gas Well Locations in Pennsylvania (PA DEP, 2018).

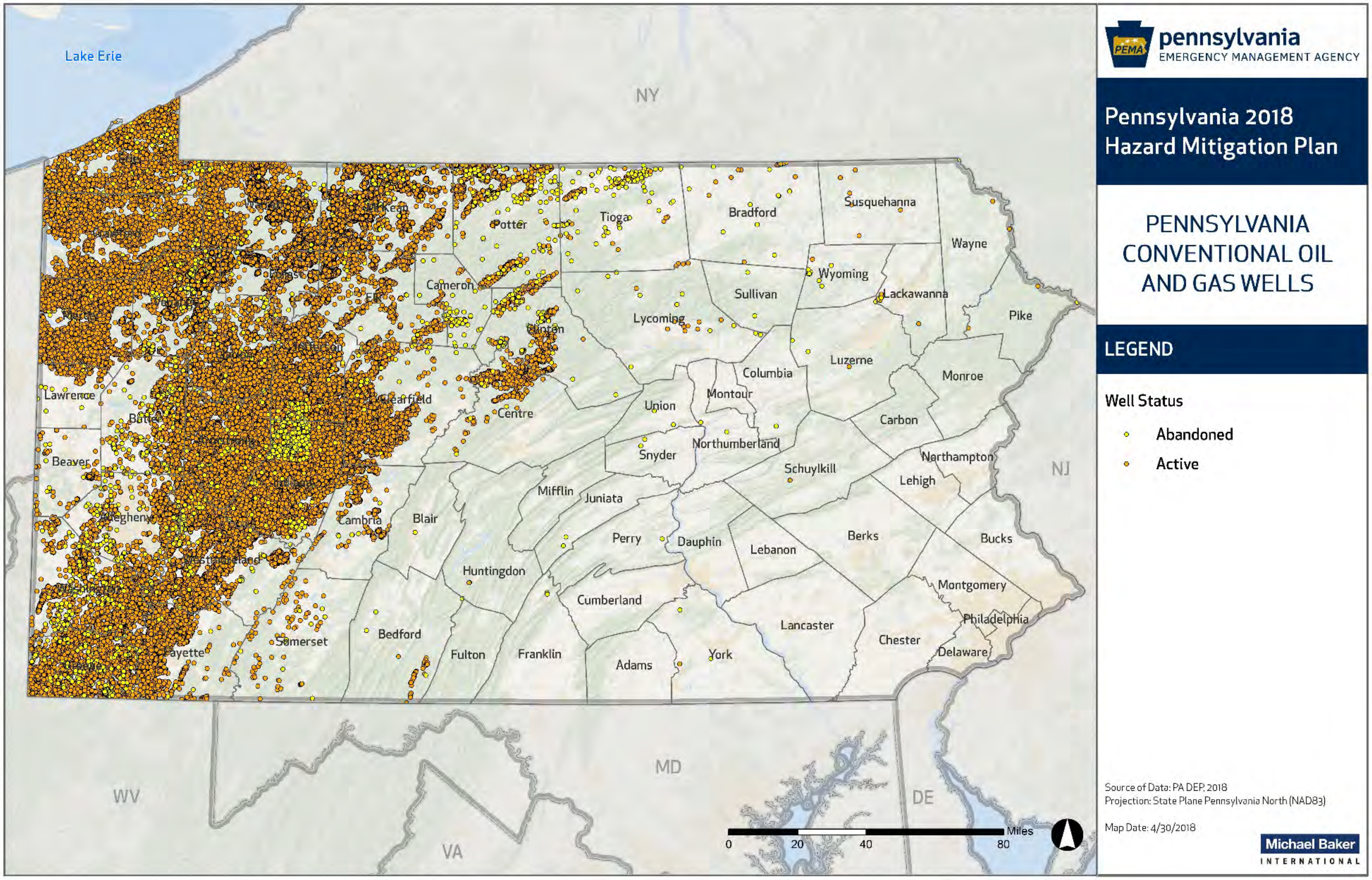


Table 4.3.22-1 Number of conventional oil and gas wells by county throughout Pennsylvania (PASDA, 2018)							
COUNTY	ABANDONED OIL AND GAS WELLS	ACTIVE OIL AND GAS WELLS	DEP ABANDONED LIST	PLUGGED OIL AND GAS WELLS	PLUGGED OG WELL	INACTIVE OIL AND GAS WELLS	TOTAL OIL AND GAS WELLS
Adams	0	0	0	0	0	0	0
Allegheny	91	1,145	55	127	485	3	1,906
Armstrong	95	8,540	51	34	744	25	9,489
Beaver	26	152	3	28	66	0	275
Bedford	4	36	0	0	43	0	83
Berks	0	0	0	0	0	0	0
Blair	1	0	0	0	9	0	10
Bradford	9	16	3	1	46	5	80
Bucks	0	0	0	0	1	0	1
Butler	155	1,316	119	62	461	3	2,116
Cambria	6	619	2	0	125	14	766
Cameron	64	54	0	10	64	2	194
Carbon	0	0	0	0	2	0	2
Centre	8	739	0	0	139	10	896
Chester	0	0	0	0	0	0	0
Clarion	32	3,601	56	16	642	19	4,366
Clearfield	32	4,150	1	2	513	16	4,714
Clinton	95	508	36	47	222	3	911
Columbia	1	0	0	0	0	0	1
Crawford	26	3,086	32	72	795	8	4,019
Cumberland	0	0	0	0	0	0	0
Dauphin	0	0	0	0	0	0	0
Delaware	0	0	0	0	0	0	0
Elk	14	2,676	22	126	1,295	7	4,140
Erie	187	2,815	102	33	737	5	3,879
Fayette	18	3,081	4	14	324	7	3,448
Forest	79	4,620	84	94	689	96	5,662

Table 4.3.22-1 Number of conventional oil and gas wells by county throughout Pennsylvania (PASDA, 2018)

COUNTY	ABANDONED OIL AND GAS WELLS	ACTIVE OIL AND GAS WELLS	DEP ABANDONED LIST	PLUGGED OIL AND GAS WELLS	PLUGGED OG WELL	INACTIVE OIL AND GAS WELLS	TOTAL OIL AND GAS WELLS
Franklin	1	1	0	0	0	0	2
Fulton	0	0	0	0	5	0	5
Greene	299	2,205	47	15	1,765	20	4,351
Huntingdon	0	2	0	0	2	0	4
Indiana	351	11,372	18	13	878	33	12,665
Jefferson	159	5,197	25	37	791	31	6,240
Juniata	2	0	0	0	2	0	4
Lackawanna	3	3	0	0	7	0	13
Lancaster	0	0	0	0	0	0	0
Lawrence	4	174	8	2	49	1	238
Lebanon	0	0	0	0	0	0	0
Lehigh	0	0	0	0	0	0	0
Luzerne	3	1	0	0	7	0	11
Lycoming	8	13	4	0	32	3	60
McKean	254	10,016	289	1,012	6,758	56	18,385
Mercer	5	3,227	22	3	314	1	3,572
Mifflin	0	0	0	0	2	0	2
Monroe	0	0	0	0	1	0	1
Montgomery	0	0	0	0	1	0	1
Montour	0	0	0	0	0	0	0
Northampton	0	0	0	0	0	0	0
Northumberland	2	0	0	0	2	0	4
Perry	1	0	0	0	0	0	1
Philadelphia	0	0	0	0	0	0	0
Pike	1	2	0	0	1	0	4
Potter	195	1,184	44	61	508	17	2,009
Schuylkill	0	2	0	0	0	0	2

Table 4.3.22-1 Number of conventional oil and gas wells by county throughout Pennsylvania (PASDA, 2018)							
COUNTY	ABANDONED OIL AND GAS WELLS	ACTIVE OIL AND GAS WELLS	DEP ABANDONED LIST	PLUGGED OIL AND GAS WELLS	PLUGGED OG WELL	INACTIVE OIL AND GAS WELLS	TOTAL OIL AND GAS WELLS
Snyder	2	0	0	0	1	0	3
Somerset	10	76	0	0	125	6	217
Sullivan	2	0	0	0	3	0	5
Susquehanna	0	6	0	0	7	0	13
Tioga	98	106	17	66	92	4	383
Union	2	0	0	0	0	0	2
Venango	295	6,123	926	946	2,178	45	10,513
Warren	98	11,541	309	328	1,732	1	14,009
Washington	135	1,949	71	90	1,193	10	3,448
Wayne	1	2	0	0	7	0	10
Westmoreland	89	5,823	18	49	708	41	6,728
Wyoming	7	2	0	0	7	0	16
York	2	1	0	0	1	0	4
Total	**2,972**	**96,182**	**2,368**	**3,288**	**24,581**	**492**	**129,883**

4.3.22.2. Range of Magnitude

As is the case with all-natural resource extraction, a variety of potential hazards exist with oil and gas extraction. Abandoned oil and gas wells that are not properly plugged can contaminate groundwater and consequently domestic 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. Additional information on incidents involving oil and gas transmission and distribution by pipeline is available in Section 4.3.33 Utility Interruption.

Methane can leak into domestic drinking wells and pose fire and explosion hazards. In addition, natural gas well fires can 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. When methane gas from unplugged gas wells seeps into underground coal mines, miners are at risk of asphyxiation and are subject to impacts of explosion.

Figure 4.3.22-2 Photos of natural gas well fires. *Left*: Hopewell Township, Washington County, Pennsylvania. (Pittsburgh Post Gazette, June 17, 2010). *Right:* Dunkard Township, Greene County, Pennsylvania (WPXI, February 12, 2014)

4.3.22.3. Past Occurrence

Pennsylvania has a long history of oil and gas well drilling. Though relatively infrequent, many accidents and incidents have occurred related to the extraction of these natural resources. For example, in January 1988, an oil spill occurred when a four-million-gallon oil storage tank split in Floreffe, Pennsylvania. This occurred Allegheny County, approximately 20 miles from Pittsburgh. The tank, owned by Ashland Oil Company, leaked oil into an adjacent parking lot. Eventually, the contents flowed into the Monongahela River, which led to the Ohio River. The Environment Protection Agency (EPA) reported the spill affected approximately contaminated drinking water for three million people in three states and their river ecosystems, killed wildlife, and damaged property and businesses (EPA, 2017). However, no comprehensive list of oil and gas related incidents exist for the Commonwealth, but conventional oil and gas well incidents are more common northwestern Pennsylvania counties. The hazards associated with each incident vary widely and encompass damages including serious injury, explosion, fire and water contamination.

4.3.22.4. Future Occurrence

It is difficult to predict when and where environmental hazards will arise as they are often related to equipment failure and human error. Adequate monitoring through the Department of Environment Protection (DEP) will reduce the likelihood of potential impacts to the community and the environment. Risk associated with conventional oil and gas drilling is expected to remain moderate, with some of the highest risk emerging from very old conventional wells that are not properly mapped or whose caps and protective features have begun to deteriorate.

4.3.22.5. Environmental Impacts

Though injury and death have resulted from oil and gas well drilling and extraction, the majority of impacts from this human-made hazard are environmental in nature. Wells that are improperly drilled or plugged can contaminate groundwater resulting in water well contamination or eventually surface water contamination. Drilling additives stored on site can leak and contaminated soil, surface water and groundwater. Oil leaks at the well site from oil pipelines contaminate soil and surface water damage aquatic life and ecosystems.

4.3.22.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to conventional oil and gas wells, high risk areas were defined as areas within 1000 yards of active, inactive, or unplugged wells. The area impacted by a conventional oil and gas well incident will depend on the well, spillage, and atmospheric conditions. For this assessment, however, 1000 yards was selected as a representative distance within which death, injury, or significant property damage could occur. In addition, the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 766, or 17 percent, are located within 1000 yards of a conventional well (Table 4.3.22-2). These facilities have a combined replacement value of more than $358 million, or approximately nine percent of the known value of geolocated state facilities.

Table 4.3.22-2 Vulnerability of state facilities to conventional oil and gas wells

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	1	11%
Department of Banking and Securities	0	0%
State Civil Service Commission	0	0%

Table 4.3.22-2 Vulnerability of state facilities to conventional oil and gas wells		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Department of Community and Economic Development	1	25%
Department of Agriculture	2	13%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	132	19%
Department of Education	0	0%
Department of Environmental Protections	2	15%
Department of General Services	0	0%
Department of Health	13	27%
Department of Labor and Industry	7	10%
Department of Military and Veterans Affairs		0%
Department of Public Welfare	16	16%
Department of Revenue	1	10%
Department of Transportation	314	19%
Drug and Alcohol Programs	0	0%
Executive Offices	1	50%
Fish and Boat Commission	19	12%
Governor's Office	0	0%
Insurance Department	0	0%
Liquor Control Board	82	15%
Emergency Management Agency	1	13%
Historical and Museum Commission	9	30%
State Police	10	28%
Public School Employees' Retirement System	1	17%
State Department	0	0%
State Employees' Retirement System	0	0%
Thaddeus Stevens College of Technology	0	0%
Treasury	0	0%
State System of Higher Education	154	18%
Total	**766**	**17%**

There are 2,315 vulnerable critical facility structures in a high-risk area (Table 4.3.22-3). Of the Commonwealth’s total number of structures, 20 percent of the buildings are vulnerable to risks associating with coal mines, resulting in $38,421,657,928 in replacement value.

Table 4.3.22-3 Vulnerability of critical facilities to conventional oil and gas wells		
TYPE	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF TOTAL STRUCTURES BY TYPE
Agricultural	27	10%
Banking	0	0%
Commercial	1	4%
Communication	131	21%
Dam	420	12%
Education (colleges and universities)	17	11%
Education (public schools)	495	16%
Emergency Operation Center	11	16%
Energy	9	16%
Fire Station	519	19%
Government	0	0%
Hospital	52	15%
National Monuments or Icons	0	0%
Nuclear	0	0%
Police Station	210	17%
Transportation	7	9%
Water	416	23%
Total	**2,315**	**17%**

4.3.22.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to conventional oil and gas well incidents, all census blocks with centroid within with centroid within high risk areas were identified in Table 4.3.22-4. The population, building counts, and building value of all vulnerable census blocks were then aggregated to the county scale. The counties most affected by this hazard are Allegheny, Erie, West Moreland, and Washington.

Table 4.3.22-4 Vulnerability of people and buildings to conventional oil and gas wells				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Adams	0	0	$0	0%
Allegheny	403,291	167,399	$50,111,204	31%
Armstrong	64,063	29,553	$6,074,230	92%
Beaver	15,069	6,290	$1,612,292	8%
Bedford	439	246	$33,922	1%
Berks	0	0	$0	0%
Blair	759	299	$79,126	1%
Bradford	636	343	$45,516	1%
Bucks	0	0	$0	0%
Butler	63,592	26,910	$7,590,178	35%

Table 4.3.22-4 Vulnerability of people and buildings to conventional oil and gas wells				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Cambria	15,371	5,980	$1,279,625	8%
Cameron	224	416	$59,961	7%
Carbon	0	0	$0	0%
Centre	1,299	1,048	$201,187	1%
Chester	0	0	$0	0%
Clarion	31,933	15,465	$3,128,164	75%
Clearfield	26,463	13,138	$2,519,120	33%
Clinton	1,155	1,483	$217,746	6%
Columbia	150	78	$14,761	0%
Crawford	52,798	24,508	$5,115,757	54%
Cumberland	0	0	$0	0%
Dauphin	0	0	$0	0%
Delaware	0	0	$0	0%
Elk	11,136	5,904	$1,459,467	35%
Erie	257,035	98,972	$28,011,488	92%
Fayette	61,859	26,790	$4,885,207	39%
Forest	2,485	3,834	$563,576	43%
Franklin	37	16	$2,726	0%
Fulton	8	6	$800	0%
Greene	35,051	14,739	$3,111,531	91%
Huntingdon	77	29	$5,040	0%
Indiana	84,475	34,415	$7,901,262	96%
Jefferson	33,880	16,912	$3,298,198	72%
Juniata	41	26	$3,400	0%
Lackawanna	511	222	$49,119	0%
Lancaster	0	0	$0	0%
Lawrence	9,103	3,390	$953,324	7%
Lebanon	712	278	$50,244	0%
Lehigh	1,629	793	$156,160	1%
Luzerne	0	0	$0	0%
Lycoming	1,629	793	$156,160	1%
McKean	32,344	15,115	$3,500,989	75%
Mercer	94,976	42,108	$10,846,751	83%
Mifflin	0	0	$0	0%
Monroe	0	0	$0	0%
Montgomery	0	0	$0	0%
Montour	0	0	$0	0%
Northampton	378	186	$44,681	0%

Table 4.3.22-4 Vulnerability of people and buildings to conventional oil and gas wells				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Northumberland	378	186	$44,681	0%
Perry	123	49	$13,270	0%
Philadelphia	0	0	$0	0%
Pike	1,137	455	$109,143	1%
Potter	6,501	4,134	$695,151	29%
Schuylkill	58	27	$4,246	0%
Snyder	118	47	$6,483	0%
Somerset	4,696	2,819	$529,142	7%
Sullivan	41	39	$5,348	1%
Susquehanna	416	253	$56,224	1%
Tioga	6,333	3,137	$600,124	15%
Union	206	72	$12,280	0%
Venango	39,036	19,093	$4,007,437	70%
Warren	37,030	19,121	$4,140,071	87%
Washington	136,899	59,251	$15,219,526	64%
Wayne	92	73	$10,046	0%
Westmoreland	225,397	100,087	$25,355,777	62%
Wyoming	157	79	$11,518	0%
York	943	374	$76,899	0%
Total	**1,762,162**	**766,001**	**$193,779,437**	**13%**

4.3.23. Environmental Hazard – Gas and Liquid Pipeline

4.3.23.1. Location and Extent

Pipelines are a vital component of the nation's infrastructure that transport two of the materials most essential to daily life – water and energy products. This profile addresses the risks posed by the gas and liquid pipeline systems that move energy products in Pennsylvania. These pipeline systems cross both rural and densely populated areas, and range in length from a few thousand feet to hundreds of miles. Pipeline systems are defined by federal regulations as all parts of a pipeline facility through which a hazardous liquid or gas moves, including piping, valves, pumps or compressors, metering and delivery stations, and storage and breakout tanks. Although pipelines are typically located underground, they may also be located aboveground when dictated by operational considerations (such as connections to pump and compressor stations) or environmental conditions (such as geological characteristics) (FEMA, 2015).

Natural gas pipelines are the most common type of pipeline in the United States, and serve to transport natural gas from the point of production to the point of use. Three major types of pipelines move natural gas: gathering lines, transmission lines, and distribution lines. Gathering lines are the pipelines that move natural gas from the production well to a processing facility. Gas transmission lines are the large pipelines (6 to 48 inches in diameter) that move natural gas from the processing facility to local distribution networks. Gas transmission lines are designed to transport natural gas long distances at high pressures (often 200 – 1,500 psi). There are approximately 300,000 miles of gas transmission pipelines in the United States. Gas distribution lines are the smaller gas mains and service lines (1/2 to 2 inches in diameter) that move natural gas from the transmission network directly to homes and businesses. Gas distribution pipelines are designed to transport natural gas shorter distances at relatively low pressures. There are approximately 2.2 million miles of gas distribution lines in the United States (PHMSA, 2018).

Liquid petroleum pipelines are the second most common type of pipeline in the United States, and serve to transport crude oil, refined product, and highly volatile liquids (HVLs) to local distribution networks. For crude oil and its refined products, there are three major types of pipelines that move the product from producing areas to local distribution networks: gathering lines, transmission lines, and refined product lines. Gathering lines are the smaller pipelines (2 to 8 inches in diameter) that gather crude oil from production wells. Crude oil transmission lines are the larger, cross-country pipelines (8 to 48 inches in diameter) that move crude oil from producing areas to refineries. There are approximately 72,000 miles of crude oil transmission pipelines in the United States. Refined product lines are the small to large lines (8 to 42 inches in diameter) that deliver refined petroleum products to storage terminals. There are approximately 63,000 miles of refined products pipelines in the United States (Pipelines 101, 2018). Tanker trucks take the refined petroleum products the last few miles from the storage terminals to gas stations and homes.

Highly volatile liquids (HVLs) are products that are liquid when stored at a certain temperature or pressure, but quickly vaporize when released into the atmosphere. HVLs include natural gas liquids (NGLs), ethylene, propylene, and anhydrous ammonia. There are approximately 69,000 miles of HVL pipelines in the United States. These pipelines are becoming increasingly common as NGL production grows. NGLs are liquids produced at both natural gas processing plants and oil refineries that have many uses spanning nearly all sectors of the economy. As the use of hydraulic fracturing to extract natural gas from shale gas formations expands, the production of NGLs is growing.

Pipeline failures are low-probability, potentially high-consequence events. Although gas and liquid pipeline failures are infrequent, the hazardous and inflammable materials released by these events can pose a significant threat to public safety and the built and natural environment. Explosions associated with pipeline failures, for example, can cause severe injury to nearby residents and destroy homes and other property. Corrosion is a major cause of pipeline failure, and is often associated with pipeline age (FEMA, 2015). Besides corrosion, pipeline failures can be caused by external impacts from farm or construction machinery, structural failures, mechanical defects, and natural hazards. Land development tends to increase the likelihood of external impacts and pipeline failure. Land development without appropriate planning can also impede access to pipelines for operation and maintenance or emergency response.

Figure 4.3.23-1 Photograph of an explosion on a 30-inch interstate natural gas pipeline in rural Salem Township, Pennsylvania. Source: NPR State Impact.

According to the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA), in 2016 Pennsylvania had 87,931 miles of natural gas pipelines and 3,113 miles of liquid petroleum pipelines. The state's natural gas pipelines include 803 miles of gas gathering lines, 10,056 miles of gas transmission lines, and 77,072 miles of gas distribution lines. The state's liquid petroleum pipelines include 23 miles of crude oil pipeline, 1,942 miles of refined petroleum product pipeline, and 1,148 miles of HVL pipeline (PHMSA, 2018). Figure 4.3.23-2 and Figure 4.3.23-3 show the mix of pipeline types in Pennsylvania and in the United States. The state mix is similar to the national mix, with a smaller share of crude oil pipelines (too small to be visible in the figure) and a larger share of gas distribution lines.

Figure 4.3.23-2 Pennsylvania Pipeline Mileage Percentage by Type (PHMSA, 2016).

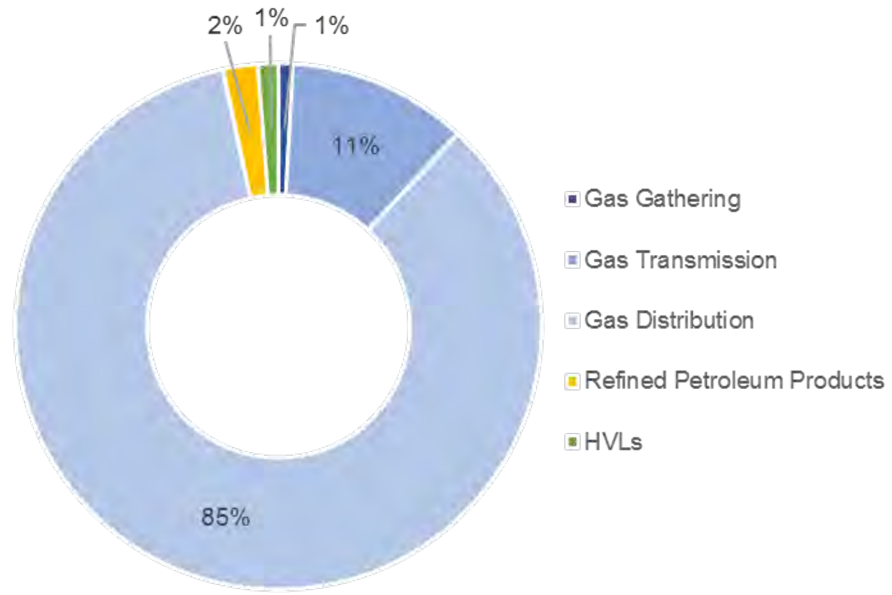
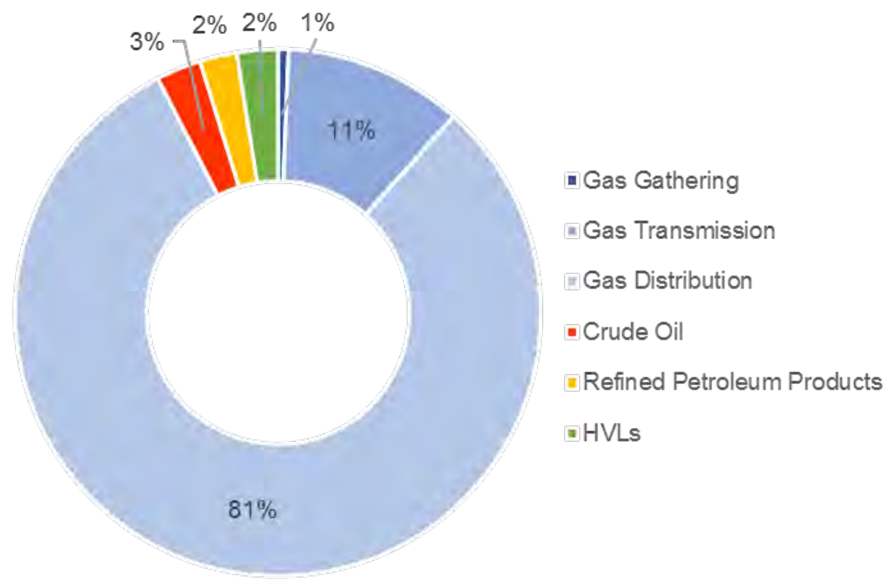


Figure 4.3.23-3 U.S. Pipeline Mileage Percentage by Type (PHMSA, 2016).



Two agencies that provide information on the location and extent of pipelines within Pennsylvania are the U.S. Energy Information Administration (EIA) and the U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA). Figure 4.3.23-4 shows the location of major pipelines in Pennsylvania as compiled by the EIA. The EIA defines major pipelines as interstate trunk lines and selected intrastate lines (as well as gathering lines for natural gas), and assembles pipeline data from the Federal Energy Regulatory Commission, industry sources, and other publicly available sources. The network of natural gas pipelines is particularly dense in the northwestern part of the state.

Table 4.3.23-1 shows the pipeline mileage per county as distributed by PHMSA. While the state totals provided above include all pipelines in the PHMSA database, the county summary provided below includes only those pipelines categorized as active as of February 20, 2018. Excluding permanently abandoned pipelines results in a slightly lower total mileage. Among Pennsylvania counties, Greene and Washington counties have the highest mileage of natural gas transmission pipelines, and Washington, Chester, and Berks counties have the highest mileage of liquid petroleum pipelines.

Figure 4.3.23-4 Major Pipelines of Pennsylvania (EIA, 2018).

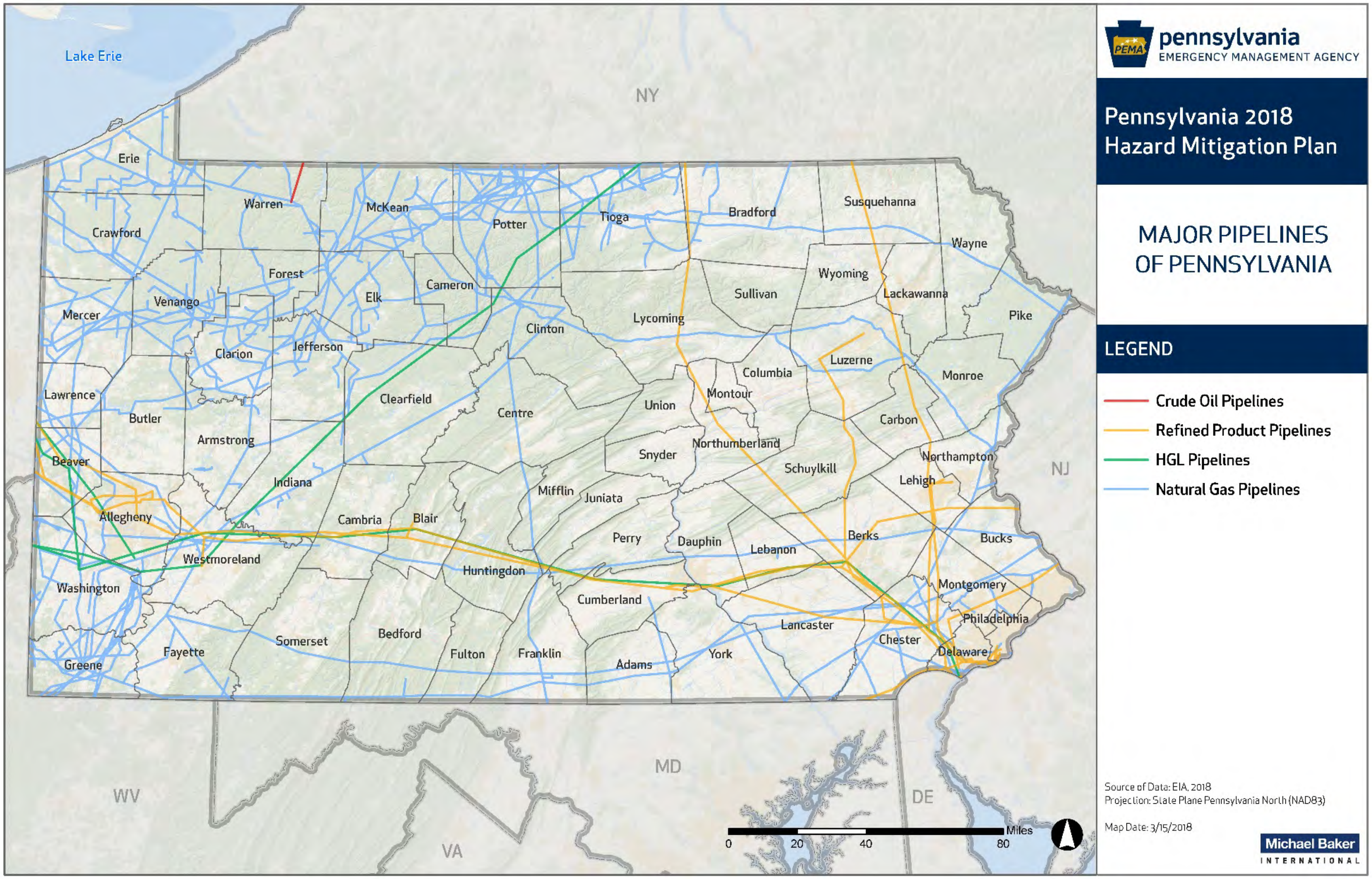


Table 4.3.23-1 Pennsylvania Active Pipeline Mileage by County (PHMSA, 2018)			
COUNTY	NATURAL GAS TRANSMISSION PIPELINES (MILES)	LIQUID PETROLEUM PIPELINES (MILES)	TOTAL GAS AND LIQUID PIPELINES (MILES)
Adams	148.5	0.0	148.5
Allegheny	284.3	151.0	435.2
Armstrong	209.1	0.0	209.1
Beaver	167.9	128.1	296.0
Bedford	111.1	0.0	111.1
Berks	156.5	219.5	375.9
Blair	66.5	75.1	141.5
Bradford	139.5	29.8	169.3
Bucks	243.3	47.5	290.8
Butler	96.6	20.2	116.7
Cambria	110.8	64.8	175.6
Cameron	68.9	17.8	86.7
Carbon	9.1	81.1	90.2
Centre	150.5	0.0	150.5
Chester	355.6	227.7	583.4
Clarion	98.5	0.0	98.5
Clearfield	158.3	35.2	193.5
Clinton	264.6	3.7	268.2
Columbia	35.2	0.0	35.2
Crawford	68.1	0.0	68.1
Cumberland	18.5	79.5	97.9
Dauphin	110.3	85.1	195.4
Delaware	82.7	213.8	296.5
Elk	208.4	3.3	211.7
Erie	141.8	0.0	141.8
Fayette	250.4	0.0	250.4
Forest	71.6	0.0	71.6
Franklin	197.4	0.0	197.4
Fulton	58.6	0.0	58.6
Greene	608.8	27.2	636.0
Huntingdon	91.4	73.3	164.7
Indiana	151.8	89.8	241.6
Jefferson	165.5	2.3	167.9
Juniata	50.4	13.0	63.4
Lackawanna	41.0	47.0	88.0
Lancaster	214.2	61.3	275.6

Table 4.3.23-1 Pennsylvania Active Pipeline Mileage by County (PHMSA, 2018)			
COUNTY	NATURAL GAS TRANSMISSION PIPELINES (MILES)	LIQUID PETROLEUM PIPELINES (MILES)	TOTAL GAS AND LIQUID PIPELINES (MILES)
Lawrence	160.7	8.0	168.6
Lebanon	86.9	76.5	163.4
Lehigh	10.9	120.0	131.0
Luzerne	197.1	121.1	318.2
Lycoming	265.4	35.1	300.5
McKean	252.9	0.0	252.9
Mercer	243.9	0.0	243.9
Mifflin	32.3	0.0	32.3
Monroe	108.1	0.0	108.1
Montgomery	224.4	78.2	302.6
Montour	9.9	3.0	12.8
Northampton	141.9	17.6	159.5
Northumberland	22.4	34.2	56.6
Perry	111.6	47.5	159.1
Philadelphia	9.0	70.8	79.8
Pike	77.2	0.0	77.2
Potter	495.8	25.7	521.5
Schuylkill	1.1	75.0	76.1
Snyder	0.0	0.0	0.0
Somerset	158.9	0.0	158.9
Sullivan	24.7	0.0	24.7
Susquehanna	132.8	82.0	214.7
Tioga	317.6	28.0	345.6
Union	0.0	0.0	0.0
Venango	111.3	0.0	111.3
Warren	140.0	20.8	160.8
Washington	512.4	256.0	768.4
Wayne	44.6	0.0	44.6
Westmoreland	435.8	144.7	580.5
Wyoming	20.1	27.2	47.3
York	180.0	20.9	200.9
Total	**9,935.2**	**3,089.1**	**13,024.4**

4.3.23.2. Range of Magnitude

Many factors determine the magnitude of the hazard posed by pipeline failures, including the chemicals released, the failure mode of the pipeline, the operating conditions of the pipeline at the time of the incident, and the characteristics of the surrounding area. Impacts to life and property can result from inhalation or ingestion of toxins, exposure to a fire or explosion, or exposure to contaminated soils or drinking water (FEMA, 2015). These impacts may include:

- Serious injuries or fatalities;
- Damage to buildings and infrastructure;
- Disruptions and closures to critical infrastructure and services, including transportation routes and emergency medical services;
- Residential, commercial, and industrial energy supply losses;
- Disruption of local businesses and regional economies; and
- Displacement of residential communities or businesses.

Understanding pipeline threats and hazards begins with understanding the physical and chemical properties of the products in the pipeline. Natural gas is a clean-burning fuel that consists mostly of methane (94 percent) and ethane (2 percent). Some relevant characteristics of natural gas are summarized below:

- Although natural gas is nontoxic, it can cause asphyxiation if released in an enclosed area.
- Natural gas is combustible and natural gas fires produce large amounts of radiant heat.
- If an ignition source exists, natural gas releases can result in a sudden fire or explosion near the point of release. Once the release ends, however, the hazard declines very quickly as the gas disperses.
- If natural gas migrates into a building and accumulates inside, the hazard can persist for longer.

Liquid petroleum pipelines can carry many different crude oil and refined petroleum products with widely varying physical and chemical properties. Many of these products can spread over land and water, flowing into valleys, ravines, and waterways. Relevant characteristics of some liquid petroleum products are summarized below:

- Most crude oils are heavier and less toxic than refined petroleum products, and do not penetrate porous surfaces such as soil and sand. Because these products do not evaporate and tend to adhere to surfaces, however, they remain in the environment longer than refined products. Oil spills may take weeks, months, or even years to clean up.
- Most refined petroleum products are highly fluid, spready quickly over land or water surfaces, and penetrate porous surfaces. These products are usually flammable, and their volatile components can burn the eyes and skin and irritate the nose, eyes, and mouth. Because these products have a high evaporation rate and generally do not adhere to surfaces, they are easier to clean up. Refined petroleum products also produce vapors that are heavier than air. These vapors will collect in low areas.
- Highly volatile liquids are lighter than air and will form a vapor cloud when released to the atmosphere.

- Anhydrous ammonia is a highly volatile liquid that is particularly toxic and corrosive. It is typically transported under pressure as liquefied gas, and rapidly expands when released.

In some cases, natural hazard events can cause pipeline failures and/or complicate emergency response activities. When a pipeline failure occurs during a natural disaster, access to the pipeline may be restricted, waterlines for fire suppression may be compromised, and response personnel and resources may be limited. In addition, the potential threat of a pipeline failure can be amplified by natural hazard events that are accompanied by winds, thunderstorms, or floods. These conditions can spread contamination more quickly and exacerbate the threat to local water supplies, air quality, soil, and agriculture. In October of 2016, for example, water supplies in several towns in north-central Pennsylvania were threatened when flash floods and landslides caused a pipeline to rupture near Wallis Run Creek, spilling nearly 55,000 gallons of gasoline into the tributary of the West Branch Susquehanna River. Response officials reported that access to the site of the rupture was limited by the severe flooding, and Pennsylvania American Water suspended operations at their downstream drinking water plant as a precaution (State Impact, 2016). Other natural hazard events that can lead to pipeline failure include earthquakes, land subsidence, avalanches, lightning, fires, and severe winter storms (FEMA, 1997).

Several exacerbating or mitigating circumstances can affect the severity of a pipeline failure. Mitigating circumstances include precautionary measures taken in advance to reduce the impact of a release on the surrounding environment. After a release, primary and secondary containment or shielding by sheltering-in-place can help protect people and property. Exacerbating circumstances can include weather conditions, the micro-meteorological effects of buildings and terrain, and lack of code compliance or maintenance. 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 pipelines and surrounding buildings.

4.3.23.3. Past Occurrence

The U.S. Department of Transportation's Pipeline and Hazardous Materials Safety Administration (PHMSA) is the federal agency charged with prescribing safety standards for transportation pipelines and pipeline facilities. PHMSA has collected pipeline incident reports in various formats since 1970, and has created a comprehensive database of all pipeline incident reports submitted from 1998 through 2017 (available at https://www.phmsa.dot.gov/data-and-statistics/pipeline/pipeline-incident-20-year-trends). This database includes a wealth of information on the causes and impacts of pipeline failures in the U.S. Table 4.3.23-2 presents a summary of significant pipeline incidents in Pennsylvania by pipeline type. Significant incidents are those that involve 1) Fatality or injury requiring in-patient hospitalization, 2) $50,000 or more in total costs, measured in 1984 dollars, 3) HVL releases of 5 or more barrels or other liquid releases of 50 or more barrels, and/or liquid releases resulting in an unintentional fire or explosion.

Natural gas mains and service lines (the components of the gas distribution system) accounted for half the significant pipeline incidents reported to PHMSA between 1998 and 2017. Gas transmission and hazardous liquid pipelines, however, accounted for most of the cost.

Table 4.3.23-2 Significant Pipeline Incidents in Pennsylvania by Pipeline Type, 1998-2017 (PHMSA, 2018)

PIPELINE TYPE	NUMBER	FATALITIES	INJURIES	TOTAL COST CURRENT YEAR DOLLARS
Gas Distribution	99	21	70	$29,330,675
Gas Gathering	1	0	0	$414,088
Gas Transmission	44	0	4	$69,884,891
Hazardous Liquid	53	0	2	$59,391,165
Total	197	21	76	$159,020,819

Figure 4.3.23-5 and Figure 4.3.23-6 provide a year-by-year summary of the frequency and consequence of significant pipeline incidents for gas transmission pipelines and hazardous liquid pipelines. The figures show that significant incidents tend to occur every year, and that the associated costs vary widely. The five most costly incidents occurred in 1999, 2000, 2005, 2011, and 2016. The reported causes of these incidents included corrosion, material or welding failure, and temperature extremes (such as when cold weather causes frost heaves or frozen instrumentation lines).

Figure 4.3.23-5 Frequency of Significant Pipeline Incidents in Pennsylvania (PHMSA, 2018).

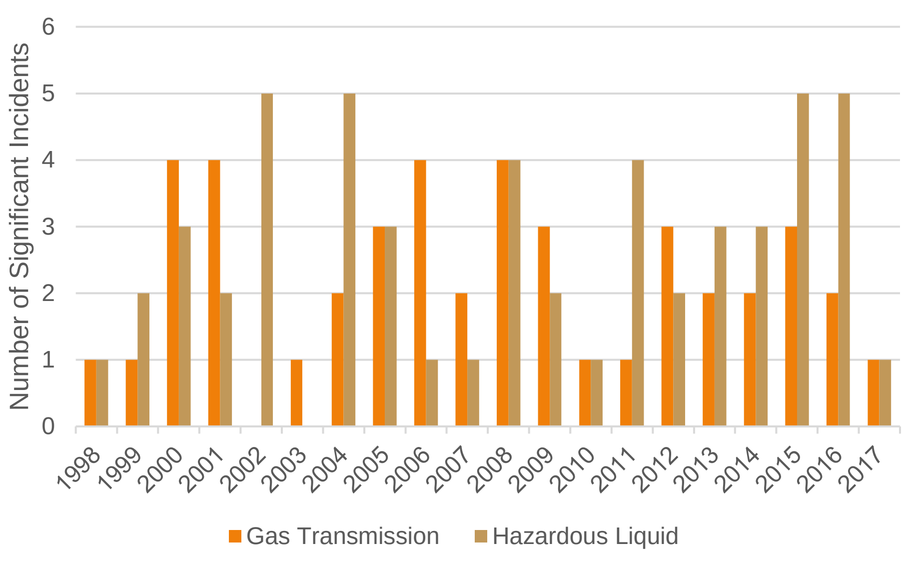
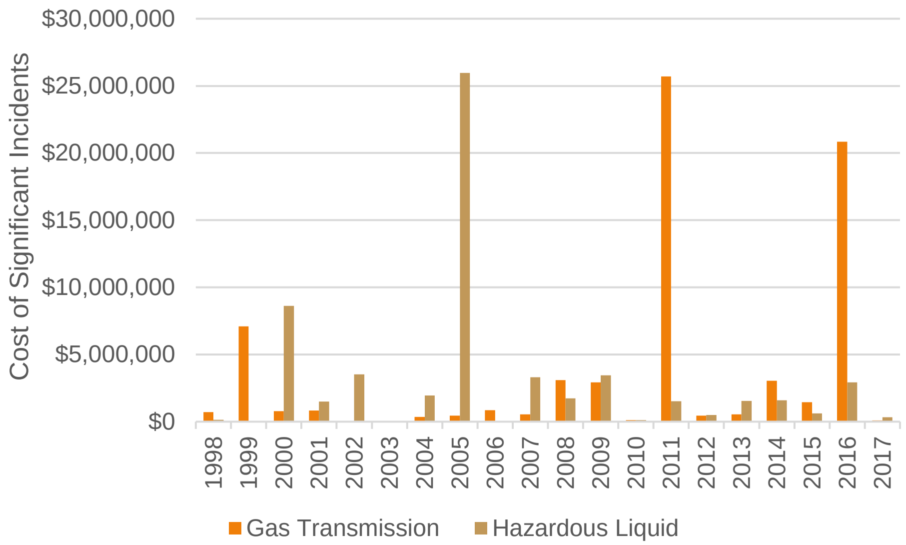
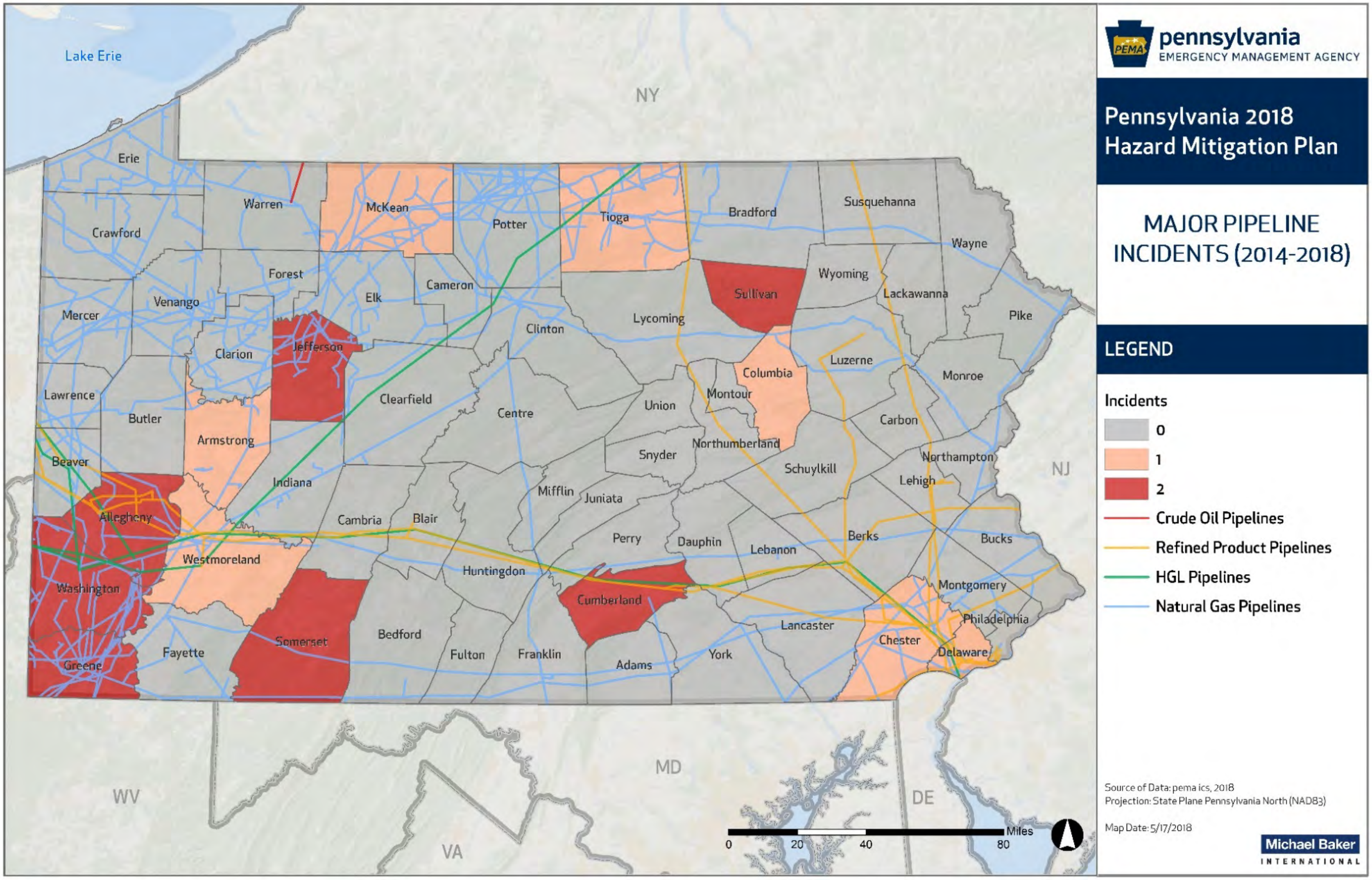


Figure 4.3.23-6 Cost of Significant Pipeline Incidents in Pennsylvania (PHMSA, 2018).



Major pipeline incidents in Pennsylvania are also captured in PEMA's incident management system, PEMA-KC. An incident management system provides a centralized communication platform for state and local agencies engaged in incident response, allowing for more effective cross-agency and cross-jurisdictional collaboration. Incidents entered into the system typically involve responses from multiple organizations within a single jurisdiction; responses from organizations outside the jurisdiction in which the incident occurred; and/or significant public health, environmental, or economic effects with regional or national implications. For this plan update, PEMA-KC data for pipeline incidents were available from June 2014 to March 2018. During this time, PEMA-KC captured 21 major pipeline incidents in 14 counties. Many of these incidents occurred in the southwestern part of the state (Figure 4.3.23-7).

Figure 4.3.23-7 Major pipeline incidents in Pennsylvania (PEMA, 2018).



4.3.23.4. *Future Occurrence*

The future probability of high-impact pipeline failures will be shaped by the maintenance of existing pipeline systems, the construction of new pipeline systems, and the amount of new development that occurs near pipelines. According to the annual reports submitted to PHMSA, 75 percent of Pennsylvania's liquid petroleum pipelines were installed before 1970, and 56 percent were installed before 1960. As the metal in these aging pipelines reacts with the environment, it can become corroded, causing a loss of pipe strength that can lead to leakage or rupture. Corrosion is one of the most prevalent causes of pipeline incidents, and was listed as the cause for 20 percent of significant pipeline incidents nationwide between 1998 and 2017, and 15 percent of pipeline incidents in Pennsylvania. Maintenance and repair, however, can reduce the risk of corrosion. Improved technologies have led to better prevention, monitoring, detection, and mitigation of external pipeline corrosion for older as well as newer pipelines (PHMSA, 2018).

The future occurrence of high impact pipeline failures will also be determined by the location and character of new pipeline construction. The development of the Marcellus Shale has made Pennsylvania the nation's second largest natural gas-producing state, and is driving a new wave of pipeline construction (EIA, 2018). According to the Pennsylvania Department of Environmental Protection (DEP), the state can expect "unprecedented" growth in its natural gas pipeline system to transport natural gas and related byproducts from thousands of wells throughout the state (PA DEP, 2016).

Finally, land development near a pipeline right-of-way can bring people in close proximity to pipeline hazards. Figure 4.3.23-8 provides an example of new development surrounding an existing pipeline. Land development adjacent to natural gas and liquid petroleum pipelines increases the likelihood of damage to the pipeline, and also increase the exposure of people and property to pipeline failure hazards.

Figure 4.3.23-8 Example of New Development Near Pipeline (FEMA, 2015).

4.3.23.5. Environmental Impacts

The environmental impacts of hazardous material releases from pipelines could include:

- Surface and groundwater contamination
- Other effects on water quality such as changes in water temperature
- Damage to streams, lakes, ponds, estuaries, and wetland ecosystems
- Air quality effects – pollutants, smoke, and dust
- Loss of quality in landscape
- Reduced soil quality
- Damage to plant communities – loss of biodiversity; damage to vegetation
- Damage to animal species – animal fatalities; degradation of wildlife and aquatic habitat; pollution of drinking water for wildlife; loss of biodiversity; disease

These impacts are a particular concern for liquid petroleum pipelines, since liquid petroleum products can flow into valleys, ravines, and waterways. To minimize the environmental impacts of liquid petroleum pipelines, federal regulations require pipeline operators to include drinking water sources and unusually sensitive ecological resources in the “high consequence areas” that they prioritize for integrity management.

4.3.23.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to pipeline failures, all structures located within one-quarter mile of the major pipelines shown in Figure 4.3.23-4 were identified. The area impacted by a given pipeline incident will depend on the pipeline contents, pipeline diameter and operating pressure, and atmospheric conditions. For this assessment, however, one-quarter mile was selected as a representative distance within which death, injury, or significant property damage could occur. In addition, the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 446, or 10 percent, are located within a quarter mile of a major gas or liquid pipeline (Table 4.3.25-3). These facilities have a combined replacement value of more than $240 million, or approximately 6% of the known value of geolocated state facilities.

Table 4.3.23-3 Vulnerability of state facilities to pipeline failure.

DEPARTMENT	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF DEPARTMENT STRUCTURES
Department of Agriculture	2	13%
Department of Conservation and Natural Resources	1	50%
Department of Corrections	125	18%
Department of Health	6	13%
Department of Labor and Industry	5	7%
Department of Public Welfare	5	5%
Department of Revenue	1	10%
Department of Transportation	202	12%
Executive Offices	1	50%

Table 4.3.23-3 Vulnerability of state facilities to pipeline failure.		
DEPARTMENT	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF DEPARTMENT STRUCTURES
Liquor Control Board	63	12%
PA Historical and Museum Commission	4	13%
PA State Police	6	17%
PA State System of Higher Education	25	3%
Total	**446**	**10%**

Of the 14,011 geolocated critical facilities, 1,278 or 9 percent, are located within a quarter mile of a major gas or liquid pipeline (Table 4.3.21-4). These facilities have a combined replacement value of more than $19 billion, or approximately 10% of the known value of geolocated critical facilities.

Table 4.3.23-4 Vulnerability of critical facilities to pipeline failure		
TYPE	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF TOTAL STRUCTURES BY TYPE
Agricultural	18	7%
Commercial	1	4%
Communication	56	9%
Dam	277	8%
Education (colleges and universities)	15	9%
Education (public schools)	289	9%
Emergency Operation Center	4	6%
Energy	11	20%
Fire Station	279	10%
Government	1	4%
Hospital	24	7%
Nuclear	1	20%
Police Station	119	10%
Transportation	8	11%
Water	175	10%
Total	**1,278**	**9%**

4.3.23.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to pipeline failures, all census blocks with centers located within one-quarter mile of a major pipeline were identified. The population, building counts, and building value of all vulnerable census blocks were then aggregated to the county scale. The counties with the highest percentage of exposed building value are Greene, Beaver, and Tioga counties. For each of these counties, more than a quarter of the total building value is vulnerable to a gas or liquid pipeline failure. The counties with the most people exposed to pipeline failure, in contrast, are Allegheny, Delaware, and Chester counties. In each of these counties, more than 100,000 people are vulnerable to a gas or liquid pipeline failure. Across the state, about 10 percent of total building value is vulnerable to a gas or liquid pipeline failure.

Table 4.3.23-5 Vulnerability of people and buildings to pipeline failure

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Adams	12,601	4,518	$1,470,046	14%
Allegheny	199,757	84,465	$24,356,151	15%
Armstrong	2,824	1,347	$221,193	3%
Beaver	42,417	17,759	$5,259,562	27%
Bedford	587	318	$49,091	1%
Berks	39,074	15,058	$4,512,954	10%
Blair	13,246	5,926	$1,643,632	13%
Bradford	3,770	1,762	$322,779	6%
Bucks	40,456	14,649	$5,459,730	7%
Butler	8,893	3,725	$1,037,429	5%
Cambria	4,543	2,061	$411,847	3%
Cameron	580	527	$89,744	10%
Carbon	837	640	$119,270	2%
Centre	2,268	1,076	$361,901	2%
Chester	105,767	38,929	$16,010,225	23%
Clarion	5,064	2,636	$502,948	12%
Clearfield	3,190	1,437	$349,846	5%
Clinton	377	444	$63,971	2%
Columbia	220	214	$27,608	0%
Crawford	10,469	5,009	$1,145,876	12%
Cumberland	30,305	11,389	$3,935,352	14%
Dauphin	20,187	8,408	$2,499,274	8%
Delaware	113,558	40,468	$14,087,765	21%
Elk	5,376	2,880	$681,911	16%
Erie	53,898	19,502	$5,922,800	19%
Fayette	8,806	4,001	$876,232	7%
Forest	931	1,298	$171,953	13%
Franklin	5,721	2,300	$544,234	4%
Fulton	384	195	$39,526	3%
Greene	10,100	4,479	$1,126,219	33%
Huntingdon	1,218	704	$122,594	3%
Indiana	11,688	5,160	$1,170,643	14%
Jefferson	5,996	3,041	$780,606	17%

Table 4.3.23-5 Vulnerability of people and buildings to pipeline failure				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $**	**PERCENT OF TOTAL COUNTY BUILDING VALUE**
Juniata	49	31	$3,851	0%
Lackawanna	1,802	794	$198,526	1%
Lancaster	49,833	18,730	$5,853,202	11%
Lawrence	11,379	5,474	$1,201,531	13%
Lebanon	14,569	6,466	$1,701,266	12%
Lehigh	30,026	11,835	$3,739,206	9%
Luzerne	20,955	8,879	$2,375,222	7%
Lycoming	5,178	2,293	$521,185	4%
McKean	5,483	2,843	$559,915	12%
Mercer	23,494	10,821	$2,712,056	21%
Mifflin	428	190	$41,202	1%
Monroe	6,116	2,246	$513,811	3%
Montgomery	82,454	29,587	$11,987,925	10%
Montour	15	7	$1,323	0%
Northampton	13,767	5,578	$1,472,111	4%
Northumberland	3,257	1,390	$346,059	4%
Perry	2,041	968	$194,443	5%
Philadelphia	25,526	9,717	$2,923,943	2%
Pike	3,689	1,996	$499,679	6%
Potter	3,681	2,581	$431,362	18%
Schuylkill	5,175	2,263	$487,797	3%
Somerset	2,865	1,912	$372,326	5%
Susquehanna	1,202	617	$130,846	3%
Tioga	10,113	4,989	$1,089,336	27%
Venango	14,186	6,565	$1,271,701	22%
Warren	7,923	4,105	$1,050,257	22%
Washington	47,982	20,905	$5,316,991	23%
Wayne	1,905	950	$181,206	3%
Westmoreland	39,404	17,227	$4,604,344	11%
Wyoming	513	197	$41,489	2%
York	31,400	12,889	$3,901,312	8%
Total	**1,231,518**	**501,370**	**151,100,335**	**10%**

4.3.24. Environmental Hazard – Hazardous Materials Releases

4.3.24.1. Location and Extent

Hazardous material releases pose threats to the natural environment, the built environment, and public safety through the diffusion of harmful substances, materials, or products. Hazardous materials can include toxic chemicals, infectious substances, biohazardous waste, and any materials that are explosive, corrosive, flammable, or radioactive. Hazardous material releases can occur wherever hazardous materials are manufactured, used, stored, or transported. Such releases can occur along transportation routes or at fixed-site facilities. Hazardous material releases can result in human and wildlife injury, property damage, and contamination of air, water, and soils.

Transportation of hazardous materials on highways involves tanker trucks or trailers, which are responsible for the greatest number of hazardous material release incidents (FEMA, 1997). There are over 120,000 miles of highway in the Commonwealth and many of those are used to transport hazardous materials (PennDOT, 2016). These roads also cross rivers and streams at many points and have the potential to pollute surface water and groundwater that serve as domestic water supplies for parts of the Commonwealth.

Potential also exists for hazardous material releases to occur along rail lines as collisions and derailments of train cars can result in large spills. Several railroad accidents have occurred in Pennsylvania involving hazardous materials (NTSB, 2018).

Pipelines also transport hazardous liquids and flammable substances such as natural gas. Incidents can occur when pipes corrode, are damaged during excavation, incorrectly operated, or damaged by other forces. Pipelines exist in all but two counties in Pennsylvania (see Section 4.3.25.3). Pipelines transporting natural gas compose most of the total pipeline miles in the Commonwealth. According to the Pipeline and Hazardous Materials Safety Administration, Pennsylvania has 9,935 miles of active natural gas transmission pipelines and 3,089 miles of active liquid pipelines. Of the liquid pipeline mileage, approximately 1,1,48 miles carry highly volatile liquids. In addition, hazardous materials can be transported by aircraft or by watercraft. Crashes, spills of materials, and fires on these vessels can pose a hazard.

Fixed-site facilities that use, manufacture, or store hazardous materials in Pennsylvania pose significant risk to public health and the environment and 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. These statutes require that all owners or operators of facilities that manufacture, produce, use, import, export, store, supply, or distribute any extremely hazardous substance, as defined by the EPA, at or above the threshold planning quantity, as established by EPA, report to the county where the facility is located and the Commonwealth. Such facility is subject to the requirement to assist the Local Emergency Planning Committee (LEPC) in the development of an Off-site Emergency Response Plan. The community right-to-know reporting requirements keep communities abreast of the presence and release of chemicals at individual facilities. In 2011, there were 3,298 SARA Title III facilities in Pennsylvania.

The list of SARA Title III facilities is not an exhaustive, fully-comprehensive inventory of all hazardous material locations within the Commonwealth. The EPA also tracks key information about chemicals handled by industrial facilities through its Toxics Release Inventory (TRI) database. Facilities which employ ten or more full-time employees and which manufacture or process 25,000 pounds or more, or otherwise use 10,000 pounds or more, of any SARA Section 313-listed toxic chemical in the course of a calendar year are required to report TRI information to the EPA, the federal enforcement agency for SARA Title III, and PEMA. As of 2016, there were 3,849 facilities on EPA's TRI (EPA, 2016). The breakdown of these facilities by county is shown in Table 4.3.24-1.

Table 4.3.24-1 TRI Facilities in Pennsylvania by County (EPA, 2016)

COUNTY	NUMBER OF TRI FACILITIES	COUNTY	NUMBER OF TRI FACILITIES
Adams	17	Lackawanna	29
Allegheny	375	Lancaster	209
Armstrong	33	Lawrence	61
Beaver	184	Lebanon	64
Bedford	15	Lehigh	66
Berks	162	Luzerne	72
Blair	65	Lycoming	46
Bradford	40	McKean	54
Bucks	155	Mercer	110
Butler	141	Mifflin	10
Cambria	52	Monroe	16
Cameron	7	Montgomery	146
Carbon	29	Montour	19
Centre	12	Northampton	87
Chester	73	Northumberland	38
Clarion	6	Perry	0
Clearfield	28	Philadelphia	115
Clinton	26	Pike	0
Columbia	18	Potter	7
Crawford	49	Schuylkill	110
Cumberland	52	Snyder	12
Dauphin	57	Somerset	19
Delaware	90	Sullivan	0
Elk	70	Susquehanna	0
Erie	129	Tioga	21
Fayette	13	Union	6
Forest	0	Venango	54
Franklin	32	Warren	48
Fulton	10	Washington	75

Table 4.3.24-1 TRI Facilities in Pennsylvania by County (EPA, 2016)			
COUNTY	NUMBER OF TRI FACILITIES	COUNTY	NUMBER OF TRI FACILITIES
Greene	3	Wayne	3
Huntingdon	6	Westmoreland	122
Indiana	70	Wyoming	6
Jefferson	21	York	174
Juniata	10	**TOTAL**	**3,849**

Additional hazardous materials are contained at the military installations within Pennsylvania. Nuclear facilities are another type of fixed-facility that poses risk of hazard material release. For more information about nuclear incidents, reference Section 4.3.29.

4.3.24.2. Range of Magnitude

Hazardous material releases can contaminate air, water, and soils possibly resulting in death and/or injuries. Dispersion can take place rapidly when transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events. As previously mentioned, 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 mitigating or exacerbating 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 on 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.

A worst-case scenario event of a hazardous material release would be one equivalent to the Lac-Megantic train derailment in July 2013. An unmanned train broke loose and sped downhill before jumping the tracks near the Montreal-Maine border. The train carried 72 cars of petroleum crude oil. The derailment resulted in the fire and explosion of multiple tanks. This event had no warning time, exacerbating the damage. The derailment and explosions destroyed an estimated 30 buildings and forced the evacuation of 2,000 residents. The death toll was 47 (TSB, 2014). One of the worst recorded hazardous materials incident known in Pennsylvania occurred in March 2009 when a tractor trailer overturned spilling 33,000 pounds of toxic hydrofluoric acid near Wind Gap, Pennsylvania resulting in the evacuation of 5,000 people (USA Today, 2009). Residents were evacuated because contact with concentrated solutions of the acid can cause severe burns and inhaling the gas can cause respiratory irritation, severe eye damage, and pulmonary edema. More recently in Pennsylvania, a train derailment incident required the evacuation an entire town of approximately 1,000 residents roughly 100 miles southeast of Pittsburgh. In August 2017, at least 32 cars on a CSX freight train derailed causing some cars to catch fire. CSX reported that one car containing liquid petroleum gas and another containing molten sulfur leaked and caught fire. Additionally, one of the cars collided with a home and set fire to the garage (CBS News, 2017).

4.3.24.3. Past Occurrence

Since the passage of SARA Title III, facilities that produce, use, or store hazardous chemicals must notify the public through their county's 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 facility. SARA Title III and Pennsylvania Hazardous Material Emergency Planning and Response Act (Act 165) also require a written follow-up report to PEMA and the county where the facility is located. 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 (EOC) to provide effective emergency response coordination. Table 4.3.24-22 shows the number of hazardous material incidents by county from 2013 through April 2018 as reported to PEMA's incident management system, PEMA-KC. The table does not include incidents reported at a state or regional level.

Table 4.3.24-2 Number of hazardous materials incidents by county, 2013 - April 2018 (PEMA-KC, 2018).

COUNTY	NO. OF INCIDENTS IN 2013	NO. OF INCIDENTS IN 2014	NO. OF INCIDENTS IN 2015	NO. OF INCIDENTS IN 2016	NO. OF INCIDENTS IN 2017	NO. OF INCIDENTS IN 2018
Adams	7	5	3	11	8	1
Allegheny	123	139	123	101	115	37
Armstrong	13	10	5	8	7	2
Beaver	26	49	30	42	37	5
Bedford	6	11	13	9	12	2
Berks	62	69	67	68	86	32
Blair	4	8	8	15	14	7

Table 4.3.24-2 Number of hazardous materials incidents by county, 2013 - April 2018 (PEMA-KC, 2018).						
COUNTY	NO. OF INCIDENTS IN 2013	NO. OF INCIDENTS IN 2014	NO. OF INCIDENTS IN 2015	NO. OF INCIDENTS IN 2016	NO. OF INCIDENTS IN 2017	NO. OF INCIDENTS IN 2018
Bradford	28	23	13	13	4	1
Bucks	24	64	36	38	40	17
Butler	15	17	14	4	8	3
Cambria	16	17	23	8	14	3
Cameron	1	1	0	1	1	0
Carbon	6	7	14	6	8	1
Centre	2	7	14	15	12	3
Chester	21	39	26	31	38	16
Clarion	13	20	20	15	16	1
Clearfield	16	14	13	15	12	2
Clinton	10	12	7	9	6	2
Columbia	9	6	7	3	7	0
Crawford	4	4	8	10	5	2
Cumberland	16	28	34	31	28	10
Dauphin	25	30	35	28	40	10
Delaware	27	51	56	54	35	14
Elk	4	3	2	6	16	0
Erie	22	28	35	21	27	7
Fayette	22	42	17	11	6	6
Forest	1	2	3	1	2	2
Franklin	6	7	12	38	36	11
Fulton	0	2	0	3	1	1
Greene	25	136	181	130	219	61
Huntingdon	7	8	3	5	7	3
Indiana	16	19	10	13	4	2
Jefferson	51	47	43	38	15	6
Juniata	0	1	0	1	4	0
Lackawanna	50	41	29	18	14	5
Lancaster	35	50	45	36	42	10
Lawrence	17	16	16	5	27	3
Lebanon	2	9	18	23	43	12
Lehigh	48	56	59	36	56	15
Luzerne	21	19	35	35	32	15
Lycoming	4	13	9	7	13	4
McKean	17	19	21	18	9	1
Mercer	11	7	23	17	13	3
Mifflin	1	1	1	1	8	0

Table 4.3.24-2 Number of hazardous materials incidents by county, 2013 - April 2018 (PEMA-KC, 2018).						
COUNTY	NO. OF INCIDENTS IN 2013	NO. OF INCIDENTS IN 2014	NO. OF INCIDENTS IN 2015	NO. OF INCIDENTS IN 2016	NO. OF INCIDENTS IN 2017	NO. OF INCIDENTS IN 2018
Monroe	15	31	17	14	10	3
Montgomery	55	106	70	80	69	21
Montour	1	2	1	2	2	0
Northampton	218	224	375	387	388	144
Northumberland	8	13	13	14	11	4
Perry	4	3	5	4	0	1
Philadelphia	44	94	115	92	68	19
Pike	4	1	1	2	2	1
Potter	1	3	13	11	4	2
Schuylkill	16	13	12	8	11	3
Snyder	1	4	6	4	1	0
Somerset	13	15	30	32	21	3
Sullivan	11	8	4	1	1	3
Susquehanna	14	21	22	4	10	4
Tioga	0	9	38	10	14	2
Union	2	7	12	5	4	1
Venango	11	7	8	6	2	0
Warren	7	13	15	13	10	5
Washington	210	421	322	305	272	65
Wayne	6	4	3	3	1	0
Westmoreland	40	58	57	60	84	16
Wyoming	9	22	7	7	9	1
York	29	52	52	36	44	13
TOTAL	**1,553**	**2,288**	**2,329**	**2,098**	**2,185**	**649**

Transportation-related hazardous material release incidents are also tracked by the federal government. The U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) maintains information on highway-related hazardous material release incidents. PHMSA reports that between 2008 and 2017, there were over 7,500 highway-related incidents resulting in 65 injuries, one fatalities, and nearly $19 million in damages (Table 4.3.24-3).

Table 4.3.24-3 Highway-Related Hazardous Material Release Incident Statistics (PHMSA)					
YEAR	NO. OF INCIDENTS	MAJOR INJURIES	MINOR INJURIES	FATALITIES	DAMAGES
2017	769	1	4	0	$1,597,464
2016	782	0	7	1	$1,798,875

Table 4.3.24-3 Highway-Related Hazardous Material Release Incident Statistics (PHMSA)					
YEAR	NO. OF INCIDENTS	MAJOR INJURIES	MINOR INJURIES	FATALITIES	DAMAGES
2015	772	2	11	0	$1,122,313
2014	814	2	5	0	$2,535,651
2013	761	3	2	0	$1,427,005
2012	745	1	2	0	$2,444,939
2011	670	1	4	0	$3,193,758
2010	695	0	3	0	$2,161,339
2009	739	1	9	0	$926,492
2008	869	1	6	0	$1,537,665
Total	**7,616**	**12**	**53**	**1**	**$18,745,501**

A number of severe rail events involving the release of hazardous materials have also occurred in Pennsylvania including the August 2017 derailment incident southeast of Pittsburgh previously discussed. PHMSA also tracks rail incidents that result in the release of hazardous materials. Between 2008 and 2017, there were 245 rail-related incidents resulting in five injuries, no fatalities, and over $13 million in damages (Table 4.3.24-4).

Table 4.3.24-4 Rail-Related Hazardous Material Release Incident Statistics (PHMSA).					
YEAR	NO. OF INCIDENTS	MAJOR INJURIES	MINOR INJURIES	FATALITIES	DAMAGES
2017	21	0	0	0	$7,628,699
2016	20	0	0	0	$135,701
2015	18	0	1	0	$63,274
2014	34	0	0	0	$4,609,233
2013	38	1	0	0	$787,150
2012	19	0	0	0	$177,003
2011	27	0	1	0	$83,562
2010	22	0	1	0	$14,650
2009	17	0	0	0	$19,500
2008	29	1	0	0	$88,270
Total	**245**	**2**	**3**	**0**	**$13,607,042**

There have been 352 air-related incidents resulting in eight injuries, no fatalities, and over $27,000 in damages (Table 4.3.24-5). There have only been three water-related incidents since 2008 occurring in 2011, 2013, and 2014 resulting in no injuries or fatalities and approximately $22,000 in damages.

Table 4.3.24-5 Air-Related Hazardous Material Release Incident Statistics (PHMSA)					
YEAR	NO. OF INCIDENTS	MAJOR INJURIES	MINOR INJURIES	FATAILITIES	DAMAGES
2017	24	0	0	0	$0
2016	15	0	0	0	$14,000
2015	21	0	0	0	$0
2014	34	0	0	0	$3,345
2013	20	0	0	0	$0
2012	21	0	8	0	$6,500
2011	42	0	0	0	$1,500
2010	33	0	0	0	$880
2009	33	0	0	0	$0
2008	30	0	0	0	$1,188
Total	**352**	**0**	**8**	**0**	**$27,413**
**2013 events totaled through June 30.*					

Pipeline releases can also result in fatality, injury, damage, the release highly volatile liquids, or liquid releases that result in unintentional fire or explosion. Section 4.3.25.3 contains information on injuries, fatalities, and property damage from gas distribution and transmission incidents and hazardous liquid incidents with respect to pipelines.

4.3.24.4. Future Occurrence

While many hazardous material release incidents have occurred in Pennsylvania 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. Intentional acts are addressed under Section 4.3.30. Risk associated with hazardous materials release is expected to remain moderate. Since hazardous materials release incidents occur annually in Pennsylvania, a 100 percent annual probability is anticipated.

4.3.24.5. Environmental Impacts

The environmental impacts of hazardous material releases include:

- Hydrologic effects – surface and groundwater contamination
- Other effects on water quality such as changes in water temperature
- Damage to streams, lakes, ponds, estuaries, and wetland ecosystems
- Air quality effects – pollutants, smoke, and dust
- Loss of quality in landscape
- Reduced soil quality
- Damage to plant communities – loss of biodiversity; damage to vegetation
- Damage to animal species – animal fatalities; degradation of wildlife and aquatic habitat; pollution of drinking water for wildlife; loss of biodiversity; disease

4.3.24.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to hazardous material release, all facilities located in areas characterized as high risk were identified. High-risk areas are defined as those within one-quarter mile of major Interstates, U.S. highways, state highways, and rail lines, and areas within 1.5 miles of hazardous materials sites identified in Hazus.

As shown in Table 4.3.23-6, 3,877 state-owned or leased facilities were identified in areas at high risk to hazardous material release, the highest concentration of which are structures owned or leased by the Department of Transportation; 1,505 Department of Transportation facilities are identified as vulnerable. High percentages, between 77 and 100 percent, of structures owned or leased by all state departments are at risk to hazardous material release. The replacement value of the 3,877 total vulnerable facilities is estimated to be more than $3.7 billion, or 96 percent of the value of all state-owned or leased facilities.

Table 4.3.24-6 Vulnerability of state facilities to hazard materials release.

DEPARTMENT	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF DEPARTMENT STRUCTURES
Attorney General	8	89%
Department of Agriculture	14	88%
Department of Banking and Securities	2	100%
Department of Community and Economic Development	4	100%
Department of Conservation and Natural Resources	2	100%
Department of Corrections	575	83%
Department of Education	1	100%
Department of Environmental Protection	12	92%
Department of General Services	130	99%
Department of Health	46	96%
Department of Labor and Industry	69	100%
Department of Military and Veterans Affairs	1	100%
Department of Public Welfare	91	93%
Department of Revenue	10	100%
Department of Transportation	1505	89%
Drug and Alcohol Programs	1	100%
Emergency Management Agency	7	88%
Executive Offices	1	50%
Fish and Boat Commission	132	86%
Governor's Office	1	100%
Historical and Museum Commission	25	83%
Insurance Department	2	100%
Liquor Control Board	515	94%

Table 4.3.24-6 Vulnerability of state facilities to hazard materials release.		
DEPARTMENT	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF DEPARTMENT STRUCTURES**
Public School Employees' Retirement System	6	100%
State Civil Service Commission	1	100%
State Department	1	100%
State Employees' Retirement System	4	100%
State Police	29	81%
State System of Higher Education	660	77%
Thaddeus Stevens College of Technology	20	100%
Treasury Department	2	100%
Total	**3,877**	**87%**

With respect to critical facilities, the types of facilities most vulnerable to hazardous material release in terms of number of facilities include fire departments, public schools, police departments, water facilities, and dams (Table 4.3.23-7). Water treatment facilities and water suppliers are particularly vulnerable to hazardous material releases. If a hazardous materials release impacted one of these facilities, the effects could be widespread depending on the service area of each entity. In total, approximately 70 percent of all identified critical facilities are vulnerable to hazardous materials release.

Table 4.3.24-7 Vulnerability of critical facilities to hazardous materials release.		
TYPE	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF STRUCTURES BY TYPE**
Agricultural	242	88%
Banking	3	100%
Commercial	25	93%
Communication	339	55%
Dam	1,417	41%
Education (colleges and universities)	131	82%
Education (public schools)	2,465	78%
Emergency Operation Center	64	93%
Energy	28	51%
Fire Station	2,349	87%
Government	22	88%
Hospitals	296	87%
National Monuments or Icon	4	67%
Nuclear	4	80%
Police Station	1,094	88%

Table 4.3.24-7 Vulnerability of critical facilities to hazardous materials release.		
TYPE	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF STRUCTURES BY TYPE**
Transportation	57	76%
Water	1,222	68%
TOTAL	**9,762**	**70%**

A total of 9,762 critical facilities were identified in areas at high risk to hazardous material release. The total replacement cost of these critical facilities is estimated to be nearly $140 billion, or 72 percent of the total value of all critical facilities in the Commonwealth. Not all facilities will experience equal losses in the case of a hazardous material release. Losses will depend on the magnitude of the spill and the type of facility. For example, losses may be higher for a water supply facility where multiple municipalities depend on a contaminated source.

4.3.24.7. Jurisdictional Vulnerability Assessment and Loss Estimation

The vulnerability of a community and the environment to a spill or release of an extremely hazardous substance at a facility or from a transportation accident depends on many variables. These include: the specific chemical, the extent of the spill or release, the proximity of waterways, and the number of people residing in a radius from the facility or accident location that can reasonably be expected to be adversely affected.

Furthermore, the vulnerability of a community and the environment to a hazardous material release from a transportation incident is directly related to several specific variables; namely the mode and class of transportation. Each mode is further subject to several categories of hazard. Each mode of transportation (truck/highway, aircraft, rail, watercraft, or pipeline) has separate and distinct factors affecting the vulnerability. Transportation carriers must have response plans in place to address accidents, otherwise the local emergency response team will step-in to secure and restore the area. Quick response minimizes the volume and concentration of hazardous materials that disperse through air, water, and soil.

All types of population are evaluated in determining the population at risk within the radius of vulnerability including hospitals, schools, homes for the elderly, and critical infrastructure facilities. There are more than 3,800 facilities in Pennsylvania included on the EPA's TRI and that store extremely hazardous substances. Populations in communities that contain these facilities are more vulnerable to facility releases, particularly those within 1.5 miles of a given facility. Jurisdictions within one-quarter mile of major highways and railways are considered more vulnerable in the event of a transportation incident involving hazardous materials. Note that there is some overlap among these vulnerable jurisdictions. For example, an individual that lives within 1.5 miles of a hazardous materials site may also live within one-quarter mile of a major road.

To determine jurisdictional vulnerability to hazardous materials release, GIS analysis was conducted to identify all census blocks with centers located in areas characterized by high risk of hazardous material release. As previously defined, high-risk areas are those within one-quarter mile of major Interstates, U.S. highways, state highways, and rail lines, and areas within 1.5 miles of hazardous materials sites identified in Hazus. The total population and buildings within these census blocks were summed by county to determine the total vulnerable population and the total number and value of vulnerable buildings. Table 4.3.23-8 shows the results of this assessment.

Table 4.3.24-8 Vulnerability of people and buildings vulnerable to hazardous material release.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Adams	51,617	20,582	$5,724,742	55%
Allegheny	826,790	343,143	$115,010,066	71%
Armstrong	38,248	17,962	$4,114,229	63%
Beaver	102,446	44,382	$12,140,220	63%
Bedford	20,394	9,884	$2,112,790	47%
Berks	296,615	107,519	$32,950,359	#N/A
Blair	79,338	34,076	$9,110,695	70%
Bradford	28,245	11,990	$3,069,268	54%
Bucks	374,522	136,639	$51,423,037	63%
Butler	94,690	39,794	$12,783,073	60%
Cambria	86,589	40,139	$10,666,209	67%
Cameron	3,585	2,372	$591,511	66%
Carbon	37,332	17,190	$3,833,103	52%
Centre	93,780	29,405	$10,064,462	63%
Chester	324,214	115,239	$46,740,076	68%
Clarion	21,670	9,390	$2,386,682	58%
Clearfield	47,136	21,937	$5,051,148	65%
Clinton	24,895	9,785	$2,374,185	63%
Columbia	44,702	17,445	$4,912,291	69%
Crawford	43,429	20,402	$5,445,285	57%
Cumberland	143,008	55,313	$18,455,228	65%
Dauphin	173,599	68,906	$22,125,720	68%
Delaware	412,818	145,995	$49,693,720	73%
Elk	25,183	12,107	$3,114,477	75%
Erie	221,107	84,173	$24,620,294	81%
Fayette	77,123	34,218	$7,626,129	61%
Forest	1,576	1,656	$238,487	18%
Franklin	75,773	31,175	$7,816,513	54%
Fulton	5,101	2,547	$501,473	37%
Greene	14,201	5,346	$1,312,652	38%

Table 4.3.24-8 Vulnerability of people and buildings vulnerable to hazardous material release.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Huntingdon	19,260	8,118	$1,649,963	39%
Indiana	47,206	18,413	$4,911,403	59%
Jefferson	27,396	12,725	$2,936,672	64%
Juniata	10,823	4,681	$1,019,712	48%
Lackawanna	169,732	66,213	$20,515,847	80%
Lancaster	355,308	132,090	$39,753,909	73%
Lawrence	56,751	25,263	$6,350,750	69%
Lebanon	91,213	35,926	$10,141,874	71%
Lehigh	277,893	100,153	$32,438,124	81%
Luzerne	236,730	101,801	$27,082,431	77%
Lycoming	75,220	31,134	$8,219,646	69%
McKean	29,238	13,042	$3,309,470	71%
Mercer	75,775	32,813	$9,518,610	73%
Mifflin	25,600	11,691	$2,649,103	61%
Monroe	52,116	21,864	$6,165,515	32%
Montgomery	597,831	214,133	$87,965,971	77%
Montour	12,013	5,126	$1,364,537	74%
Northampton	228,794	86,522	$25,978,567	78%
Northumberland	71,830	33,487	$7,636,910	80%
Perry	15,922	7,099	$1,581,340	38%
Philadelphia	1,331,048	462,599	$147,342,883	89%
Pike	8,164	6,034	$1,407,417	17%
Potter	6,943	4,146	$986,304	41%
Schuylkill	106,901	49,840	$11,732,657	75%
Snyder	19,395	7,837	$2,077,247	56%
Somerset	38,052	17,974	$4,157,019	53%
Sullivan	2,348	1,814	$323,918	32%
Susquehanna	15,156	7,291	$1,580,894	38%
Tioga	18,641	8,241	$1,951,123	48%
Union	23,120	8,920	$2,447,950	60%
Venango	34,147	16,301	$3,633,790	63%
Warren	24,739	12,184	$3,010,809	63%
Washington	122,761	54,079	$14,464,833	61%
Wayne	12,786	6,429	$1,443,048	23%
Westmoreland	238,377	107,485	$28,142,300	68%
Wyoming	10,807	5,017	$1,094,544	41%

Table 4.3.24-8 Vulnerability of people and buildings vulnerable to hazardous material release.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
York	261,259	103,672	$30,933,011	65%
TOTAL	**8,541,021**	**3,332,868**	**1,033,928,225**	**70%**

Using the methodology defined above, all 67 counties were identified as having population and buildings vulnerable to hazardous material releases. Throughout the Commonwealth, more than 8.5 million people have been identified as vulnerable to hazardous material release. The counties with the largest vulnerable populations include Philadelphia, Allegheny, Montgomery, Delaware, Bucks, and Lancaster Counties.

Jurisdictional losses from hazardous material releases come from damage to buildings and infrastructure, as well as the cost of cleanup. In terms of building exposure, Philadelphia is also the most threatened by hazardous materials releases with 462,599 exposed buildings valued at approximately $147 billion (Table 4.3.24-8). Allegheny County is the second-most threatened jurisdiction in with 343,572 potentially impacted buildings valued at approximately $115 billion. Forest County is least threatened by hazardous materials releases with 1,656 exposed buildings value at nearly $240 million, which represents only 18 percent of the total value of all buildings in the County. The assessment reveals that much of the Commonwealth is vulnerable to hazardous material release with 70 percent of the total value of all buildings in Pennsylvania at risk.

PEMA assigned chemical facility ratings and transportation threat ratings for counties in Pennsylvania in its 2007 Hazardous Material Emergency Response Preparedness Report. In the report, four counties in Pennsylvania were assigned a “high” chemical facility rating and fourteen counties were assigned a “high” transportation threat rating. This information is included in Table 4.3.24-9. More recent chemical and transportation threat ratings are not currently available. In addition, PEMA maintains a list of how many emergency response teams are in each county in Pennsylvania. Allegheny has five teams while all other counties have one or two teams. Counties with fewer response teams could result in increased vulnerability due reduced response capabilities.

Table 4.3.24-9 Pennsylvania County Chemical Facility and Transportation Threat Ratings (PEMA, 2007a)			
COUNTY	CHEMICAL FACILITY RATING	TRANSPORTATION THREAT RATING	NO. OF EMERGENCY RESPONSE TEAMS
Adams	Moderate	Moderate	1
Allegheny	High	High	5
Armstrong	Moderately Low	Moderate	1
Beaver	High	High	1

Table 4.3.24-9 Pennsylvania County Chemical Facility and Transportation Threat Ratings (PEMA, 2007a)

COUNTY	CHEMICAL FACILITY RATING	TRANSPORTATION THREAT RATING	NO. OF EMERGENCY RESPONSE TEAMS
Bedford	Significant	Significant	1
Berks	Moderate	Significant	1
Blair	Moderate	Not Provided	1
Bradford	Low to High	Low	1
Bucks	Low	Moderate	1
Butler	Low to Moderate	Moderate	1
Cambria	Low to Moderate	Low to Moderate	1
Cameron	Moderate	Low	1
Carbon	N/A	N/A	N/A
Centre	Significant	Significant	1
Chester	Low to Moderate	Moderate to High	1
Clarion	Moderate	Moderate to Significant	1
Clearfield	Significant	Significant	1
Clinton	Significant	Significant	1
Columbia	Low to Moderate	Low to Moderate	1
Crawford	Low	Moderate	1
Cumberland	Low to Moderate	High	1
Dauphin	Low	Moderate	1
Delaware	Significant	Significant	1
Elk	Moderate	Moderate	1
Erie	Moderate	High	1
Fayette	Significant	Significant	1
Forest	No Threat	Moderate	1
Franklin	Moderate	Not Provided	1
Fulton	Low	High	1
Greene	Low	Moderate	1
Huntingdon	Low to Moderate	High	1
Indiana	Low to Significant	Moderate	1
Jefferson	Not Provided	High	2
Juniata	Moderate	High	1
Lackawanna	N/A	N/A	N/A
Lancaster	Significant	Significant	1
Lawrence	Not Provided	Not Provided	1
Lebanon	Not Provided	High	1
Lehigh	Moderate	Moderate	1

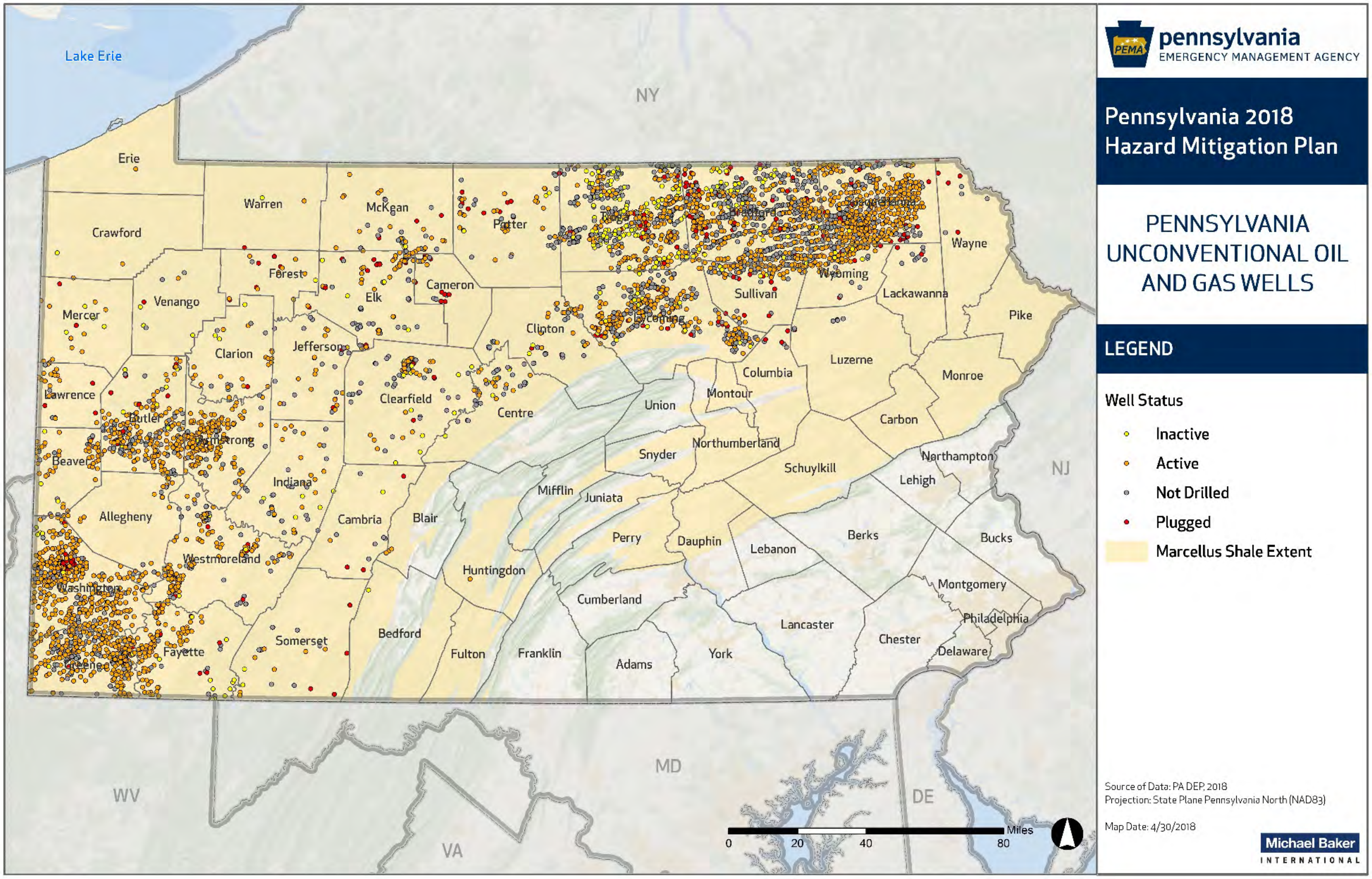
Table 4.3.24-9 Pennsylvania County Chemical Facility and Transportation Threat Ratings (PEMA, 2007a)			
COUNTY	CHEMICAL FACILITY RATING	TRANSPORTATION THREAT RATING	NO. OF EMERGENCY RESPONSE TEAMS
Luzerne	Low	High	2
Lycoming	Low to Moderate	Moderate	1
McKean	Moderate	Moderate	1
Mercer	Low	High	1
Mifflin	Not Provided	Not Provided	1
Monroe	Moderate	Significant	1
Montgomery	High	High	1
Montour	Low to Moderate	Moderate	2
Northampton	Moderate to Significant	Significant	1
Northumberland	High	Moderate	1
Perry	Low to Moderate	Moderate	1
Philadelphia	Not Provided	Not Provided	2
Pike	Low	Moderate	1
Potter	Not Provided	Moderate	1
Schuylkill	Moderate	Moderate	1
Snyder	Not Provided	Not Provided	1
Somerset	Moderate	Moderate	1
Sullivan	Moderate	Not Provided	1
Susquehanna	Low to Moderate	Not Provided	1
Tioga	Moderate	High	1
Union	Significant	Significant	2
Venango	Low	High	1
Warren	Moderate	Moderately High	1
Washington	N/A	N/A	N/A
Wayne	Low	Low	1
Westmoreland	Moderate	Moderate	1
Wyoming	Low	Low	1
York	Moderate	Moderate to High	1

4.3.25. Environmental Hazard – Unconventional Wells

4.3.25.1. Location and Extent

The Pennsylvania Department of Environmental Protection (PA DEP) defines unconventional wells as wells drilled deep into shale rock formations found thousands of feet underground. These formations, mainly Marcellus Shale and Utica Shale, contain and produce natural gas. These wells use horizontal drilling techniques that use large quantities of high-pressured water, approximately one to eight million gallons, mixed with sand and other additives including hydrochloric and muriatic acid, to hydraulically fracture the rock. This practice is more commonly known as fracking (PA DEP, 2017). This type of extraction presents new and unique challenges and hazards in the Commonwealth. Approximately 20,000 permits have been issued for unconventional oil and gas well drilling to date in Pennsylvania, skyrocketing in the years 2009 to 2014. However, the number of permits for unconventional well drilling decreased 59 percent in 2016 from 2014, with 1321 permits from 3182 permits (PA DEP, 2017). Table 4.3.25-1 depicts the presence of Marcellus Shale in 58 of the 67 Commonwealth counties. The Marcellus Shale formation underlies more than 75 percent of Pennsylvania as illustrated in Figure 4.3.25-1.

Figure 4.3.25-1 Unconventional Oil and Gas Well Locations and the location in Pennsylvania (PA DEP, 2018).



Since the 2010 Hazard Mitigation Plan, Marcellus Shale related natural gas extraction has become widespread throughout the Commonwealth. It should be noted that the number of unconventional well permits issued is not an indication of the number of unconventional wells drilled. Wells are permitted a minimum of several months prior to construction, and some permitted wells are never drilled.

Table 4.3.25-1 Number of unconventional well permits issued and unconventional wells drilled to 2018 in Pennsylvania counties (PASDA, 2018).

COUNTY	MARCELLUS SHALE FORMATION PRESENT	# OF UNCONVENTIONAL PERMITS ISSUED	# OF ACTIVE UNCONVENTIONAL DRILLED WELLS
Adams	No	0	0
Allegheny	Yes	325	198
Armstrong	Yes	464	289
Beaver	Yes	322	150
Bedford	Yes	2	0
Berks	Yes	0	0
Blair	Yes	9	6
Bradford	Yes	3,853	1,233
Bucks	No	0	0
Butler	Yes	1,100	580
Cambria	Yes	25	2
Cameron	Yes	145	64
Carbon	Yes	0	0
Centre	Yes	202	34
Chester	No	0	0
Clarion	Yes	128	42
Clearfield	Yes	456	104
Clinton	Yes	198	77
Columbia	Yes	18	
Crawford	Yes	10	2
Cumberland	Yes	0	0
Dauphin	Yes	0	0
Delaware	No	0	0
Elk	Yes	442	164
Erie	Yes	1	1
Fayette	Yes	470	292
Forest	Yes	67	19
Franklin	Yes	0	0
Fulton	Yes	0	0
Greene	Yes	2,507	1,443
Huntingdon	Yes	3	1

Table 4.3.25-1 Number of unconventional well permits issued and unconventional wells drilled to 2018 in Pennsylvania counties (PASDA, 2018).			
COUNTY	**MARCELLUS SHALE FORMATION PRESENT**	**# OF UNCONVENTIONAL PERMITS ISSUED**	**# OF ACTIVE UNCONVENTIONAL DRILLED WELLS**
Indiana	Yes	125	41
Jefferson	Yes	190	47
Juniata	Yes	0	0
Lackawanna	Yes	29	0
Lancaster	No	0	0
Lawrence	Yes	208	58
Lebanon	Yes	0	0
Lehigh	No	0	0
Luzerne	Yes	15	0
Lycoming	Yes	1,947	910
McKean	Yes	309	120
Mercer	Yes	110	53
Mifflin	Yes	0	0
Monroe	Yes	0	0
Montgomery	No	0	0
Montour	Yes	0	0
Northampton	Yes	0	0
Northumberland	Yes	0	0
Perry	Yes	0	0
Philadelphia	No	0	0
Pike	Yes	0	0
Potter	Yes	327	88
Schuylkill	Yes	0	0
Snyder	Yes	0	0
Somerset	Yes	59	18
Sullivan	Yes	437	155
Susquehanna	Yes	2,846	1,544
Tioga	Yes	1,641	958
Union	Yes	0	0
Venango	Yes	22	1
Warren	Yes	20	1
Washington	Yes	3,279	1,911
Wayne	Yes	21	0
Westmoreland	Yes	627	346
Wyoming	Yes	591	254
York	No	0	0
	Total	**24,029**	**11,056**

4.3.25.2. Range of Magnitude

Unconventional well drilling has introduced a new set of hazards to the oil and gas industry in addition to the normal risks associated with the industry. The fluid or "frac fluid" that is recovered from this process must be properly treated as the water quality is very poor. It's extremely saline and can be three to six times as salty as sea water. Other contaminants can include barium, bromine, lithium strontium, sulfate, ammonium and very high concentrations of total dissolved solids (TDS). There is also some concern about normally occurring radioactive materials (NORMS) present in shale and potentially present in recovered drilling fluid but there is very little data available on the radioactivity of frac fluid in Pennsylvania (Kirby, 2010).

Currently there is no known technology to treat water with this level of salinity (Vidic, 2010), but research is underway. High levels of TDSs, though not harmful to humans, can be extremely harmful to aquatic life and can damage industrial equipment. Often recovered frac fluid is stored in earthen impoundments and after treatment is taken to a sewage treatment facility. There is concern surrounding the toxic solid waste that remains after frack fluid is treated.

In addition to the traditional hazards associated with oil and gas well drilling, potential impacts from Marcellus Shale gas well drilling include:

- Surface water depletion from high consumptive use with low return rates affecting drinking water supplies, and aquatic ecosystems and organisms.
- Contaminated surface and groundwater resulting from hydraulic fracturing and the recovery of contaminated hydraulic fracturing fluid.
- Mishandling of solid toxic waste.

In a report compiled by Penn Environment, several environmental and public health violations were found from fracking. For example, in 2014, a tank exploded and spilled approximately 3,000 gallons of frac fluid onto the well pad and surrounding soil. Between 2007 to 2016, there have been approximately 300 cases of drinking water contamination. River pollution was also found from fracking (Penn Environment, 2017). In 2011, an accident in Bradford County poured frac fluid into a local stream that flowed into the Susquehanna River. Studies are still underway to determine the true impact of the accident.

In 2010, the worst environmental disaster in United States history was and can be attributed to oil well drilling and extraction. British Petroleum's (BP) Deepwater Horizon oil rig, located in the Gulf of Mexico off the coast of Louisiana, began leaking millions of gallons of oil into the ocean after an explosion occurred at the site on April 20, 2010 killing 11 workers. The resulting environmental and economic impacts have been devastating to the region.

4.3.25.3. Past Occurrence

There is no comprehensive database of unconventional oil and gas well incidents in Pennsylvania. However, major gas and oil well incidents in Pennsylvania are captured in PEMA's incident management system, PEMA-KC. An incident management system provides a centralized communication platform for state and local agencies engaged in incident response, allowing for more effective cross-agency and cross-jurisdictional collaboration. Incidents entered into the system typically involve responses from multiple organizations within a single jurisdiction; responses from organizations outside the jurisdiction in which the incident occurred; and/or significant public health, environmental, or economic effects with regional or national implications. For this plan update, PEMA-KC data for all gas and oil well incidents were available from June 2014 to March 2018; PEMA-KC does not differentiate between conventional and unconventional wells, and 119 major gas and oil well incidents were recorded in 28 counties. Many of these incidents occurred in the western part of the state (Table 4.3.25-2). Twenty nine percent of documented events were categorized as fire and 54 percent were categorized as Hazardous Materials.

Table 4.3.25-2 Number of gas and oil well incidents per county by year between 2013 to 2018 (PEMA-KC, 2018)

COUNTY	2013	2014	2015	2016	2017	2018	TOTAL
Adams	0	0	0	0	0	0	**0**
Allegheny	0	0	3	0	0	0	**3**
Armstrong	0	1	0	0	0	0	**1**
Beaver	0	0	0	0	0	0	**0**
Bedford	0	0	0	0	0	0	**0**
Berks	0	1	0	0	0	0	**1**
Blair	0	0	0	0	0	0	**0**
Bradford	2	3	0	0	0	0	**5**
Bucks	0	0	0	0	0	0	**0**
Butler	0	1	0	0	0	0	**1**
Cambria	0	0	1	1	0	0	**2**
Cameron	0	0	0	1	0	0	**1**
Carbon	0	0	0	0	0	0	**0**
Centre	0	0	0	0	0	0	**0**
Chester	0	0	0	0	0	0	**0**
Clarion	0	0	1	1	0	0	**2**
Clearfield	0	0	0	1	0	0	**1**
Clinton	0	0	0	1	0	0	**1**
Columbia	0	0	0	0	0	0	**0**
Crawford	0	0	0	1	0	0	**1**
Cumberland	0	0	0	0	0	0	**0**
Dauphin	0	0	0	0	0	0	**0**
Delaware	0	0	0	0	0	0	**0**
Elk	0	0	0	0	0	0	**0**
Erie	2	0	2	1	0	1	**6**
Fayette	1	1	0	0	0	0	**2**
Forest	1	0	0	0	0	0	**1**
Franklin	0	0	0	0	0	0	**0**
Fulton	0	0	0	0	0	0	**0**
Greene	1	4	2	1	5	1	**14**
Huntingdon	0	0	0	1	0	0	**1**

Table 4.3.25-2 Number of gas and oil well incidents per county by year between 2013 to 2018 (PEMA-KC, 2018)							
COUNTY	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**TOTAL**
Indiana	0	0	0	0	0	0	**0**
Jefferson	2	0	0	1	1	0	**4**
Juniata	0	0	0	0	0	0	**0**
Lackawanna	0	0	0	0	0	0	**0**
Lancaster	0	0	0	0	0	0	**0**
Lawrence	0	0	0	0	0	0	**0**
Lebanon	0	0	0	0	0	0	**0**
Lehigh	0	0	0	0	0	0	**0**
Luzerne	0	0	0	0	0	0	**0**
Lycoming	0	0	0	0	0	0	**0**
McKean	2	0	0	0	0	0	**2**
Mercer	0	3	0	1	0	0	**4**
Mifflin	0	0	0	0	0	0	**0**
Monroe	0	0	0	0	0	0	**0**
Montgomery	0	0	0	0	0	0	**0**
Montour	0	0	0	0	0	0	**0**
Northampton	0	0	0	0	0	0	**0**
Northumberland	0	0	0	0	0	0	**0**
Perry	0	0	0	0	0	0	**0**
Philadelphia	0	0	0	1	0	0	**1**
Pike	0	0	0	0	0	0	**0**
Potter	0	0	1	2	0	0	**3**
Schuylkill	0	0	0	0	0	0	**0**
Somerset	0	0	1	0	1	0	**2**
Snyder	0	0	0	0	0	0	**0**
Sullivan	0	0	0	0	0	0	**0**
Susquehanna	1	7	0	1	0	2	**11**
Tioga	0	0	3	1	0	0	**4**
Union	0	0	0	0	0	0	**0**
Venango	0	0	2	0	0	0	**2**
Warren	0	0	2	0	1	0	**3**
Washington	4	6	5	3	2	1	**21**
Wayne	0	0	0	0	0	0	**0**
Westmoreland	3	1	7	1	0	0	**12**
Wyoming	3	3	1	0	0	0	**7**
York	0	0	0	0	0	0	**0**
Total	**22**	**31**	**31**	**20**	**10**	**5**	**119**

4.3.25.4. Future Occurrence

As is the case with conventional wells, it remains difficult to predict the number or frequency of unconventional well site incidents. Based on the short history of past occurrence, Pennsylvania should expect multiple incidences to occur annually. However, the number of unconventional wells in Pennsylvania has stabilized in recent years, as opposed to the explosive growth of this industry seen in 2009-2010. As the number of oil and gas wells remains steady moving forward, the probability of occurrence is likely to stabilize, though it remains high.

4.3.25.5. Environmental Impacts

There are serious water contamination and pollution concerns associated with unconventional oil and gas wells like Marcellus and Utica Shale wells. Additional potential environmental impacts of Marcellus Shale play drilling include surface water depletion and the accompanying damage to aquatic ecosystems; contaminated surface, groundwater, and soil resulting from hydraulic fracturing; the recovery of contaminated hydraulic fracturing fluid, and solid toxic waste produced from treatment. The overall environmental impacts of unconventional oil and gas wells are still being uncovered, as the industry is still new and environmental impacts continue to be studied.

On a much larger scale, American Rivers, a leading national river conservation organization, placed two of Pennsylvanian's rivers on the list of the top ten Most Endangered Rivers in America. Number one on the list is the Upper Delaware River and the Monongahela River is listed as number seven. Both rivers are listed as threatened by natural gas extraction specifically related to Marcellus Shale. Combined these water bodies supply drinking water to more than 17 million people.

4.3.25.6. State Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to unconventional wells, all structures located within 1000 yards of active, inactive, or unplugged wells in were identified. The area impacted by an incident will depend on the well, the nature of the incident, and atmospheric conditions. For this assessment, however, 1000 yards was selected as a representative distance within which death, injury, or significant property damage could occur. In addition, the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 2878, or 64.5 percent, are located within 1000 yards of an unconventional well (Table 4.3.25-3). These facilities have a combined replacement value of more than $1.4 billion, or approximately 38 percent of the known value of geolocated state facilities.

Table 4.3.25-3 Vulnerability of state facilities to unconventional wells

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	7	78%

Table 4.3.25-3 Vulnerability of state facilities to unconventional wells		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Department of Banking and Securities	1	50%
State Civil Service Commission	1	100%
Department of Community and Economic Development	2	50%
Department of Agriculture	9	56%
Department of Conservation and Natural Resources	1	50%
Department of Corrections	405	58%
Department of Education	1	100%
Department of Environmental Protections	9	69%
Department of General Services	59	45%
Department of Health	35	73%
Department of Labor and Industry	40	58%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	58	59%
Department of Revenue	7	70%
Department of Transportation	1317	78%
Drug and Alcohol Programs	0	0%
Executive Offices	1	50%
Fish and Boat Commission	86	56%
Governor's Office	1	100%
Insurance Department	0	0%
Liquor Control Board	412	75%
Emergency Management Agency	7	88%
Historical and Museum Commission	21	70%
State Police	23	64%
Public School Employees' Retirement System	2	33%
State Department	0	0%
State Employees' Retirement System	1	25%
Thaddeus Stevens College of Technology	20	100%
Treasury	2	100%
State System of Higher Education	350	41%
Total	**2878**	**64.5%**

There are 6,278 vulnerable critical facility structures in a high-risk area (Table 4.3.21-4). Of the Commonwealth’s total number of structures, 46 percent of the buildings are vulnerable to risks associating with unconventional wells, resulting in $88,529,665,186 in replacement value.

Table 4.3.25-4 Vulnerability of critical facilities to unconventional wells		
TYPE	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF TOTAL STRUCTURES BY TYPE**
Agricultural	152	55%
Banking	2	67%
Commercial	18	67%
Communication	160	26%
Dam	848	25%
Education (colleges and universities)	82	52%
Education (public schools)	1,379	43%
Emergency Operation Center	49	71%
Energy	15	27%
Fire Station	1,698	63%
Government	6	24%
Hospital	162	47%
National Monuments or Icons	1	17%
Nuclear	0	0%
Police Station	829	67%
Transportation	43	57%
Water	834	46%
Total	**6,278**	**45%**

4.3.25.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to unconventional wells risk, all census blocks with centroid within 1000 yards of active or abandoned unconventional wells were identified. The population, building counts, and building value of all vulnerable census blocks were then aggregated to the county scale. The counties with the highest vulnerable population are Westmoreland, Greene, Bradford, Butler, and Washington.

Table 4.3.25-5 Vulnerability of people and buildings to unconventional wells				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $**	**PERCENT OF TOTAL COUNTY BUILDING VALUE**
Adams	0	0	$0	0%
Allegheny	6,769	3,039	$705,739	0%
Armstrong	10,577	4,722	$1,045,967	16%
Beaver	6,611	2,898	$671,759	3%
Bedford	67	21	$2,650	0%
Berks	0	0	$0	0%
Blair	255	110	$15,030	0%
Bradford	16,643	7,886	$1,204,177	21%
Bucks	0	0	$0	0%

Table 4.3.25-5 Vulnerability of people and buildings to unconventional wells				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Butler	22,217	9,702	$2,184,345	10%
Cambria	943	393	$80,732	1%
Cameron	0	4	$845	0%
Carbon	0	0	$0	0%
Centre	178	118	$27,122	0%
Chester	0	0	$0	0%
Clarion	672	329	$49,353	1%
Clearfield	444	286	$40,489	1%
Clinton	21	54	$7,738	0%
Columbia	49	24	$3,417	0%
Crawford	229	100	$17,158	0%
Cumberland	0	0	$0	0%
Dauphin	0	0	$0	0%
Delaware	0	0	$0	0%
Elk	402	300	$64,317	2%
Erie	194	93	$12,439	0%
Fayette	14,107	6,246	$1,000,795	8%
Forest	75	265	$34,120	3%
Franklin	0	0	$0	0%
Fulton	68	34	$4,871	0%
Greene	15,124	5,800	$1,190,331	35%
Huntingdon	20	22	$2,801	0%
Indiana	1,451	638	$125,031	2%
Jefferson	1,033	507	$79,139	2%
Juniata	0	0	$0	0%
Lackawanna	212	79	$15,828	0%
Lancaster	0	0	$0	0%
Lawrence	1,602	679	$104,709	1%
Lebanon	0	0	$0	0%
Lehigh	0	0	$0	0%
Luzerne	237	105	$19,935	0%
Lycoming	5,245	2,669	$500,380	4%
McKean	84	96	$12,978	0%
Mercer	1,255	515	$124,159	1%
Mifflin	0	0	$0	0%
Monroe	0	0	$0	0%
Montgomery	0	0	$0	0%

Table 4.3.25-5 Vulnerability of people and buildings to unconventional wells				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Montour	0	0	$0	0%
Northampton	0	0	$0	0%
Northumberland	0	0	$0	0%
Perry	0	0	$0	0%
Philadelphia	0	0	$0	0%
Pike	0	0	$0	0%
Potter	487	356	$54,292	2%
Schuylkill	0	0	$0	0%
Somerset	473	261	$48,313	1%
Snyder	0	0	$0	0%
Sullivan	1,481	1,336	$205,320	20%
Susquehanna	13,862	6,872	$1,143,810	28%
Tioga	8,881	4,317	$661,126	16%
Union	0	0	$0	0%
Venango	274	115	$16,734	0%
Warren	98	111	$18,675	0%
Washington	29,327	13,254	$2,755,992	12%
Wayne	115	73	$12,317	0%
Westmoreland	14,576	6,920	$1,641,346	4%
Wyoming	3,923	1,754	$340,699	13%
York	0	0	$0	0%
Total	**180,213**	**83,069**	**16,242,107**	**1%**

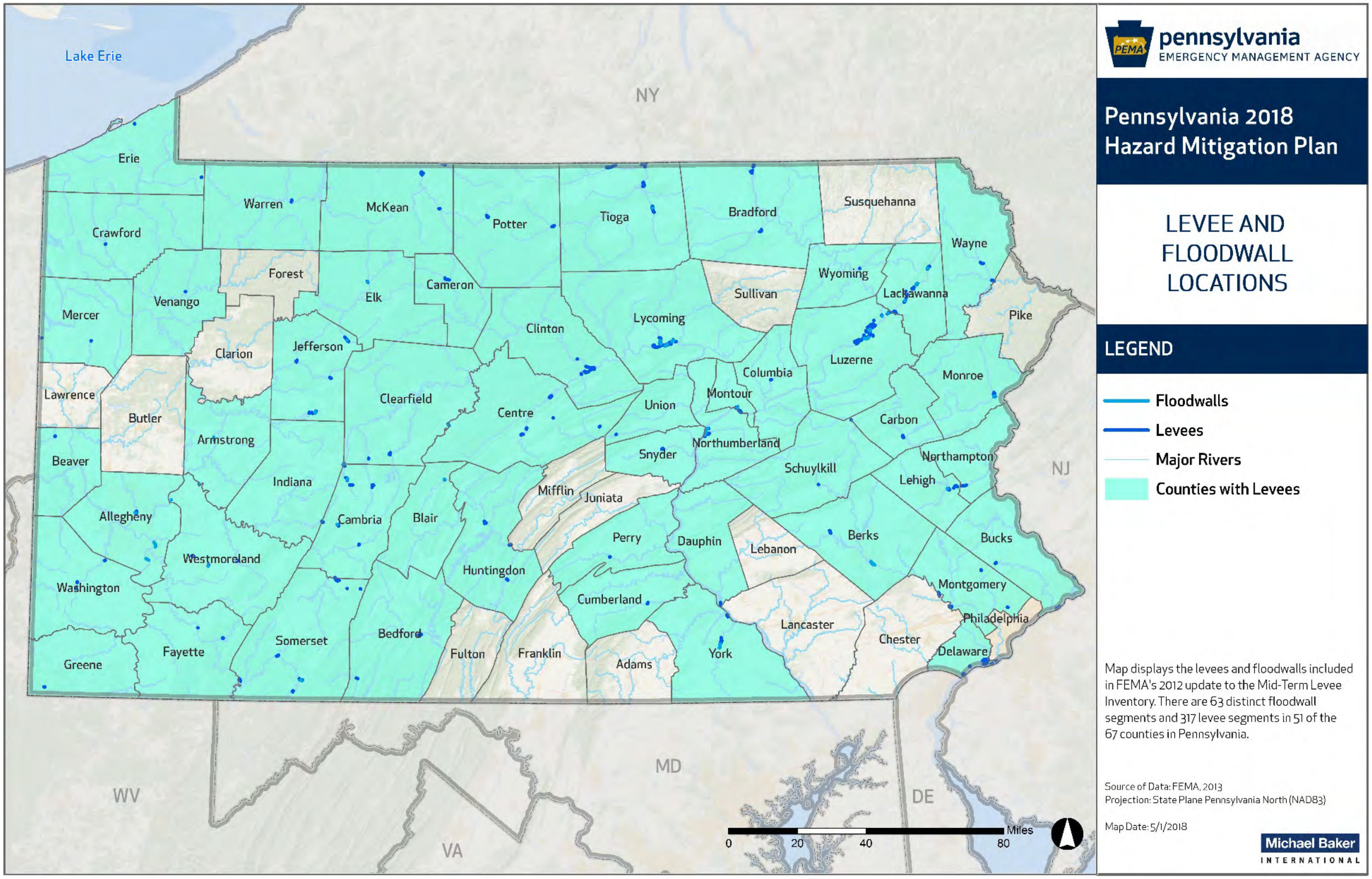
4.3.26. Levee Failure

4.3.26.1. Location and Extent

FEMA completed an inventory of all known levees across Pennsylvania in 2009 with an update in 2012, known as the Mid-Term Levee Inventory (MLI). This is the most recent comprehensive levee inventory that is available at this time. The MLI contains levee data gathered for structures designed to protect from the 1%-annual-chance flood event. The area behind a maintained and certified levee that is designed to protect from a 1%-annual-chance flood is called a Levee Protected Area. Although the MLI also frequently includes levees that were not designed to protect against this base flood, it does not include every levee in every county – especially small levees and agricultural levees not engineered or accreditable to the 1%-annual-chance event (FEMA-Region III, 2012). FEMA's inventory was compiled using all effective Flood Insurance Rate Maps and Flood Insurance Study reports in Pennsylvania, the USACE levee inventory, the DEP's Flood Control Project summaries, information from local governments, aerial photography, and additional information such as news articles and websites.

A total of 317 levee segments and 63 floodwall segments levees have been identified throughout Pennsylvania via the MLI, with at least one levee in 51 of 67 counties (FEMA-Region III, 2012). Figure 4.3.26-1 shows the locations of the levees and floodwalls as identified in the MLI. Note that levees generally protect small areas that may not be able to be seen on the map. As shown in the map, the distribution of these systems is relatively scattered throughout the Commonwealth with many having been constructed in more populated areas to protect property and structures from flood events. Particularly extensive levee systems have been built in the Scranton Wilkes-Barre area in Luzerne and Lackawanna Counties; Lycoming County also has a significant amount of levee systems.

Figure 4.3.26-1 Levee and Floodwall Locations in Pennsylvania (FEMA, 2012).



In the event of a levee failure, flood waters will ultimately inundate the protected area landward of the levee. The extent of inundation is dependent on the flooding intensity. Failure of a levee during a 1%-annual-chance flood will inundate the approximate 100-year flood plain previously protected by the levee. Residential and commercial buildings located nearest the levee overtopping or breach location will suffer the most damage from the initial embankment failure flood wave. Landward buildings will be damaged by inundation.

Levees require maintenance to continue to provide the level of protection for which they were designed and built. Maintenance and operational responsibilities, referred to as sponsorship, belong to a variety of entities including local, state, and federal government and private land owners. Table 4.3.26-1 shows the entity responsible for constructing, operating, and maintaining levee systems as reported by the number of levee miles per county. This information was obtained from the National Levee Database (NLD) maintained by the USACE.

Table 4.3.26-1 Sponsorship of Levee Systems by County (NLD, 2018)

COUNTY	LOCALLY CONSTRUCTED, LOCALLY OPERATED & MAINTAINED (MILES)	USACE CONSTRUCTED & USACE OPERATED (MILES)	USACE CONSTRUCTED, TURNED OVER TO PUBLIC SPONSOR OPERATIONS & MAINTENANCE (MILES)	TOTAL (MILES)
Adams	0.00	0.00	0.00	0.00
Allegheny	0.46	0.00	0.97	1.43
Armstrong	0.00	0.00	0.87	0.87
Beaver	0.35	0.00	0.00	0.35
Bedford	2.06	0.00	0.00	2.06
Berks	0.00	0.00	0.00	0.00
Blair	0.00	0.00	0.00	0.00
Bradford	1.33	0.00	0.00	1.33
Bucks	0.74	0.00	0.00	0.74
Butler	0.00	0.00	0.00	0.00
Cambria*	4.31	1.39	0.35	6.05
Cameron	0.00	0.00	0.00	0.00
Carbon	0.9	0.00	0.00	0.90
Centre*	0.65	0.00	0.00	0.65
Chester	0.00	0.00	0.00	0.00
Clarion	0.00	0.00	0.00	0.00
Clearfield	1.13	0.00	0.46	1.59
Clinton	0.00	0.00	6.57	6.57
Columbia	0.00	0.00	0.00	0.00
Crawford	0.00	0.00	0.00	0.00
Cumberland	0.00	0.00	0.00	0.00

Table 4.3.26-1 Sponsorship of Levee Systems by County (NLD, 2018)

COUNTY	LOCALLY CONSTRUCTED, LOCALLY OPERATED & MAINTAINED (MILES)	USACE CONSTRUCTED & USACE OPERATED (MILES)	USACE CONSTRUCTED, TURNED OVER TO PUBLIC SPONSOR OPERATIONS & MAINTENANCE (MILES)	TOTAL (MILES)
Dauphin	0.00	0.00	0.00	0.00
Delaware	0.00	0.00	0.65	0.65
Elk	0.00	0.00	0.46	0.46
Erie	0.00	0.00	0.00	0.00
Fayette	0.00	0.00	0.00	0.00
Forest	0.00	0.00	0.00	0.00
Franklin	0.00	0.00	0.00	0.00
Fulton	0.00	0.00	0.00	0.00
Greene	0.45	0.00	0.00	0.45
Huntingdon	1.29	0.00	0.00	1.29
Indiana	0.96	0.00	0.00	0.96
Jefferson	3.16	2.79	0.00	5.95
Juniata	0.00	0.00	0.00	0.00
Lackawanna	3.15	0.00	5.93	9.08
Lancaster	0.00	0.00	0.00	0.00
Lawrence	0.00	0.00	0.00	0.00
Lebanon	0.00	0.00	0.00	0.00
Lehigh	0.14	0.00	0.85	0.99
Luzerne	1.27	0.00	16.02	17.29
Lycoming	0.00	0.00	13.78	13.78
McKean	1.61	0.00	0.00	1.61
Mercer	0.00	0.00	0.00	0.00
Mifflin	0.00	0.00	0.00	0.00
Monroe	3.02	0.00	0.00	3.02
Montgomery	0.18	0.00	0.00	0.18
Montour	4.44	0.00	0.00	4.44
Northampton	0.00	0.00	1.55	1.55
Northumberland	0.17	0.00	5.04	5.21
Perry	0.00	0.00	0.00	0.00
Philadelphia	0.00	0.00	0.00	0.00
Pike	0.00	0.00	0.00	0.00
Potter	1.53	0.00	0.00	1.53
Schuylkill	0.00	0.00	0.00	0.00
Snyder	0.00	0.00	0.00	0.00

Table 4.3.26-1 Sponsorship of Levee Systems by County (NLD, 2018)				
COUNTY	LOCALLY CONSTRUCTED, LOCALLY OPERATED & MAINTAINED (MILES)	USACE CONSTRUCTED & USACE OPERATED (MILES)	USACE CONSTRUCTED, TURNED OVER TO PUBLIC SPONSOR OPERATIONS & MAINTENANCE (MILES)	TOTAL (MILES)
Somerset	5.33	0.00	0.00	5.33
Sullivan	0.00	0.00	0.00	0.00
Susquehanna	0.00	0.00	0.00	0.00
Tioga	1.63	0.00	2.91	4.54
Union	0.00	0.00	0.00	0.00
Venango	0.00	0.00	0.17	0.17
Warren	0.64	0.00	0.00	0.64
Washington	0.16	0.00	0.05	0.21
Wayne	0.89	0.00	0.00	0.89
Westmoreland	1.42	0.00	0.00	1.42
Wyoming	0.00	0.00	0.00	0.00
York	0.00	7.35	0.00	7.35
Total	**43.37**	**11.53**	**56.63**	**111.53**
*Includes some levee systems that span 2 or more counties.				

Well-maintained levees may obtain certification through independent inspections. Levee owners need to both maintain levees and pay for an independent inspection to have the levee certified as providing flood protection. The impacts of an un-certified levee include levee failure and insurance rate increases as FEMA identifies that these structures are not designed to protect to the 1%-annual-chance flood height on Flood Insurance Rate Maps.

4.3.26.2. Range of Magnitude

Flood-related hazards due to levee failures range in magnitude including: overtopping, when the water-level rises over the top of the levee; back-ending, when water flows around the back of the levee, outside of the edge of the levee system; and total failure as seen during Hurricane Katrina. Levees are typically designed with three feet of freeboard to prevent overtopping, but older levees were not built to that standard (FEMA, 2016).

A levee failure causes flooding in landward areas adjacent to the levee system. The failure of a levee or other flood protection structure could be devastating depending on the level of flooding against which the structure is designed to protect and the amount of landward development present. In some instances, the magnitude of flooding could be more severe under a levee failure event compared to a normal flooding event. If an abrupt failure occurs, the rushing waters of a flood wave could result in catastrophic losses.

Properties located in the area of reduced-risk landward of a levee system are not subject to the mandatory flood insurance purchase requirement of the National Flood Insurance Program. Thus, regardless of whether a levee is accredited, there is concern that properties in these areas lack flood insurance. In the event of a failure, it is likely that inundated properties will not be insured.

The worst-case levee failure is one which occurs abruptly with little warning and results in deep, fast-moving flood waters through a highly-developed or highly-populated area. While any levee may be overtopped and fail, it is the levees with large and densely-populated protected areas that have the potential to cause the most damage. In 2011, during Tropical Storm Lee, the levee system in Wilkes-Barre effectively protected the City; if its levee and floodwall system had failed, the flood impact would have been much more severe.

4.3.26.3. Past Occurrence

There is no comprehensive list of levee failures in Pennsylvania, and historically few, if any, have been reported. However, in 2011, Tropical Storm Lee exceeded the design storm level for many levees in Pennsylvania. Tropical Storm Lee placed extreme stress on Pennsylvania’s levees since the event was relatively long in duration and the ground was already saturated from Hurricane Irene the week prior. In Sayre, the levee system was overtopped and the levee was back-ended. The pump station at Sayre also flooded during this event, compounding the effects of the overtopping. While there is not a comprehensive list, there are news reports of a small agricultural levee failure in Columbia County and some levee-related flood damage from the Chemung Levee in Athens, Bradford County. In the case of Athens, the Susquehanna rose much faster than expected, and the extreme pressure exerted by the swollen river caused damage to a 125-foot portion of the levee, damaging 300 homes. More recent accounts of levee failure in Pennsylvania have not been widely reported.

4.3.26.4. Future Occurrence

Similar to dam failures, given certain circumstances, a levee failure can occur at any time. However, the probability of future occurrence can be reduced through proper design, construction, and maintenance measures. The age of the levee can increase the potential for failures if it is not maintained. In Pennsylvania, the average age of the federally-authorized levee systems is nearing 50 years, the typical life-span of a levee. The average age of the non-federally authorized systems is 48 years, with the oldest non-federally authorized system built in 1939 and the most recent in 2009 (ASCE, 2014).

Most levees are designed to operate safely at a specified level of flooding. While FEMA focuses on mapping levees that will reduce the risk of a 1%-annual-chance flood, other levees may be designed to protect against smaller or larger floods. Design specifications provide information on the percent-annual-chance flood a structure is expected to withstand, provided that structure has been adequately constructed and maintained.

Levee failure is also influenced by the frequency and severity of flood events. Therefore, potential future changes in climate and weather conditions, such as predicted increases in heavy precipitation events, may impact the future occurrences of levee failure. For more information on the future occurrence of flood events, please see Section 4.3.5.1.

4.3.26.5. Environmental Impacts

The environmental impacts of a levee failure result in significant water quality and debris disposal issues. Flood waters will back-up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooding waterway. The contents of unsecured containers of oil, fertilizers, pesticides and other chemicals get added to flood waters. Water supplies and waste water treatment could be off-line for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed. Contaminated sediment must be removed from buildings, yards and properties.

4.3.26.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to levee failure, all facilities located in areas characterized as high risk were identified. High-risk areas include the levee protected area and areas within 2,000 feet of a levee. Not all levees have protected areas identified. Therefore, the 2,000-foot buffer around each levee is intended to fill the potential gap in the analysis. While this will provide an overestimation of the risk to a levee failure, the 2,000-foot measurement was selected based on a review of the existing levee protected areas, which found that 2,000 feet was the approximate, typical size of the identified levee protected areas. The high-risk areas were then intersected with state-owned or leased facilities and critical facilities.

As shown in Table 4.3.27-2, 250 state-owned or leased facilities were identified in areas at high risk to levee failure, the highest concentration of which are facilities owned or leased by the Department of Corrections. The State System of Higher Education also has a relatively larger number of structures identified as vulnerable. However, these vulnerable facilities represent a relatively small percentage of the total facilities for these departments. The replacement value of the 250 total vulnerable facilities is estimated to be more than $137 million, or four percent of the value of all state-owned or leased facilities.

Table 4.3.26-2 Vulnerability of state facilities to levee failure.

DEPARTMENT	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF DEPARTMENT STRUCTURES
Attorney General	1	11%
Department of Agriculture	0	0%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	85	12%
Department of Education	0	0%
Department of Environmental Protection	5	38%
Department of General Services	2	2%
Department of Health	6	13%
Department of Labor and Industry	13	19%

Table 4.3.26-2 Vulnerability of state facilities to levee failure.		
DEPARTMENT	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF DEPARTMENT STRUCTURES**
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	12	12%
Department of Revenue	1	10%
Department of Transportation	17	1%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	22	14%
Governor's Office	0	0%
Historical and Museum Commission	0	0%
Insurance Department	0	0%
Liquor Control Board	34	6%
Public School Employees' Retirement System	2	33%
State Civil Service Commission	1	100%
State Department	0	0%
State Employees' Retirement System	1	25%
State Police	1	3%
State System of Higher Education	46	5%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	1	50%
Total	**250**	**6%**

With respect to critical facilities, the types of facilities most vulnerable to levee failure include fire departments, public schools, police departments, and water facilities (Table 4.3.26-3). All critical facilities identified as vulnerable represent a small percentage of the total structures for each facility type.

Table 4.3.26-3 Vulnerability of critical facilities to levee failure.		
TYPE	**NUMBER OF VULNERABLE STRUCTURES**	**PERCENT OF STRUCTURES BY TYPE**
Agricultural	14	5%
Banking	0	0%
Commercial	0	0%
Communication	10	2%
Dam	22	1%

Table 4.3.26-3 Vulnerability of critical facilities to levee failure.		
TYPE	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF STRUCTURES BY TYPE
Education (colleges and universities)	6	4%
Education (public schools)	76	2%
Emergency Operation Center	3	4%
Energy	1	2%
Fire Station	127	5%
Government	1	4%
Hospitals	12	4%
National Monuments or Icon	0	0%
Nuclear	0	0%
Police Stations	76	6%
Transportation	1	1%
Water	53	3%
TOTAL	**402**	**3%**

A total of 402 critical facilities were identified in areas at high risk to levee failure. The total replacement cost of these critical facilities is estimated to be approximately $5.5 billion, or three percent of the total value of all critical facilities in the Commonwealth.

4.3.26.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To determine jurisdictional vulnerability to levee failure, GIS analysis was conducted to identify all census blocks with centers located in areas characterized as high risk to levee failure. As previously defined, high-risk areas include levee protected areas and areas within 2,000 feet of a levee. The total population and buildings within these census blocks were summed by county to determine the total vulnerable population and the total number and value of vulnerable buildings. Table 4.3.27-4 shows the results of this assessment.

Table 4.3.26-4 Vulnerability of people and buildings to levee failure.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Adams	0	0	$0	0.0%
Allegheny	4,253	1,920	$477,812	0.3%
Armstrong	0	0	$0	0.0%
Beaver	97	51	$7,353	0.0%
Bedford	2,637	1,217	$304,955	6.7%
Berks	922	381	$97,321	0.2%

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Berks	0	0	$0	0.0%
Blair	943	390	$64,080	0.5%
Bradford	3,928	1,480	$426,997	7.5%
Bucks	4,552	1,885	$823,621	1.0%
Butler	0	0	$0	0.0%
Cambria	7,020	3,153	$663,236	4.2%
Cameron	2,038	1,003	$349,433	39.2%
Carbon	2,393	1,064	$246,435	3.4%
Centre	2,302	1,051	$291,186	1.8%
Chester	223	110	$79,756	0.1%
Clarion	0	0	$0	0.0%
Clearfield	1,316	601	$108,286	1.4%
Clinton	8,962	2,490	$855,202	22.6%
Columbia	85	42	$8,559	0.1%
Crawford	731	502	$221,639	2.3%
Cumberland	406	213	$61,719	0.2%
Dauphin	0	0	$0	0.0%
Delaware	10,149	3,934	$1,305,391	1.9%
Elk	986	504	$101,091	2.4%
Erie	3,601	1,420	$280,111	0.9%
Fayette	1,105	333	$82,517	0.7%
Forest	0	0	$0	0.0%
Franklin	0	0	$0	0.0%
Fulton	0	0	$0	0.0%
Greene	112	54	$7,782	0.2%
Huntingdon	5,932	1,916	$554,986	13.3%
Indiana	346	162	$26,691	0.3%
Jefferson	9,799	4,519	$1,275,627	28.0%
Juniata	0	0	$0	0.0%
Lackawanna	24,713	10,178	$3,479,315	13.6%
Lancaster	0	0	$0	0.0%
Lawrence	0	0	$0	0.0%
Lebanon	0	0	$0	0.0%
Lehigh	7,188	2,159	$582,291	1.5%
Luzerne	53,526	22,149	$6,669,102	18.9%
Lycoming	25,565	9,964	$3,210,286	27.0%

Table 4.3.26-4 Vulnerability of people and buildings to levee failure.				
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $**	**PERCENT OF COUNTY BUILDING VALUE**
McKean	1,154	628	$137,932	3.0%
Mercer	3,209	1,345	$591,802	4.5%
Mifflin	141	71	$10,725	0.2%
Monroe	6,324	2,526	$926,390	4.9%
Montgomery	5,090	1,885	$828,310	0.7%
Montour	4,341	1,800	$431,294	23.3%
Northampton	6,973	1,901	$877,847	2.7%
Northumberland	9,382	3,732	$1,085,301	11.3%
Perry	69	30	$4,211	0.1%
Philadelphia	0	1	$548	0.0%
Pike	25	12	$2,224	0.0%
Potter	2,240	1,189	$427,512	17.6%
Schuylkill	3,044	1,430	$373,769	2.4%
Snyder	652	344	$123,934	3.4%
Somerset	7,484	3,540	$768,729	9.8%
Sullivan	0	0	$0	0.0%
Susquehanna	0	0	$0	0.0%
Tioga	5,538	2,406	$598,519	14.8%
Union	31	47	$6,778	0.2%
Venango	923	428	$78,962	1.4%
Warren	1,034	500	$92,956	1.9%
Washington	2,068	1,076	$483,742	2.0%
Wayne	1,584	769	$204,226	3.3%
Westmoreland	8,096	3,876	$1,141,587	2.8%
Wyoming	66	27	$15,568	0.6%
York	14,032	4,750	$1,607,382	3.4%
Total	**269,330**	**109,158**	**33,483,028**	**2.3%**

In terms of vulnerable populations identified, Luzerne, Lycoming, and Lackawanna Counties are at the greatest risk of levee failure. These are the counties in which extensive levee system have been built. Similarly, these three counties are at the highest risk in terms of number and total value of vulnerable buildings. Just over 1,000 vulnerable buildings were identified in Cameron County. The value of these vulnerable buildings represents 39 percent of the total value of all buildings in the County, which is the highest percent in the Commonwealth.

In total, 269,330 people and 109,158 buildings throughout Pennsylvania were identified as vulnerable to levee failure. The value of the total buildings at high risk is estimated to be nearly $33.5 billion, or two percent of the total value of all buildings in the Commonwealth.

4.3.27. Mass Food and Animal Feed Contamination

4.3.27.1. Location and Extent

Mass food or animal feed contamination hazards occur when food or food sources are contaminated with pathogenic bacteria, viruses, or parasites, as well as chemical or natural toxins. They may lead to foodborne illnesses and/or interruptions in the food supply. Contamination may occur due to natural foodborne illnesses and chemical, biological, radiological, or nuclear exposure (c-BRNE). Most foodborne illnesses are caused by Campylobacter in poultry, E. Coli in beef, leafy greens, and raw milk, Listeria in deli meats, unpasteurized soft cheeses, and produce, Salmonella in eggs, poultry, meat, and produce, Vibrio in raw oysters, Norovirus in many foods, and Toxoplasma in meats (CDC, 2013). These events can happen at any time and in any place in Pennsylvania and are sometimes regional or even national events. At the same time, though, Pennsylvania is one of the nation’s leading agricultural producers with over 7,000 dairy farms, the highest concentration of snack food production in the country, and retail food establishments from corner convenience marts to farmers’ markets to large grocery store chains.

In addition, a major concern of mass food and animal feed contamination hazards is that, in general, places generally only have a three-day supply of food. The food supply chain is very vulnerable to interruption, whether or not the product comes from Pennsylvania. An interruption in the food supply would be a major vulnerability for the health and survival of Pennsylvania communities.

4.3.27.2. Range of Magnitude

Like invasive species, mass food and animal feed contamination hazards can vastly vary based on the type of contamination, the method of contamination, and the origin of contamination. Different pathogens and chemicals that can contaminate human food and animal feed have varying degrees of aggressiveness that can range from a sore stomach to serious illness, hospitalization, and even death. For example, the Centers for Disease Control and Prevention (CDC) reports approximately 1.2 million illnesses, 23,000 hospitalizations, and 450 deaths in the United States each year from *salmonella* alone. In 2017, 26 people in Pennsylvania were infected with *salmonella* during a six-month span from handling live poultry (CDC 2017).

A possible worst-case scenario would be if there was large-scale campylobacter or salmonella outbreak found in Pennsylvania’s poultry farms. An event like this would cause human suffering but would also have a crippling effect on the state’s poultry production and farm-based economy.

4.3.27.3. Past Occurrence

According to representatives from the Department of Agriculture, mass food and animal feed contamination events are difficult to capture as they occur because of the lapse in time between infection and manifestation of an illness. Usually, they are isolated events. However, in recent years, the CDC has tracked the following outbreak events in Pennsylvania:

- 2018 – Shell Eggs - *Salmonella*
- 2018 – Romaine Lettuce - *E. coli*
- 2018 – Frozen Shredded Coconut – *Salmonella*
- 2017 – Leafy Greens - *E. coli*
- 2017 – Maradol Papayas – Salmonella
- 2016 – Beef Products - *E. coli*
- 2016 – Flour - *E. coli*
- 2016 – Organic Shake and Meal Products – *Salmonella*
- 2016 – Packaged Salads - *Listeria monocytogenes*
- 2015 – Chipotle Mexican Grill Restaurants - *E. coli*
- 2015 – Cucumbers - *Salmonella*

This is not an exhaustive list of past occurrences but illustrates that Pennsylvanians have been sickened by contaminations in other states. However, Pennsylvania has not been the origin or cause of a mass food or animal feed contamination.

4.3.27.4. Future Occurrence

The CDC estimates that one in six people gets sick from contaminated food each year, but those events are expected to be individualized and small in scope. The focus of this as a hazard is on large-scale contamination and illness. With the aggressive testing and food safety outreach the Department of Agriculture conducts, the overall probability of a mass food or animal feed contamination event is *unlikely* according to the Risk Factor Methodology (see Section 4.1).

4.3.27.5. Environmental Impacts

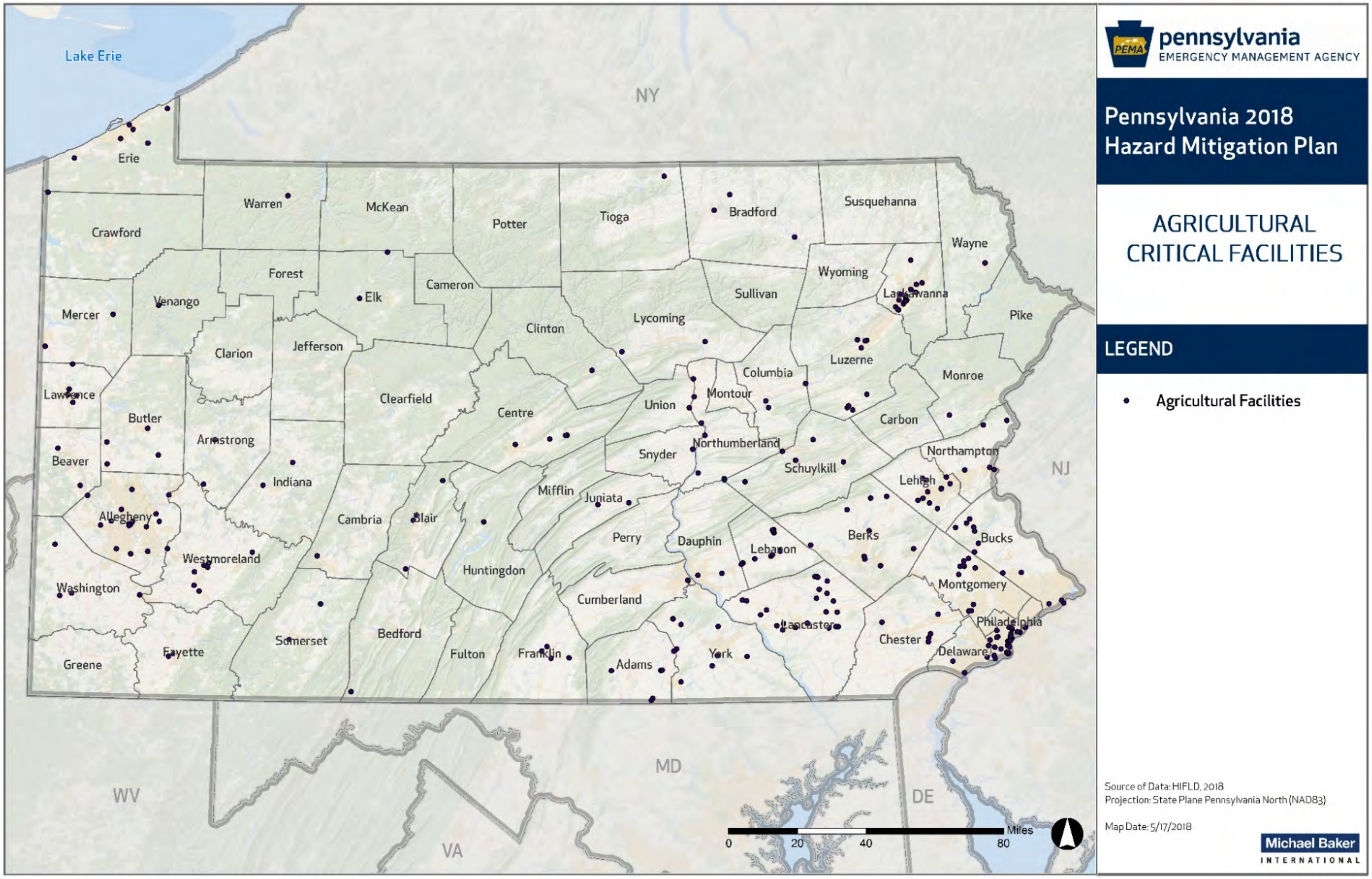
The major identified environmental impact of mass food and animal feed contamination is the waste disposal of significant numbers of animals. If this waste disposal is not planned for, rotting carcasses could cause environmental degradation, including water pollution. They might also have a role in spreading infections disease. Additionally, there are primary impacts to public health and to the agricultural economy in Pennsylvania. Should there be a mass food or animal feed contamination event, even if the event is not focused in Pennsylvania, the potential losses from fear-based cancellation of food orders could be devastating. This would also cause a surplus of animals on Pennsylvania farms that agricultural producers cannot feed but also cannot sell.

4.3.27.6. State Facility Vulnerability Assessment and Loss Estimation

State facilities generally are no more or less vulnerable to mass food and animal feed contamination than the general population. However, the 275 agricultural critical facilities identified in the critical facility inventory are likely to be the most vulnerable to a food or animal feed contamination event. The location of the agricultural facilities in the state critical facilities inventory is shown in Figure 4.3.27-1.

The physical plant and facilities of the Commonwealth are not likely to be damaged by a mass food or animal feed contamination event. However, high rates of absenteeism associated with a pandemic or an infectious disease will likely lead to significant economic costs in lost productivity and increased medical costs in nearly all state agencies. Additionally, the 106 agricultural critical facilities would face lost revenues depending on the type and magnitude of the contamination event.

Figure 4.3.27-1 Distribution of agricultural critical facilities throughout Pennsylvania (HIFLD, 2018).



4.3.27.7. Jurisdictional Vulnerability Assessment and Loss Estimation

Jurisdictional losses in a mass food or animal feed contamination event stem from lost wages and productivity, not losses to buildings or land. Losses are difficult to estimate because the exact rates of absenteeism and cost of treating a widespread disease will depend on the virus or bacterium in question, the availability of vaccination or treatment, and the severity of symptoms. The CDC estimates that infections of *Salmonella* alone create $365 million in direct medical costs annually, some of which would certainly be experienced in Pennsylvania. Communities with large populations of the elderly and the very young are more vulnerable to this kind of an event as they are usually the most susceptible to foodborne illnesses.

4.3.28. Nuclear Incident

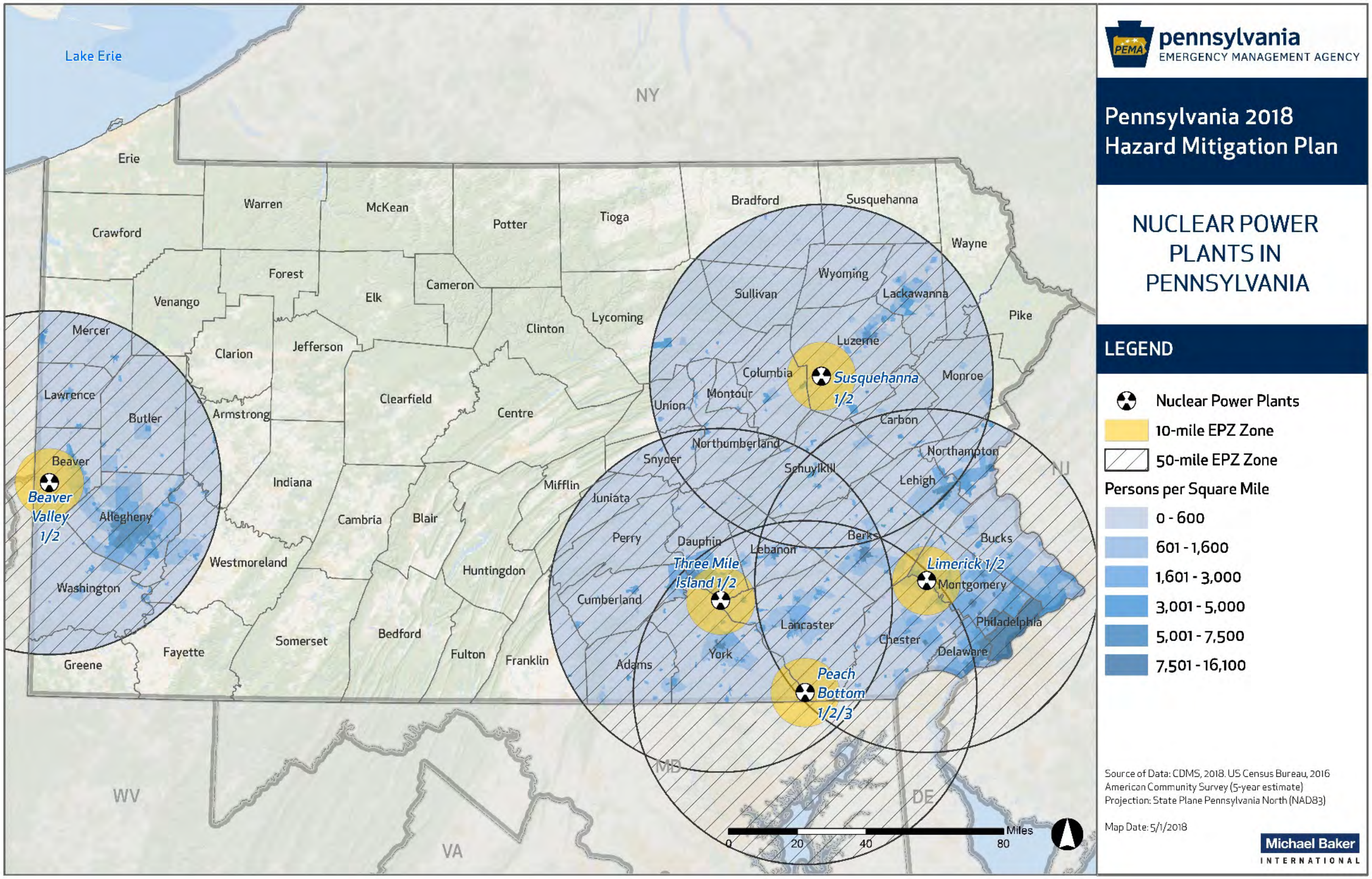
4.3.28.1. Location and Extent

Nuclear power is an important source of energy in the Commonwealth, and there are five nuclear power stations in Pennsylvania:

- Beaver Valley Power Station, Shippingport Borough, Beaver County;
- Limerick Generating Station, Limerick Township, Montgomery County;
- Peach Bottom Atomic Power Station, Peach Bottom Township, York County;
- Susquehanna Steam Electric Station, Salem Township, Luzerne County; and
- Three Mile Island Nuclear Generating Station, Londonderry Township, Dauphin County.

Most of these generating stations are concentrated in the eastern portion of the state, as seen in Figure 4.3.28-1. Four of the five nuclear power plants in the Commonwealth have two operating licensed units. Three Mile Island (TMI) has only one operating license with the second unit in a state of Post-Defueling Monitored Storage (PDMS).

Figure 4.3.28-1 Location of Pennsylvania nuclear power stations, their Emergency Planning Zones (EPZs), and the population density of affected municipalities (Hazus, 2018 and US Census, 2016).



The Nuclear Regulatory Commission encourages the use of Probabilistic Risk Assessments (PRA) to estimate quantitatively the potential risk to public health and safety considering the design, operations and maintenance practices at nuclear power plants. PRAs typically focus on accidents that can severely damage the core and that may challenge containment. FEMA, PEMA and county governments have formulated Radiological Emergency Response Plans that include a *Plume Exposure Pathway Emergency Planning Zone (EPZ)* with a radius of about ten miles from each nuclear power facility and an *Ingestion Exposure Pathway EPZ* with a radius of about fifty miles from each facility. The exact size and configuration of the EPZ may vary in relation to local emergency response capabilities, topography, road networks, and political boundaries.

The estimated populations located in the Plume Exposure Pathway EPZ range from 28,074 at Peach Bottom Atomic Power Station to 289,403 at Limerick Generating Station, as shown in Table 4.3.28-1 (Pennsylvania populations only). The estimated populations located in the Ingestion Exposure EPZ range from 361,103 at the Three Mile Island Nuclear Generating Station to 5,891,043 at the Limerick Generating Station.

The combined population of Pennsylvanians in all five Plume Exposure EPZs is approximately 681,576. As indicated in Figure 4.3.28-1, the municipalities located within the 50-mile Ingestion Pathway EPZs of these nuclear power-generating stations are some of the most densely populated in the state; approximately 10,495,979 Pennsylvanians live within the five Ingestion Pathway EPZs. This comprises about 82% of the total population of the Commonwealth. In addition to the Ingestion Pathway EPZs in Pennsylvania, populations in Erie, Crawford, and Mercer Counties fall within the Ingestion Pathway EPZ of the Perry Nuclear Power Plant in Northeast Ohio. Similarly, Pike County falls within the 50-mile radius of Indian Point Nuclear Generating Station in New York, and populations in Bucks, Chester, Delaware, Lancaster, Philadelphia, and Montgomery Counties fall within the Ingestion Pathway EPZs of Salem Nuclear Generating Station in Salem County, New Jersey.

Table 4.3.28-1 Population located in the Plume Exposure and Ingestion EPZs for PA nuclear power generating stations (ACR 5-year, 2016).

FACILITY	AT-RISK POPULATION: PLUME EXPOSURE EPZ (10-MILE RADIUS)	AT-RISK POPULATION: INGESTION EXPOSURE EPZ (50-MILE RADIUS)
Beaver Valley Power Station	84,647	2,220,851
Limerick Generating Station	289,403	5,891,043
Peach Bottom Atomic Power Station	28,074	878,433
Susquehanna Steam Electric Station	59,878	1,144,549
Three Mile Island Nuclear Generating Station	219,574	361,103
Total	681,576	10,495,979

4.3.28.2. Range of Magnitude

The magnitude of a nuclear incident differs for those within the Plume Exposure Pathway EPZ and those within the Ingestion Exposure Pathway EPZ. The Plume Exposure Pathway refers to whole-body external exposure to gamma radiation from a radioactive plume and from deposited materials and inhalation exposure from the passing radioactive plume. The duration of primary exposures could range in length from hours to days. The Ingestion Exposure Pathway refers to exposure primarily from ingestion of water or foods such as milk and fresh vegetables that have been contaminated with radiation.

Nuclear accidents themselves are classified into three categories:

- **Criticality accidents:** Involves loss of control of nuclear assemblies or power reactors.
- **Loss-of-coolant accidents:** Occurs whenever a reactor coolant system experiences a break or opening large enough so that the coolant inventory in the system cannot be maintained by the normally operating make-up system.
- **Loss-of-containment accidents:** Involves the release of radioactivity from materials such as tritium, fission products, plutonium, and natural, depleted, or enriched uranium. Points of release have been containment vessels at fixed facilities or damaged packages during transportation accidents.

Nuclear facilities must notify the appropriate authorities in the event of an accident. The Nuclear Regulatory Commission uses four classification levels for nuclear incidents (Nuclear Regulatory Commission, 2008):

- **Unusual Event:** Under this category, events are in process or have occurred which indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring offsite response or monitoring is expected unless further degradation occurs.
- **Alert:** If an alert is declared, events are in process or have occurred which involve an actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the EPA Protective Action Guides (PAGs).
- **Site Area Emergency:** A site area emergency involves events in process or which have occurred that result in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material are not expected to exceed the EPA PAGs except near the site boundary.
- **General Emergency:** A general emergency involves actual or imminent substantial core damage or melting of reactor fuel with the potential for loss of containment integrity. Radioactive releases during a general emergency can reasonably be expected to exceed the EPA PAGs for more than the immediate site area.

The accident at the Three Mile Island Generating Station in March 1979 remains the nation's only nuclear incident at the *General Emergency level* and remains the worst nuclear incident on record in the Commonwealth and the nation. During this incident, equipment malfunctions, design-related problems, and worker errors led to a partial meltdown of the TMI Unit 2 reactor core at TMI.

The nuclear industry has adopted pre-determined, site-specific Emergency Action Levels (EALs). The EALs provide the framework and guidance to observe, address, and classify the severity of site-specific events and conditions that are communicated to off-site emergency response organizations (Nuclear Regulatory Commission, 2008). There are additional EALs that specifically deal with issues of security, such as threats of airborne attack, hostile action within the facility, or facility attack. These EALs ensure that appropriate notifications for the security threat are made in a timely manner. Each facility is also equipped with a public alerting system, which includes a number of sirens to alert the public located in the Plume Ingestion Pathway EPZ. This alerting system is activated by the counties of each specific EPZ. Emergency notifications and instructions are communicated to the public via the Emergency Alert System as activated by the Commonwealth of Pennsylvania Emergency Operations Center. State officials also have the capability to send emergency messages as text messages to mobile devices.

4.3.28.3. Past Occurrence

Nuclear incidents rarely occur, but the incident at Three Mile Island is the worst fixed-nuclear facility accident in U.S. history. The resulting contamination and state of the reactor core led to the development of a fourteen-year cleanup and scientific effort. Additionally, the *President's Commission on the Accident at Three Mile Island* examined the costs of the accident, concluding, "The accident at Three Mile Island on March 28, 1979, generated considerable economic disturbance. Some of the impacts were short term, occurring during the first days of the accident. Many of the impacts were experienced by the local community; others will be felt at the regional and national levels." The report concluded: "It appears clear that the major costs of the TMI Unit 2 accident are associated with the emergency management replacement power and the plant refurbishment or replacement. The minimum cost estimate of nearly $1 billion supports the argument that considerable additional resources can be cost effective if spent to guard against future accidents."

Despite the severity of the damage, no injuries due to radiation exposure occurred. However, numerous studies were conducted to determine the measurable health effects related to radiation and/or stress. More than a dozen epidemiological and stress related studies conducted to date have found no discernible direct health effects to the population in the vicinity of the plant. However, one study conducted by the DOH's Three Mile Island Health Research Program did find evidence of psychological stress, "lasting in some cases for five to six years." According to the program chief, "the people suffering from stress perceived their health as being poorer than it actually was when the Health Department checked the medical records."

The issue of radiation effects resulting from the accident at TMI will continue to be debated. Radiation science does accept thresholds of expected mortality and morbidity resulting from the exposure to radiation. Administrative standards have been incorporated into plans used by public health officials and emergency planners for the purpose of making protective actions decisions pertaining to sheltering and evacuation.

The accident at Three Mile Island had a profound effect on the residents, emergency management community, government officials and nuclear industry, not only in Pennsylvania, but nationwide. There were minimal requirements for off-site emergency planning for nuclear power stations prior to this accident. Afterwards, comprehensive, coordinated, and exercised plans were developed for the state, counties, school districts, special facilities (hospitals, nursing homes and detention facilities) and municipalities to assure the safety of the population. Costs associated with an event at one of the Commonwealth’s nuclear facilities, be it real or perceived, are significant. The mitigation efforts put in place immediately following the 1979 continue until today. The Commonwealth Nuclear/Radiological plan which is a successor of the original “Annex E” is a result of the Commonwealth’s efforts to address the many components of mitigation planning. The comprehensive planning involved with the five nuclear facilities is an ongoing effort. Plans are reviewed and amended on an annual basis. Recent amendments to various planning documents and station procedures include the efforts to enhance station security measures and the means to bolster communications and response in the event of terrorist activities.

There have been no significant nuclear incidents in the Commonwealth since the 2013 Plan. However, the most recent nuclear incident to occur worldwide was that which involved the Fukushima Daiichi nuclear reactor in Okuma, Fukushima, Japan. This incident occurred on March11, 2011. An earthquake in the area resulted in a series of equipment failures, nuclear meltdowns and releases of radioactive materials. These failures and releases were largely attributed to the water that penetrated the structures following the tsunami that was generated by the earthquake. The flooding caused the failure of multiple generators meant to keep the systems operating safely after the automatic shutdown. No deaths have been directly attributed to the incidents at the reactor at this time. The World Health Organization completed a report that indicated there were only small proportional increases in the occurrence of certain cancers following the radiation exposure from the plant.

Following this incident, the United States Nuclear Regulatory Commission developed a set of recommendations based on the lessons learned from the Fukushima incident. These recommendations are meant to enhance reactor safety for US-based nuclear reactors against a variety of factors. Recommendations included the categories of regulatory framework, ensuring protection (of the facilities and equipment), enhancing mitigation, strengthening emergency preparedness and improving the efficiency of NRC programs. One of the specific recommendations involves the re-evaluation and upgrade of seismic and flooding protection of structures, systems and components for each reactor. As more information comes out, and more lessons learned are developed, it should only serve to reinforce the protections in place against any type of incident involving nuclear power stations.

4.3.28.4. Future Occurrence

Pennsylvania is home to the only nuclear power plant *General Emergency* in the nation. Since the Three Mile Island incident, nuclear power has become significantly safer and is one of the most heavily regulated industries in the nation. Despite the knowledge gained since then, there is still the potential for a similar accident to occur again at one of the five nuclear generating facilities in the Commonwealth. The Nuclear Energy Agency of the Organization for Economic Co-Operation and Development notes that studies estimate the chance of protective barriers in a modern nuclear facility at less than one in 100,000 per year (Nuclear Energy Agency 2005). Nuclear incident occurrences may also occur as a result of intentional actions; these acts are addressed under Section 4.3.30.

Across the United States, a number of *Unusual Event* and *Alert* classification level events occur each year at the 100+ nuclear facilities that warrant notification of local emergency managers. Of these, *Alert* emergencies occur less frequently. For example, in 1997, there were forty notifications of *Unusual Events* and three *Alert* events nationwide. Based on historical events, *Site Area Emergency* and *General Emergency* incidents are very rare.

4.3.28.5. Environmental Impacts

Potential environmental impacts include the long-term effects of radioactive contamination in the environment and, particularly in Pennsylvania, in agricultural products. Spills and releases of radiologically active materials from accidents can result in the contamination of soil and water. Areas underlain by limestone and some types of glacial sediments are particularly susceptible to contamination.

After a nuclear incident, another significant impact is the effect of radiation on the health of the population near the incident. The duration of primary exposure could range in length from hours to months depending on the proximity to the point of radioactive release. External radiation and inhalation and ingestion of radioactive isotopes can cause acute health effects (e.g. death, severe health impairment), chronic health effects (e.g. cancers) and psychological effects.

4.3.28.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical facilities to nuclear incidents, all structures located within the 10-mile Plume Exposure EPZ and all agricultural facilities located within the 50-mile Ingestion Exposure EPZ were identified. As in the state vulnerability assessment for drought hazard, agricultural facilities were defined based on the facility use for state facilities (Ag-Animal Facility, Ag-Nursery/Greenhouse, Ag-Storage, and Land were all assumed to represent agricultural uses), and based on the facility type for critical facilities (facilities assigned to the type “Agricultural” were known to represent agricultural uses).

Of the 4,460 geolocated state facilities, 105, or 2.4 percent, met the criteria for high nuclear hazard (Table 4.3.28-2).These facilities have a combined replacement value of more than $10.8 million, or approximately 0.3% of the known value of geolocated state facilities.

Table 4.3.28-2 Vulnerability of state facilities to nuclear incident.		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	0	0%
Department of Agriculture	6	38%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	0	0%
Department of Conservation and Natural Resources	1	50%
Department of Corrections	29	4%
Department of Education	0	0%
Department of Environmental Protection	0	0%
Department of General Services	2	2%
Department of Health	1	2%
Department of Labor and Industry	1	1%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	3	3%
Department of Revenue	0	0%
Department of Transportation	34	2%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	0	0%
Governor's Office	0	0%
Historical and Museum Commission	0	0%
Insurance Department	0	0%
Liquor Control Board	26	5%
Public School Employees' Retirement System	0	0%
State Civil Service Commission	0	0%
State Department	0	0%
State Employees' Retirement System	0	0%
State Police	2	6%
State System of Higher Education	0	0%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	0	0%
Total	**105**	**2.4%**

Of the 14,011 geolocated critical facilities, 672, or 5 percent, met the criteria for high nuclear hazard (Table 4.3.28-3). These facilities have a combined replacement value of approximately $10.7 billion, or 6 percent of the known value of geolocated critical facilities.

Table 4.3.28-3 Vulnerability of critical facilities to nuclear incident.		
TYPE	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR FACILITY TYPE**
Agricultural	230	84%
Banking	1	33%
Commercial	0	0%
Communication	16	3%
Dam	148	4%
Education (colleges and universities)	8	5%
Education (public schools)	161	5%
Emergency Operation Center	1	1%
Energy	2	4%
Fire Station	133	5%
Government	0	0%
Hospital	10	3%
National Monuments or Icon	0	0%
Nuclear	5	100%
Police Station	71	6%
Transportation	1	1%
Water	107	6%
Total	**672**	**5%**

4.3.28.7. Jurisdictional Vulnerability Assessment and Loss Estimation

In Pennsylvania, 145 municipalities and 61 school districts in eleven counties are located in the 10-mile Plume Exposure Pathway EPZs of the five Pennsylvania nuclear power generating stations. The breakdown of jurisdictional vulnerability is shown in Table 4.3.28-4. A further fourteen counties provide support services related to monitoring and the mass care of evacuees from at-risk jurisdictions. In total, approximately 1,553 municipalities and 38 counties (of 67) are located within the 50-mile Ingestion Pathway Exposure EPZ (PEMA, 2010a). This does not include the communities vulnerable to nuclear incidents in neighboring states.

Table 4.3.28-4 Counties and municipalities located within each 10-mile Plume Exposure Pathway EPZ (DEP Bureau of Radiation Protection, 2009)			
BEAVER VALLEY POWER STATION			
Risk County	**Risk Municipalities**		
Beaver County	City of Aliquippa	Glasgow Borough	Ohioville Borough
	Beaver Borough	Greene Township	Patterson Township
	Bridgewater Borough	Hanover Township	Patterson Heights Borough
	Brighton Township	Hookstown Borough	Potter Township
	Center Township	Hopewell Township	Raccoon Township

Table 4.3.28-4 Counties and municipalities located within each 10-mile Plume Exposure Pathway EPZ (DEP Bureau of Radiation Protection, 2009)			
	Chippewa Township	Independence Township	Shippingport Borough
	Fallston Borough	Industry Borough	South Beaver Township
	Frankfort Springs Borough	Midland Borough	South Heights Borough
	Georgetown Borough	Monaca Borough	Vanport Township
LIMERICK GENERATING STATION			
Risk County	**Risk Municipalities**		
Berks County	Amity Township	Douglass Township	Washington Township
	Boyertown Borough	Earl Township	
	Colebrookdale Twp.	Union Township	
Montgomery County	Collegeville Borough	Lower Salford Twp.	Skippack Township
	Douglass Township	Marlborough Twp.	Trappe Borough
	Green Lane Borough	New Hanover Twp.	Upper Frederick Twp.
	Limerick Township	Perkiomen Township	Upper Pottsgrove Twp.
	Lower Frederick Twp.	Pottstown Borough	Upper Providence Twp.
	Lower Pottsgrove Twp.	Royersford Borough	Upper Salford Twp.
	Lower Providence Twp.	Schwenksville Borough	West Pottsgrove Twp.
Chester County	Charlestown Township	North Coventry Twp.	Upper Uwchlan Twp.
	East Coventry Twp.	Phoenixville Borough	Uwchlan Township
	East Nantmeal Twp.	Schuylkill Township	Warwick Township
	East Pikeland Twp.	South Coventry Twp.	West Pikeland Twp.
	East Vincent Twp.	Spring City Borough	West Vincent Twp.
PEACH BOTTOM ATOMIC POWER STATION			
Risk County	**Risk Municipalities**		
York County	Delta Borough	Fawn Township	Lower Chanceford Township
	Peach Bottom Township	Fawn Grove Borough	
SUSQUEHANNA STEAM ELECTRIC STATION			
Risk County	**Risk Municipality**		
Columbia County	Beaver Township	Briar Creek Twp.	North Centre Twp.
	Berwick Borough	Fishing Creek Twp.	South Centre Twp.
	Briar Creek Borough	Mifflin Township	
Luzerne County	Black Creek Township	Huntington Township	Salem Township
	Butler Township	Nanticoke City	Shickshinny Borough
	Conyngham Borough	Nescopeck Borough	Slocum Township
	Conyngham Township	Nescopeck Township	Sugarloaf Township
	Dorrance Township	New Columbus Borough	Union Township
	Hollenback Township	Newport Township	
	Hunlock Township	Nuangola Borough	

Table 4.3.28-4 Counties and municipalities located within each 10-mile Plume Exposure Pathway EPZ (DEP Bureau of Radiation Protection, 2009)

THREE MILE ISLAND NUCLEAR GENERATING STATION			
Risk County	**Risk Municipalities**		
Cumberland County	Lower Allen Township	New Cumberland Borough	
Dauphin County	Conewago Township	Londonderry Township	Royalton Borough
	Derry Township	Lower Paxton Township	South Hanover Township
	Harrisburg City	Lower Swatara Township	Steelton Borough
	Highspire Borough	Middletown Borough	Swatara Township
	Hummelstown Borough	Paxtang Borough	
Lancaster County	Conoy Township	Elizabethtown Borough	West Donegal Township
	East Donegal Township	Mount Joy Township	
Lebanon County	South Londonderry Township		
York County	Conewago Township	Hellam Township	Newberry Township
	Dover Township	Lewisberry Borough	Springettsbury Township
	East Manchester Township	Manchester Borough	Warrington Township
	Fairview Township	Manchester Township	York Haven Borough
	Goldsboro Borough	Mount Wolf Borough	

The loss experienced by each jurisdiction in the case of a nuclear incident will depend on the magnitude of the event. The example of the Three Mile Island incident gives an indication of local and regional economic losses, though. The President's Commission on the Three Mile Incident calculated the economic impact of the accident, looking at direct and indirect losses and other potential growth impacts. Direct impacts to the manufacturing sector were estimated at $6.3 million. These losses occurred within a few days after the accident and quickly subsided thereafter with no evidence of permanents layoffs resulting. Food processors incurred extraordinary expenses of $250,000 with some firms purchasing equipment to detect radiation levels and converting dairy production to powdered milk.

The utility itself incurred significant costs in the areas of emergency management and plant refurbishment and replacement power. Emergency management costs ran into the hundreds of millions of dollars and replacement power for both units at a cost of $24 million a month. The unaffected unit TMI Unit 1 was shut down for 6.5 years. During this time, more than $100 million in plant upgrades and refurbishment took place. Replacement power costs today are estimated at nearly twice the 1979 dollars. Cost of the accident cleanup and placing the facility in monitored storage cost approximately $1 billion.

The impact to tourism was estimated at approximately $6.5 million with lost wages in this sector estimated from $2.8 million to $3.8 million. Losses to the agricultural sector appeared to be minimal due to off-growing season. The Pennsylvania Department of Agriculture indicated that losses were significantly less than $1 million.

To quantify the relative jurisdictional vulnerability due to impacts to people and buildings within the 10-mile Plume Exposure EPZ, GIS analysis was conducted to identify all census tracts with centers located within 10 miles of a nuclear power station. The population, building counts, and exposed building value within these census tracts was then aggregated to the county scale. As shown in Table 4.3.28-5, only ten counties in Pennsylvania have census tracts within the 10-mile Plume Exposure EPZ. The county with the largest number of vulnerable people is Montgomery County. Approximately 160,000 residents of the densely populated Montgomery County live in census tracts within the 10-mile Plume Exposure EPZ. The county with the largest percentage of exposed building value, in contrast, is Beaver County. Approximately 50 percent of the total value of all buildings in Beaver County is located in census tracts within the 10-mile Plume Exposure EPZ.

Table 4.3.28-5 Vulnerability of people and buildings to nuclear incident.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF COUNTY BUILDING VALUE
Beaver	83,535	36,399	$9,573,500	50%
Berks	28,637	11,112	$3,165,926	7%
Chester	79,079	29,606	$10,736,842	16%
Columbia	16,905	7,495	$1,735,609	24%
Cumberland	7,290	3,340	$918,376	3%
Dauphin	112,240	41,152	$12,765,069	39%
Lancaster	57,164	20,127	$5,377,498	10%
Luzerne	41,853	17,859	$3,838,908	11%
Montgomery	164,580	57,375	$19,540,615	17%
York	75,043	29,820	$7,946,242	17%
Total	**666,326**	**254,285**	**$75,598,585**	**5%**

Potential jurisdictional losses in the 50-mile EPZ will solely originate from losses in farm products and contamination of farmland in counties within the 50-mile ingestion exposure pathway. Table 4.3.28-6 illustrates possible agricultural losses resulting from a nuclear incident, enumerating farmland acreage and the associated market value of products for counties where more than half the land area falls under the 50-mile EPZ.

Table 4.3.28-6 Estimated 50-mile EPZ jurisdictional losses relating to agricultural production (USDA, 2012).

COUNTY	IMPACTED FARMLAND ACREAGE	MARKET VALUE OF AGRICULTURAL PRODUCTS SOLD (THOUSAND $)
Adams	171,305	$201,742
Allegheny	34,837	$10,397
Beaver	55,795	$20,913
Berks	233,744	$528,711
Bucks	64,024	$62,418
Butler	136,237	$52,905
Carbon	21,162	$9,339
Chester	164,495	$660,744
Columbia	122,743	$74,351
Cumberland	154,879	$195,356
Dauphin	129,378	$122,589
Delaware	4,725	$9,781
Juniata	91,032	$101,440
Lackawanna	32,750	$13,237
Lancaster	439,481	$1,474,954
Lawrence	80,468	$38,519
Lebanon	121,413	$348,933
Lehigh	76,331	$90,833
Luzerne	60,930	$20,993
Mercer	163,148	$82,650
Monroe	26,483	$10,974
Montgomery	30,780	$25,594
Montour	43,493	$47,425
Northampton	65,744	$43,496
Northumberland	129,501	$154,339
Perry	135,075	$140,401
Philadelphia	285	$768
Schuylkill	105,749	$165,853
Snyder	91,179	$165,493
Sullivan	37,481	$9,517
Union	93,241	$135,970
Washington	205,821	$35,412
Wyoming	68,749	$14,616
York	262,062	$234,064
Total	**3,654,520**	**$5,304,727**

4.3.29. Opioid Addiction

4.3.29.1. Location and Extent

Opioid addiction occurs when an individual becomes physically dependent on opioid, a class of drugs that reduces pain. Opioid is used as a broad term and includes opiates, which are drugs naturally extracted from certain types of poppy plants, and narcotics. Opioids can also be synthetically made to emulate opium.

According to the Drug Enforcement Administration (DEA) opioids come in various forms: tablets, capsules, skin patches, powder, chunks in various colors from white to shades of brown and black, liquid form for oral use and injection, syrups, suppositories, and lollipops. The Centers for Disease Control and Prevention (CDC) defines the following as the three most common types of opioids:

- **Prescription Opioids:** Opioid medication prescribed by doctors for pain treatment. Prescription opioids can be synthetic-oxycodone (OxyContin) or hydrocodone (Vicodin), or natural, like morphine.
- **Fentanyl:** A powerful synthetic opioid that is 50 to 100 times more powerful that morphine and used for treating severe pain. Illegally made and distributed fentanyl is becoming more prevalent.
- **Heroin:** An illegal natural opioid processed from morphine and is also becoming more commonly used in the United States.

Opioids are highly addictive. They block the body’s ability to feel pain and can create a sense of euphoria. Additionally, individuals often build a tolerance to opioids, which can lead to misuse and overdose.

Opioid addiction impacts the entire Commonwealth. Nationally, Pennsylvania is among four of the hardest hit states from opioid-related deaths, along with West Virginia, Ohio, and New Hampshire. The CDC estimates that nearly 38 out of every 100,000 Pennsylvania residents died from opioid-related overdoses in 2016, higher than the national rate of opioid-related deaths of approximately 20 out of 100,000 people. In Pennsylvania, overdoses caused by opioids have become the leading cause of accidental death, surpassing automobile accidents (CDC, 2017).

People under the age of 35 have been particularly vulnerable to the opioid crisis. According to a joint intelligence report prepared by the DEA Philadelphia Division and the University of Pittsburgh, between 2015 and 2016 in Pennsylvania, fentanyl use increased 380 percent among 15- to 24-year-olds while heroin use increased 970 percent in the 25- to 34-year age range. The report also documented a higher percentage of drug-related deaths attributed to opioid use in Pennsylvania’s rural communities at 42 percent, compared to 34 percent in urban comminutes.

4.3.29.2. Range of Magnitude

Opioid addiction can lead to overdose, which can be fatal. The most dangerous side effect of an opioid overdose is depressed breathing. The lack of oxygen to the brain causes permanent brain damage, leading to organ failure, and eventually, death. Signs and symptoms include respiratory depression, drowsiness, disorientation, pinpoint pupils, and clammy skin.

Opioid addiction can also be passed from mother to child in the womb. This condition, known as neonatal abstinence syndrome, has increased five-fold from 2000 to 2012, according to the National Institute on Drug Abuse (NIDA), resulting in an estimated 22,000 babies in the United States born with this condition (NIDA, 2017).

First responders—paramedics, police officers, and fire fighters, are also affected by Pennsylvania's opioid addiction crisis. In addition to the crisis consuming time and resources, first responders also face exposure risk, particularly to synthetic fentanyl. According to the DEA, it takes two to three milligrams of fentanyl to induce respiratory depression, arrest, and possibly death. Since fentanyl is indistinguishable from several other narcotics and powdered substances, first responders must take extra precaution when dealing with calls related to drug abuse (DEA, 2017).

One of the worst examples of the impacts of the opioid crisis occurred in March 2018 when thirteen people in York County died from opioid related overdoses in 10 days, six of which occurred within 48 hours. The county coroner suspected that a particularly potent batch of heroin or fentanyl was to blame (Sentinel 2018). Similarly, the City of Hazelton, in Luzerne County, experienced five opioid overdoses in 12 hours with two resulting in death on May 4, 2018. The Hazelton police chief warned citizens about a potentially deadly batch of heroin, possibly laced with fentanyl (WNEP 2018).

4.3.29.3. Past Occurrence

The CDC found that opioids are the main cause of drug-related overdoses and deaths, being responsible for nearly seventy-five percent of drug-related deaths nationally in 2017. Table 4.3.29-1 lists the total number of drug overdoses by county in 2015 and 2016. Of the more than 4,600 drug-related deaths in Pennsylvania in 2016, nearly 84 percent were attributed to two or more drugs. Therefore, drug-related overdose and death statistics account for all drug types, however, as noted above, the majority of drug-related deaths involve opioids. Philadelphia and Allegheny Counties reported the largest total numbers of drug overdoses in 2015 and 2016, while Cambria, Philadelphia, Beaver, and Armstrong Counties had the highest number of drug overdoses per capita. Drug overdose and drug-related deaths were not reported for seven counties.

Table 4.3.29-1 Number of Drug Overdoses Reported in Pennsylvania by County in 2015 and 2016 (DEA 2106).

COUNTY	2015	2016	COUNTY	2015	2016
Adams	7	28	Lackawanna	70	84
Allegheny	424	648	Lancaster	80	116
Armstrong	29	41	Lawrence	30	40
Beaver	37	102	Lebanon	20	16
Bedford	6	11	Lehigh	115	134

Table 4.3.29-1 Number of Drug Overdoses Reported in Pennsylvania by County in 2015 and 2016 (DEA 2106).

COUNTY	2015	2016	COUNTY	2015	2016
Berks	69	117	Luzerne	95	140
Blair	22	43	Lycoming	25	34
Bradford	16	17	McKean	8	7
Bucks	117	168	Mercer	18	31
Butler	47	74	Mifflin	5	6
Cambria	58	94	Monroe	41	41
Cameron	No data	No data	Montgomery	152	230
Carbon	18	17	Montour	8	5
Centre	15	20	Northampton	71	70
Chester	63	97	Northumberland	16	27
Clarion	4	7	Perry	3	9
Clearfield	13	11	Philadelphia	702	907
Clinton	4	10	Pike	7	10
Columbia	16	18	Potter	No data	No data
Crawford	28	32	Schuylkill	25	59
Cumberland	41	58	Snyder	No data	No data
Dauphin	82	84	Somerset	16	21
Delaware	202	206	Sullivan	N/A	N/A
Elk	No data	No data	Susquehanna	6	8
Erie	68	90	Tioga	3	6
Fayette	41	60	Union	2	7
Forest	No data	No data	Venango	11	9
Franklin	21	39	Warren	No data	No data
Fulton	3	11	Washington	73	106
Greene	14	19	Wayne	19	17
Huntingdon	8	7	Westmoreland	126	174
Indiana	35	45	Wyoming	7	7
Jefferson	8	7	York	99	127
Juniata	No data	No data			

As shown in Table 4.3.29-2 Pennsylvania has experienced an increase in drug-related deaths each year since 2014.

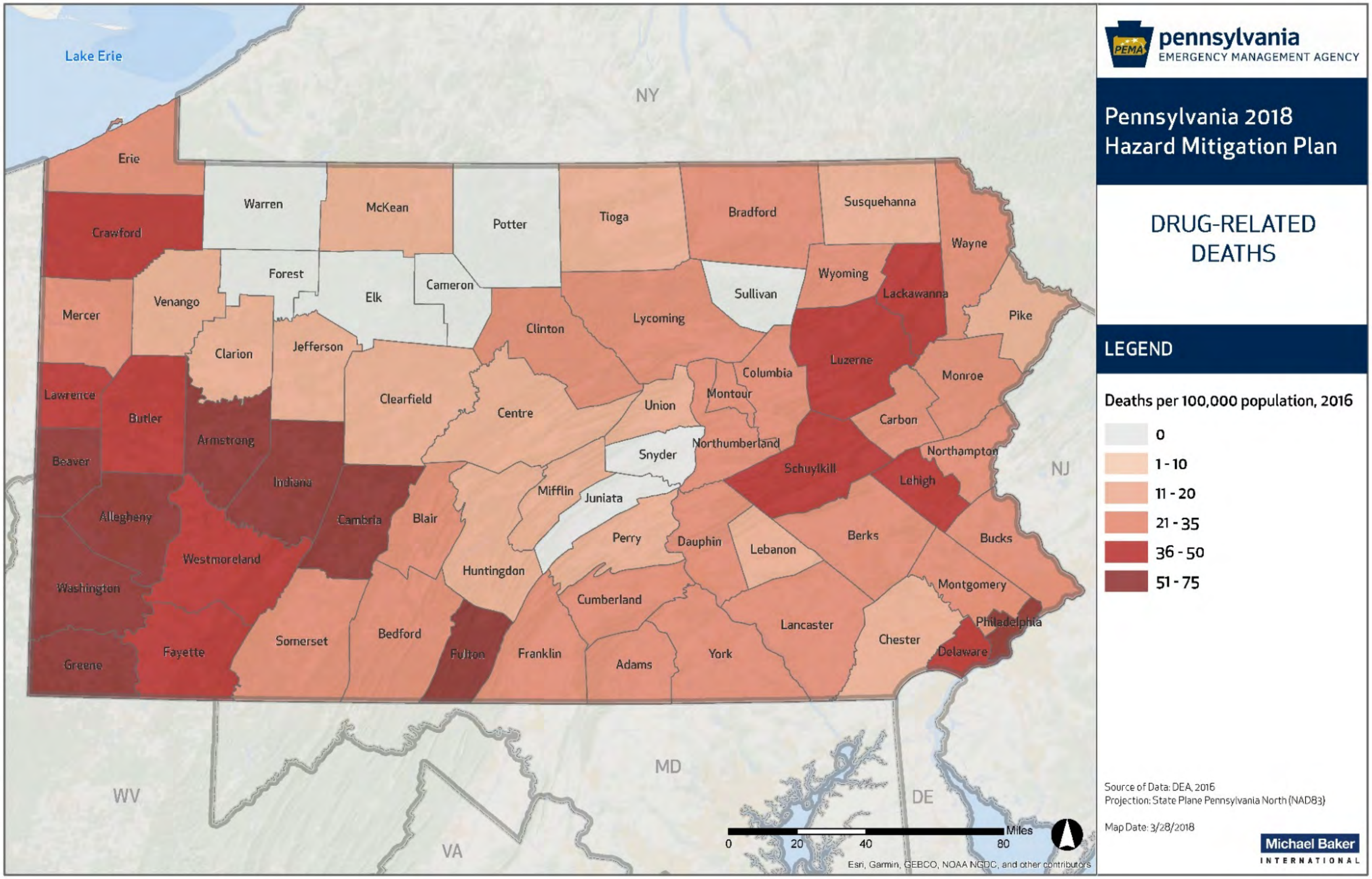
Table 4.3.29-2 Number of Drug-Related Deaths per Year in Pennsylvania (CDC, 2018)

YEAR	TOTAL DEATHS
2014	2,732
2015	3,264
2016	4,627

Table 4.3.29-2 Number of Drug-Related Deaths per Year in Pennsylvania (CDC, 2018)	
YEAR	**TOTAL DEATHS**
2017	5,545

Figure 4.3.29-1 illustrates the number of all drug-related deaths per 100,000 people in each Pennsylvania county in 2016. Philadelphia and Allegheny Counties experienced the largest total numbers of drug-related deaths. However, the five counties with the highest number of drug-related deaths per capita were Fulton, Cambria, Beaver, Armstrong, and Philadelphia respectively which corresponds to the number of reported overdoses that same year. Fentanyl related substances were present in 52 percent of decedents and heroin was present in 45 percent of decedents (DEA, 2016). County specific data for 2017 has not yet been released by CDC or DEA.

Figure 4.3.29-1 Number of drug related-deaths per 100,000 people in 2016 (DEA, 2016).



Though the opioid addiction crisis is complex and unprecedented, it is widely acknowledged that the opioid crisis began in the late 1990s when pharmaceutical companies introduced opioid-based pain medication, such as OxyContin, Percocet, and Vicodin. As these drugs became more frequently prescribed, misuse and overdose increased and it became clear that prescription opioids were highly addictive. (NIDA, 2018).

4.3.29.4. Future Occurrence

Pennsylvania has seen a steady rise in opioid related deaths over the last several years, with drug-related death rates increasing 102 percent between 2014 and 2017. If opioid related deaths continue to increase at this pace then the Commonwealth could experience an estimated 10,000 drug-related deaths in the year 2020.

However, future occurrences of opioid addiction and misuse, overdose, and fatalities are unclear as the state moves forward with overdose prevention initiatives. In January 2018, Governor Tom Wolf declared Pennsylvania's opioid addictions epidemic a disaster emergency. This declaration should enhance coordination and data collection between state and local responders, improve tools for families and first responders, and expand treatment access. The declaration also improves access to naloxone, a lifesaving drug that reverses the effects of a drug-overdose. In addition, a new Opioid Coordination Group has is housed within the Pennsylvania Emergency Management Agency. (PA DOH, 2018).

Overall, the probability of future opioid overdose and death is *highly likely* as defined by the Risk Factor Methodology (see Section 4.1).

4.3.29.5. Environmental Impacts

Fentanyl and fentanyl-related substances are hazardous materials and should be treated as such. Contact with fentanyl can impact first responders and family and friends of opioid users. Depending on the potency of the drug, it can take as little as the equivalent of a few grams of table salt to cause health complications (DEA, 2017).

According to a recent study, environmental scientists at the Cary Institute of New York found traces of opioids and other drugs in streams, rivers, and lakes. These traces came from human urine and feces, and medications that have been flushed down the toilet. However, the ecological and environmental impacts are unknown. The United States Environmental Protection Agency (EPA) suggests while the risks of pharmaceuticals found in wastewater, ambient water, and drinking water is low, further research is needed (EPA, 2014).

4.3.29.6. State Facility Vulnerability Assessment and Loss Estimation

State facilities are not at risk to the opioid crisis, but there are some occupation-specific risks that may make some employees more vulnerable. State employees working in direct patient care are vulnerable to fentanyl exposure. Since fentanyl can be ingested orally, inhaled through the nose or mouth, or absorbed through the skin or eyes, any substance suspected to contain fentanyl should be handled with extreme caution. Exposure to a small amount of fentanyl can lead to respiratory depression or death. Fentanyl-related substances have been found in powders, pills, capsules, liquids, and on blotter paper. The DEA recommends that all first responders carry a Personal Protective Equipment (PPE) kit that includes: nitrile gloves, N-95 dust masks, sturdy eye protection, paper coveralls and shoe protection, and naloxone injectors. The DEA also suggests using extreme caution when using police dogs, as they are at serious risks to health complications from inhaling fentanyl and fentanyl-related substances (DEA, 2017).

The physical plant and facilities of the Commonwealth are not likely to experience losses from the opioid addiction crisis. However, absenteeism associated with an opioid addiction in state facilities located in high-risk areas could lead to economic loss through lost productivity and increased medical costs.

4.3.29.7. Jurisdictional Vulnerability Assessment and Loss Estimation

In general, jurisdictions that are more densely populated are more vulnerable to opioid addiction threats as access to the drugs increases. However, as stated above, rural communities in general experienced larger per-capita opioid-related deaths.

Northumberland and Wyoming Counties profiled Opioid Addiction in their multi-jurisdictional hazard mitigation plans and ranked them low and medium, respectively.

Jurisdictional losses in the opioid addiction crisis stem from lost wages, productivity, and resources rather than losses to buildings or land. Locally, many Pennsylvania counties have seen an increase of time and resources devoted to the opioid epidemic as overdose and response increases however there is no comprehensive tracking mechanism to record total local losses associated with the opioid crisis.

Impacts including total costs to jurisdictions are only beginning to be understood, researched, and tracked. There is no comprehensive database currently tracking monetary losses at the local level. However, the American Enterprise Institute (AEI), using national data from the CDC and White House Council of Economic Advisors, calculated a total cost per capita ($1,799), of the opioid epidemic for Pennsylvania. Using this per capita estimate in combination with county population estimates, losses have been distributed by county as depicted in Table 4.3.29.3. The total estimated cost to Pennsylvania is more than $23 billion. It is important to note that this methodology assumes equal per capita opioid misuse and fatality across all counties however, based on reported drug overdoses and drug related deaths, it is known that some counties, including those in the southwestern region, are more vulnerable and more likely to experience higher per capita costs while counties in central and north central Pennsylvania tend to be less vulnerable and likely have lesser costs per capita. Another important caveat regarding this methodology is that that a portion of the costs will have been state losses rather than county or jurisdictional but the ratio of state to local cost burden is unknown at this time.

Nationally, the economic cost of the opioid addiction crisis is estimated at $504 billion (CEA, 2017).

Table 4.3.29-3 Estimated total cost of opioid addiction through 2015 based on per capita estimates by County (AEI 2018, USCensus 2018)

COUNTY	COST ($)	COUNTY	COST ($)
Adams	184,102,464	Lackawanna	379,159,039

Table 4.3.29-3 Estimated total cost of opioid addiction through 2015 based on per capita estimates by County (AEI 2018, USCensus 2018)			
COUNTY	**COST ($)**	**COUNTY**	**COST ($)**
Allegheny	2,200,263,352	Lancaster	976,682,497
Armstrong	118,089,958	Lawrence	156,637,131
Beaver	298,885,860	Lebanon	251,417,446
Bedford	87,215,520	Lehigh	659,322,706
Berks	751,719,346	Luzerne	570,900,057
Blair	222,099,143	Lycoming	204,799,959
Bradford	109,474,547	McKean	74,352,670
Bucks	1,130,385,459	Mercer	201,038,250
Butler	336,607,292	Mifflin	83,452,012
Cambria	239,364,146	Monroe	302,314,754
Cameron	8,261,008	Montgomery	1,486,108,925
Carbon	114,871,547	Montour	32,871,328
Centre	292,625,340	Northampton	545,825,595
Chester	934,208,107	Northumberland	165,560,171
Clarion	69,185,942	Perry	82,982,473
Clearfield	143,353,315	Philadelphia	2,843,972,537
Clinton	70,157,402	Pike	100,188,109
Columbia	118,611,668	Potter	30,226,798
Crawford	155,000,041	Schuylkill	256,481,631
Cumberland	449,868,734	Snyder	73,400,999
Dauphin	496,002,290	Somerset	134,027,299
Delaware	1,015,888,104	Sullivan	10,954,111
Elk	54,324,403	Susquehanna	73,732,015
Erie	493,899,259	Tioga	73,386,607
Fayette	236,575,696	Union	80,226,405
Forest	13,127,303	Venango	93,119,838
Franklin	277,466,966	Warren	71,346,541
Fulton	26,247,410	Washington	372,929,102
Greene	66,149,230	Wayne	92,117,795
Huntingdon	81,838,309	Westmoreland	634,375,973
Indiana	152,830,447	Wyoming	49,152,278
Jefferson	78,803,396	York	802,494,322
Juniata	44,100,686	**TOTAL**	**23,037,161,063**

Beaver County has been heavily burdened with the rising costs of the opioid crisis. With the number of deaths increasing in Beaver County from 328 deaths in 2015 to 758 in 2017, the Beaver County Coroner's Office devotes a great deal of time and resources to drug-related deaths. In addition to the loss of productivity of addicts, the cost of treating and incarcerating addicts, the loss of business, and theft due to opioid addiction in 2016, the county has also spent thousands of dollars on naloxone and prescription programs (The Times, 2018).

Indiana County has also had significant financial burden on their first responders service, coroner costs, and court costs. Coroner costs have almost doubled in six years, with $89,000 spent on autopsies in 2010, to $165,000 spent in 2016. The county has lost more than $100,000 on ambulance services. If the opioid addiction crisis continues to increase, Indiana County may be forced to cut ambulance services or raise taxes (Reuters, 2017).

4.3.30. Terrorism

4.3.30.1. Location and Extent

Terrorism is a threat everywhere. Though there is no universal definition of terrorism, the Federal Bureau of Investigation (FBI) defines terrorism 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.

There are many important considerations in evaluating terrorism hazards, such as the existence of facilities, landmarks, or other buildings of international, national, or regional importance. Military and civilian government facilities, international airports, large cities, and high-profile landmarks are considering high-risk targets, according FEMA. Other targets can include large public gatherings, water and food supplies, utilities, and corporate centers. Terrorists can also use cyber-attacks or send explosive, chemical, or biological agents through the mail (FEMA, 2013). Terrorism can take many forms and terrorists have a wide range of personal, political, or cultural agendas. Any location could therefore be a potential terrorist target.

Of particular concern to Pennsylvania are the many critical facilities in the Commonwealth. Police stations, hospitals, military installations, fire stations, schools, wastewater treatment plants, and nuclear power generation stations along with critical infrastructure such as bridges, tunnels, electric generation and distribution facilities, public water supplies, and government buildings may be potential terrorist targets. Damage to these facilities and infrastructure could cripple transportation routes and commerce. Additionally, there are over 3,300 SARA Title III facilities as well as many transportation routes vital to the entire nation traversing the Commonwealth, making intentional hazard material releases a potential threat to citizens and the environment. Environmental hazards related to hazardous material releases are addressed in full in Section 4.3.23.

4.3.30.2. Range of Magnitude

The term “terrorism” refers to intentional, criminal, and malicious acts, but the functional definition of terrorism can be interpreted in many ways. The Federal Bureau of Investigation (FBI) classifies terrorism into two categories:

- **International terrorism**: Violent acts committed by individuals and/or groups inspired by or associated with designated foreign terrorist organizations or nations, and
- **Domestic terrorism**: Acts carried out by individuals and/or groups inspired by or associated with primarily U.S.-based movements that support extremist ideologies of a political, religious, social, racial, or environmental nature.

FEMA defines the three main goals of terrorism as causing public fear, convincing citizens that the government cannot protect against terrorism, and making the motivating causes known to the public. Terrorist attacks can take many forms. FEMA identifies the following as some of the common tactics of terrorism:

- Agriterrorism—food contamination or destruction of crops via pest introduction or disease agents
- Arson/incendiary attack
- Armed attack
- Assassination
- Biological agent
- Chemical agent
- Cyberterrorism
- Conventional bomb
- Hijackings
- Intentional hazardous material release
- Kidnapping
- Nuclear bomb
- Radiological agent

Explosives have been a prominent method of conducting terrorism, but intelligence suggests that the possibility of biological or chemical terrorism is increasing. The FBI has found that the Internet, the rise of social media, and domestic extremists known as Homegrown Violent Extremists (HVEs) are reshaping terrorism and changing its form (FBI 2018).

The severity of terrorist incidents depends upon the method of attack, the proximity of the attack to people, animals, or other assets and the duration of exposure to the incident or attack device. For example, chemical agents are poisonous gases, liquids or solids that have toxic effects on people, animals, or plants. Many chemical agents can cause serious injuries or death. In this case, severity of injuries depends on the type and amount of the chemical agent used and the duration of exposure.

Biological agents are organisms or toxins that have illness-producing effects on people, livestock and crops. Some biological agents cannot be easily detected and may take time to develop. Therefore, it can be difficult to know that a biological attack has occurred until victims display symptoms. In other cases, the effects are immediate. Those affected by a biological agent require the immediate attention of professional medical personnel. Some agents are contagious which may result in the need for victims to be quarantined.

In recent years, cyber terrorism has become a larger threat than in years past. 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. 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. One of the more prominent groups involved in large-scale hacking events recently is the group Fancy Bears from Russia. They have been known to overtake websites, steal information, and alter the content that is presented to the public. 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. Further information about cyber-terrorism can be found in Section 4.3.19.

An active shooter, as defined by the U.S. 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 no pattern or method to their selection of victims. Recent high-profile incidents involving active shooters include: the 2016 Pulse nightclub shooting in Orlando, Florida, the 2017 Las Vegas shooting where a gunman opened fire in a concert setting, and the 2018 Marjory Stoneman Douglas High School shooting in Parkland, Florida. Historical active shooter events include the Sandy Hook Elementary School shootings, the Virginia Tech shootings, and the Columbine High School shootings. No substantive research has yet been compiled to address the potential vulnerability to an active shooter incident. Some of these incidents have occurred in public places, and some in places that are considered more restricted (like elementary schools and high schools). There is no discernible pattern to the location chosen by the shooters.

Instances of terrorism in the Commonwealth have thus far been limited; in the September 11, 2001 attacks, while United Flight 93 crashed in Pennsylvania, its target lay elsewhere. In this incident, four individuals hijacked the plane with the intent of crashing it into a target in Washington, D.C. They failed to reach their destination, and all 40 passengers and crew members on board perished.

The worst-case scenario for a terrorism event in Pennsylvania would be if a “dirty bomb” combining radioactive material with conventional explosives were to be detonated in Center City Philadelphia at lunchtime on a weekday. At that time of day and location, a significant number of individuals would be exposed to the bomb’s radiation both at the time of detonation and after the fact as the radiation spread. The explosive device could damage or even topple buildings, spark utility outages citywide, and/or ignite large-scale urban fires. This worst-case scenario is based on a planning scenario used in developing the Pittsburgh Central Business District Evacuation Plan; the location was switched to Philadelphia as the state’s largest population center.

4.3.30.3. Past Occurrence

There has been a high consciousness of terrorist activity in the press with few catastrophic events. The most significant terrorist attack on US soil occurred on September 11, 2001; Flight 93, the fourth hijacked aircraft in the attack, crashed in Somerset County, Pennsylvania. Another significant recent terrorist event was the detonation of a pair of homemade pressure cooker bombs at the finish line of the Boston Marathon. This event killed three people and injured a further 264 people. While this event did not happen in Pennsylvania, numerous cities throughout the Commonwealth host similar large scale outdoor activities that could be potential target. PEMA was on a state of heightened alert for the Philadelphia Marathon, which occurred shortly after the bombing in Boston.

Pennsylvania regularly experiences threats and suspected terrorist activity, as documented in PEMA's incident management system, PEMA-KC. The annual number of incidents reported across the state is summarized in Table 4.3.30-1. Bomb threats represented the majority of incidents in every year.

Table 4.3.30-1 Threat and suspected terrorist activity events, 2012-2018 (PEMA-KC, 2018)

THREAT/SUSPECTED TERRORIST ACTIVITY TYPE	2012	2013	2014	2015	2016	2017	2018*
Biological Threat	0	0	0	0	0	0	0
Bomb Found	2	5	1	2	2	1	1
Bomb Threat	29	182	207	206	152	132	35
Cyber Attacks	0	0	0	0	0	2	0
Hostage Situation	2	3	3	6	5	2	1
Sabotage	0	0	0	0	0	0	0
School Bomb Threat	5	41	37	46	39	24	6
Suspected Terrorism	0	1	0	0	1	0	0
Terroristic Threat	1	9	2	4	1	1	3
Terrorist Activity - totals	*39*	*241*	*250*	*264*	*200*	*162*	*46*
**Events totaled through April 2018*							

In addition, suspicious activity plays into terrorism hazards because of the uncertainty associated with those events. Table 4.3.30-2 displays suspicious activity events as reported to PEMA-KC from January 2012 to April 2018.

Table 4.3.30-2 Threat and suspected suspicious activity events, 2012-2018 (PEMA-KC, 2018)

THREAT/SUSPECTED SUSPICIOUS ACTIVITY TYPE	2012	2013	2014	2015	2016	2017	2018*
Suspicious Activity	24	171	117	107	88	70	20
Suspicious Device	5	20	11	15	12	8	1
Suspicious Package	8	62	44	38	47	38	13
Suspicious Substance	0	6	3	6	1	1	0
Terrorist Activity - totals	*37*	*259*	*175*	*166*	*148*	*117*	*34*
**Events totaled through April 2018*							

4.3.30.4. Future Occurrence

Based on historical events, Pennsylvania can expect to experience several terrorist incidents and suspicious activities each year. Note that this estimate is based on the occurrence of past events over a short period of time and is not the result of detailed statistical sampling. Although previous events have not resulted in what are considered significant terrorist attacks, the severity of a future incident cannot be predicted with a sufficient level of certainty. Prediction of terrorist attacks is almost impossible because terrorism is a result of human factors. As long as fringe groups maintain radically different ideas than that of the government or general population, terrorism is a possibility.

4.3.30.5. Environmental Impacts

The impacts of terrorism can vary in severity from nominal to catastrophic and are contingent upon the method of the attack, the volume of force applied, and the population density of the attack site. There may be significant loss of life for humans and animals as well as economic losses. Additionally, the impact of the attack itself may be exacerbated by the fact that human services agencies like community support programs, health and medical services, public assistance programs, and social services can experience physical damage to facilities, supplies, and equipment, as well as disruption of emergency communications. There may also be ancillary effects of terrorism such as urban fires or, in the case of a radiological device, radioactive fallout that can multiply the impact of a terrorist event.

4.3.30.6. State Facility Vulnerability Assessment and Loss Estimation

Since the probability of terrorism occurring cannot be quantified in the same way as that of many natural hazards, it is not possible to assess vulnerability in terms of likelihood of occurrence. Instead, vulnerability is assessed in terms of specific assets. By identifying potentially at-risk terrorist targets in Pennsylvania, planning efforts can be put in place to reduce the risk of attack. FEMA's *Integrating Manmade Hazards into Mitigation Planning* (2003) encourages site-specific assessments that 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 Heating, Ventilating and Air Conditioning (HVAC) systems protected and/or backed up with redundant systems?
- Electrical Engineering – Are emergency power and telecommunications available? Are alarm systems operational? Is lightning 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?

All state facilities are vulnerable to terrorism in some way, whether or not the facility itself is the target of an attack. While highly unlikely that all critical facilities would be destroyed in a single event, the total replacement cost of all state critical facilities with known replacement values is $193,956,142,183.

4.3.30.7. Jurisdictional Vulnerability Assessment and Loss Estimation

All communities in the Commonwealth are vulnerable on some level, directly or indirectly, to a terrorist attack. However, larger cities like Philadelphia and Pittsburgh are the most vulnerable to terrorist attacks due to the sheer size of these urban areas, density of the population, and concentration of critical infrastructure located there. Port facilities in Pittsburgh, Philadelphia, and Erie are also possible targets because of their role as logistics hubs. Because of its status as the state capital, Harrisburg also has elevated vulnerability.

Jurisdictional loss estimates can vary greatly in a terrorism event based on the magnitude and type of terrorist action. Catastrophic terrorism events will have proportionally catastrophic losses for the jurisdiction in question. For example, losses may be greater in an event that results in the complete destruction of a high-rise building; in that scenario, losses will stem from loss of life, the actual destruction of the building, and business interruptions. For comparison's sake, the total losses incurred by New York City in the September 11, 2001 attacks are estimated at $83-95 billion. This loss estimate includes lost tax revenue for the city, the cost of response and recovery, business interruptions, deaths, building damage, and infrastructure damage. The cost of evacuation could be significant; the City of Pittsburg estimates that should a large-scale terrorist event occur in the central business district, they would have to evacuate approximately 65,000 workers and approximately 7,000 university students. Likewise, many visitors to the central business district would require evacuation assistance. While Pennsylvania's cities are certainly smaller than New York, losses could still be severe.

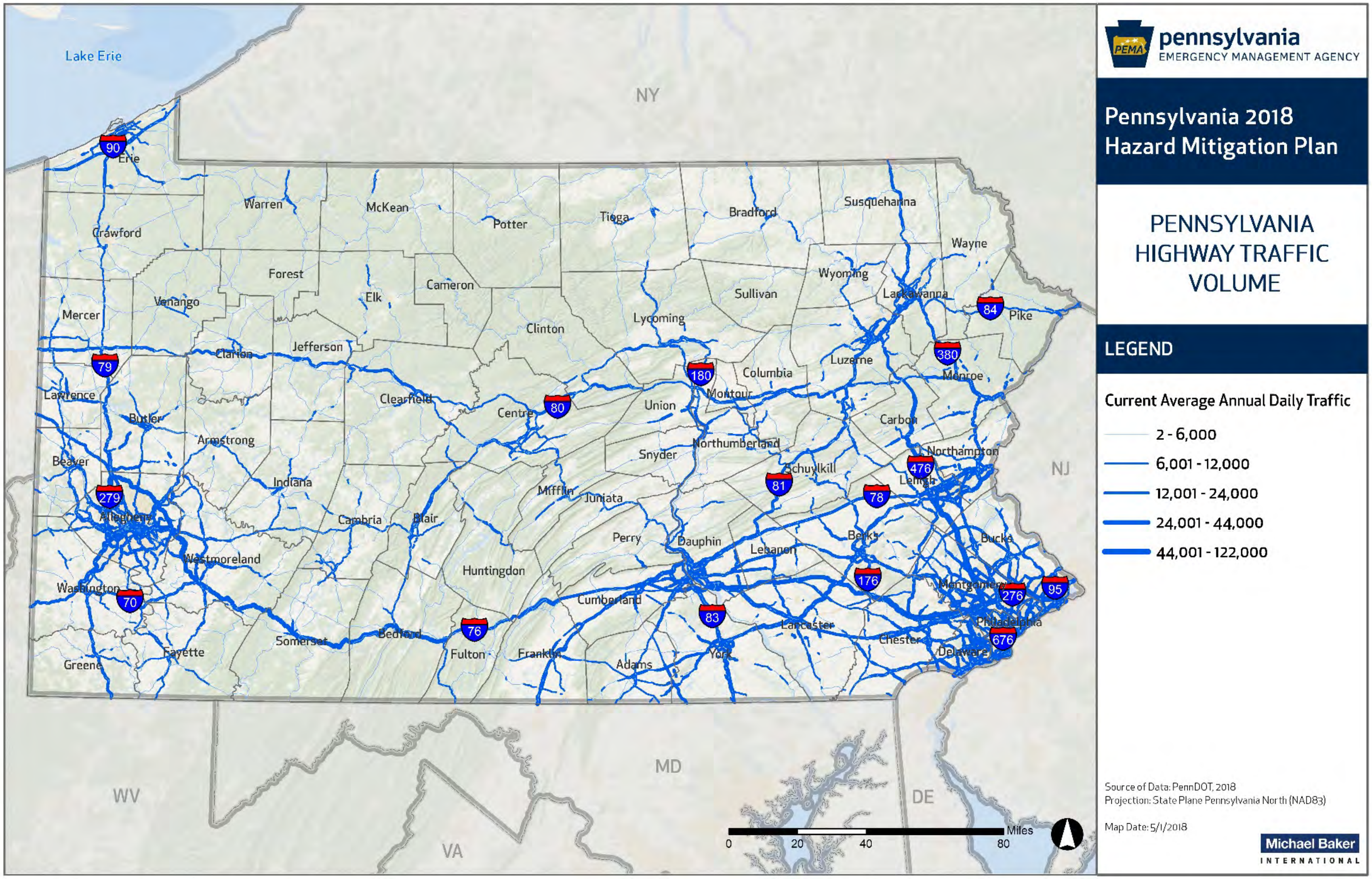
4.3.31. Transportation Accident

4.3.31.1. Location and Extent

Transportation accidents are defined as accidents involving highway, air, and rail travel. These incidents are collectively the costliest of all hazards in the Commonwealth in terms of lives lost, injuries, and economic losses. Pennsylvania has the fifth largest state highway system in the United States – larger than New York, New Jersey, and New England combined. Pennsylvania's highway transportation network consists of 119,000 linear miles of roadway, of which Pennsylvania Department of Transportation (PennDOT) is responsible for 40,500 miles, and 31,800 bridges, of which 25,000 are owned by PennDOT (Federal Highway Administration, 2017). Daily vehicle miles traveled (DVMT) on the Pennsylvania highway system is 276,966,605; 66% of this total occurs in urban areas while 34% occurs in rural areas (PennDOT, 2016). The sheer amount of roadway coupled with the high volume of traffic creates the potential for serious accidents along the Commonwealth's roads and bridges.

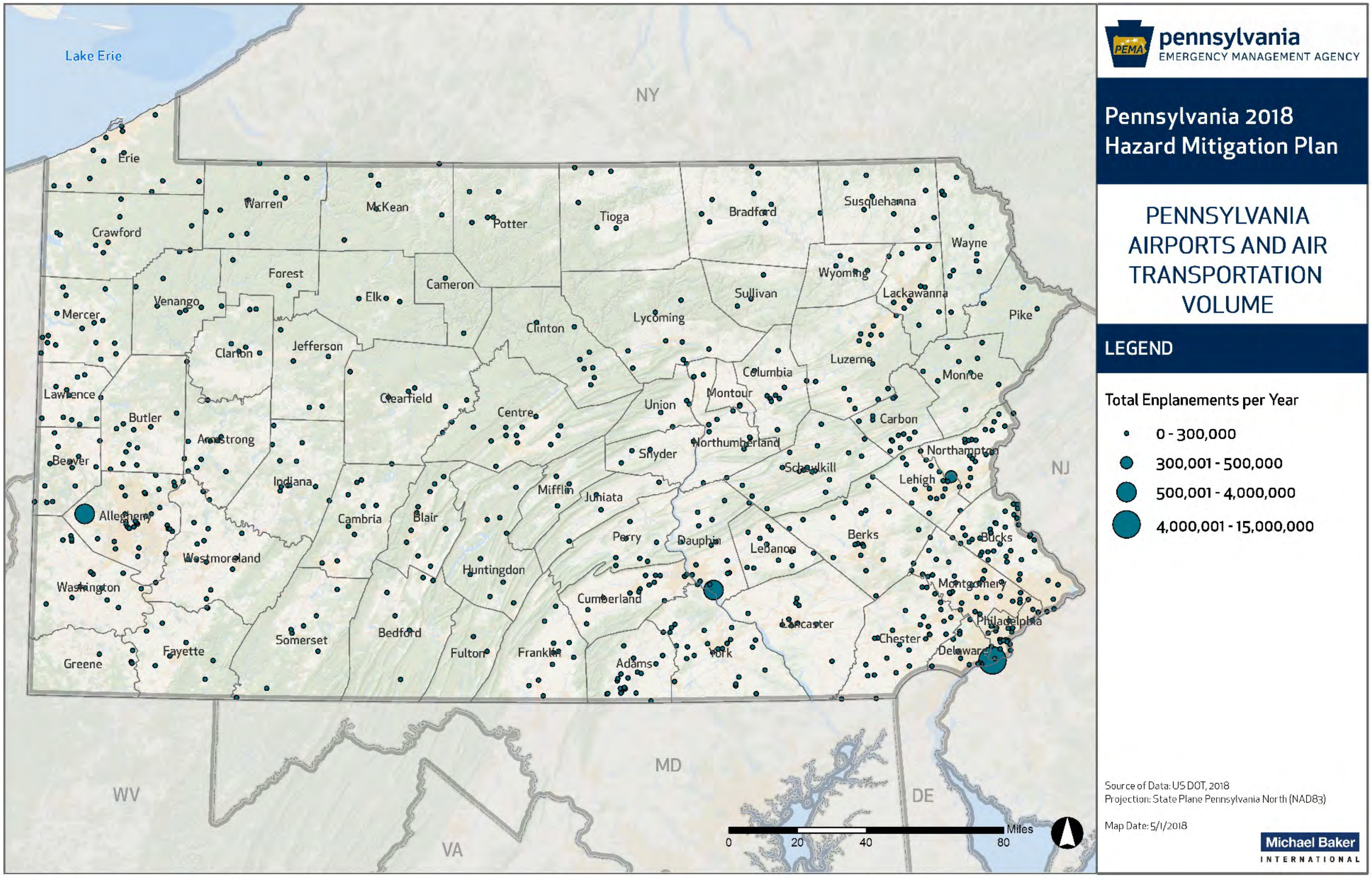
Pennsylvania's highway transportation network encompasses a number of key routes for the movement of goods and people, including Interstates 76 (PA Turnpike), 78, 79, 80, 81, 95, and 476 (PA Turnpike Northeast Extension) and US Routes 1, 15, 22, 30, 202, and 422 (PennDOT, 2016). Figure 4.3.31-1 illustrates the average annual daily traffic for Pennsylvania roads; this map highlights the volume of traffic on these and other key routes.

Figure 4.3.31-1 Average annual daily traffic on the Pennsylvania highway system (PennDOT 2018).



With 128 public use airports (including 15 commercial airports), 291 private-use airports and 288 private-use heliports across the Commonwealth (PennDOT, 2018b). Considering the number of commercial air traffic flyovers that occur every day, there exists a potential extent for air transportation accidents statewide. However, a five-mile radius around each airport can be considered a high-risk area since most aviation incidents occur near take-off and landing site. Figure 4.3.31-2 illustrates Pennsylvania's major airports and their associated yearly commercial passenger enplanements.

Figure 4.3.31-2 Pennsylvania airports and their air transportation volumes (US DOT, 2018).



Rail transportation accidents are generally classified as one of three types:

- Derailment – an accident on a railway in which a train leaves the rails;
- Collision – an accident in which a train strikes something such as another train or highway motor vehicle; and
- Other – accidents caused by other circumstances like obstructions on rails, fire, or explosion.

Rail accidents can occur anywhere along the more than 5,000 linear miles of track in the Commonwealth. Rail transportation is divided into two major categories: freight and passenger. Each category can be subdivided according to carrier type: major carrier (SFX, Norfolk Southern, Amtrak, etc.) and local or regional carriers (company/business owned and operated, regional transit agencies, etc.). There are more than 50 railroad companies operating in Pennsylvania (PennDOT, 2016b).

River traffic is now a planning consideration for the Commonwealth. Barges breaking away from moorings or their pilot boats can be a hazard. These barges can carry a wide variety of loads, including hazardous materials. Runaway barges can pose a threat to other river traffic, physical structures over and next to the waterway, and even the properties that line a waterway. Much of the potential threat depends on the load being carried. Recent events in April of 2018 included a barge colliding with a major bridge in downtown Pittsburgh.

4.3.31.2. Range of Magnitude

Significant passenger vehicle, air, and rail transportation accidents can result in a wide range of outcomes from damage solely to property to serious injury or death. Most air incidents are non-fatal and cause minor injuries or property damage. The majority of motor vehicle crashes are non-fatal in Pennsylvania, but PennDOT estimates that every hour nine people are injured in a car crash, and every seven hours someone dies as a result of a car crash. Most fatal crashes occur in May and June but the highest number of crashed overall occur in October, November, and December (PennDOT, 2016).

Railway and roadway accidents in particular have the potential to result in hazardous materials release (See Section 4.3.24). Transportation accidents can also result in broader infrastructure damage.

The worst transportation accident on record occurred in May 1998 when a tanker carrying gasoline exploded on Interstate 95 in Delaware County, causing two deaths and significant damage. The fire was so hot that it buckled the bridge girders and forced months of repairs that affected the nation’s major east coast roadway (New York Times 1998). The governor declared this event a disaster; because of its wider impact and declaration status, it can be considered the worst-case event.

4.3.31.3. Past Occurrence

Vehicular transportation accidents are a daily occurrence in the Commonwealth. According to PennDOT, in 2016, there was an average of 355 reportable crashes daily. Reportable crashes are crashes resulting in a death or injury in any degree to any person involved or crashes resulting in damage to any vehicle serious enough to require towing. In 2012, there were 124,092 reportable crashes resulting in 1,310 deaths and 86,846 injuries. In 2016, there were 129,395 reportable crashes (a 1.8% increase over 2015) resulting in 1,188 deaths (a 1.0% decrease from 2015) and 82,971 injuries (an increase of 1.2% from 2011). Of the injuries, just about 5.3% were classified as serious. Table 4.3.31-1 illustrates trends in crashes, deaths, and injuries from 2012-2016 (PennDOT, 2016).

Table 4.3.31-1 Pennsylvania vehicular transportation accident trends, 2012-2016 (PennDOT, 2016)

	2012	2013	2014	2015	2016
Reported Crashes	124,092	124,149	121,317	127,127	129,395
Total Fatalities	1,310	1,208	1,195	1,200	1,188
Total Injuries	86,846	83,089	79,758	82,004	82,971
Suspected Serious Injury	*3,458*	*3,254*	*3,042*	*3,030*	*4,397*
Suspected Minor Injury	*13,519*	*12,662*	*12,075*	*12,503*	*26,284*
Possible Injury	*43,441*	*41,755*	*40,071*	*40,364*	*23,050*
Unknown Severity	*26,428*	*25,418*	*24,570*	*26,107*	*29,240*
Deaths per 100 Million Vehicle-Miles	1.31	1.21	1.21	1.20	1.18

Aviation accidents are the least frequent type of transportation accident. The National Transportation Safety Board, the federal agency responsible for aviation accident information, indicates that from 2006-2017, there were 364 air transportation accidents in Pennsylvania. Most of these accidents involved small aircraft and many resulted in only minimal injuries. Of the total accidents, 59 were fatal, resulting in 86 deaths (NTSB, 2018).

According to the Federal Railroad Administration (FRA), there have been 296 rail incidents from 2014-2017 in the Commonwealth. During this time, there were reported a total of 382 injuries and 11 deaths from these accidents. This includes the deadly Amtrak derailment in Philadelphia that occurred in May of 2015 and led to the death of 8 passengers, 241 injuries, and over $30 million in damages. Table 4.3.31-2 provides an account of these recent rail accidents and their associated damages (FRA, 2018).

Table 4.3.31-2 Rail incidents in Pennsylvania from 2014-2017 (FRA, 2018).

COUNTY	2014 INCIDENTS	2014 DAMAGES	2015 INCIDENTS	2015 DAMAGES	2016 INCIDENTS	2016 DAMAGES	2017 INCIDENTS	2017 DAMAGES	TOTAL INCIDENTS	TOTAL DAMAGES
Adams	0	$0	0	$0	0	$0	0	$0	0	$0
Allegheny	11	$1,288,010	10	$388,424	10	$956,778	5	$403,031	36	$3,036,243
Armstrong	2	$77,000	0	$0	0	$0	0	$0	2	$77,000
Beaver	29	$780,379	9	$572,769	6	$276,085	9	$234,788	53	$1,864,021
Bedford	0	$0	0	$0	0	$0	1	$2,205,216	1	$2,205,216
Berks	1	$44,453	1	$19,100	2	$61,264	1	$18,700	5	$143,517
Blair	5	$1,981,558	2	$251,079	2	$132,775	7	$111,864	16	$2,477,276
Bradford	1	$14,100	2	$132,000	0	$0	2	$101,000	5	$247,100
Bucks	3	$73,829	6	$206,589	6	$98,658	2	$346,000	17	$725,076
Butler	0	$0	1	$627,693	0	$0	0	$0	1	$627,693
Cambria	5	$596,545	1	$14,376	1	$70,000	0	$0	7	$680,921
Cameron	0	$0	0	$0	0	$0	0	$0	0	$0
Carbon	0	$0	0	$0	0	$0	0	$0	0	$0
Centre	0	$0	0	$0	0	$0	1	$36,900	1	$36,900
Chester	1	$10,782	0	$0	4	$67,280	1	$11,687	6	$89,749
Clarion	0	$0	0	$0	0	$0	0	$0	0	$0
Clearfield	0	$0	0	$0	1	$18,700	0	$0	1	$18,700
Clinton	0	$0	0	$0	0	$0	0	$0	0	$0
Columbia	0	$0	0	$0	0	$0	0	$0	0	$0
Crawford	1	$13,000	0	$0	0	$0	0	$0	1	$13,000
Cumberland	5	$76,480	9	$373,943	2	$46,984	3	$57,691	19	$555,098
Dauphin	3	$177,360	3	$184,052	5	$357,775	5	$226,514	16	$945,701
Delaware	4	$46,210	10	$118,164	4	$3,807,857	0	$0	18	$3,972,231
Elk	0	$0	0	$0	0	$0	0	$0	0	$0
Erie	1	$25,025	2	$44,200	2	$103,310	2	$36,310	7	$208,845
Fayette	4	$28,156	3	$216,510	0	$0	2	$18,642	9	$263,308
Forest	0	$0	0	$0	0	$0	0	$0	0	$0

Table 4.3.31-2 Rail incidents in Pennsylvania from 2014-2017 (FRA, 2018).

COUNTY	2014 INCIDENTS	2014 DAMAGES	2015 INCIDENTS	2015 DAMAGES	2016 INCIDENTS	2016 DAMAGES	2017 INCIDENTS	2017 DAMAGES	TOTAL INCIDENTS	TOTAL DAMAGES
Franklin	1	$20,557	1	$43,670	0	$0	0	$0	2	$64,227
Fulton	0	$0	0	$0	0	$0	0	$0	0	$0
Greene	1	$229,486	0	$0	0	$0	0	$0	1	$229,486
Huntingdon	0	$0	1	$57,504	1	$11,318	0	$0	2	$68,822
Indiana	0	$0	1	$38,939	1	$39,800	2	$146,285	4	$225,024
Jefferson	0	$0	0	$0	0	$0	0	$0	0	$0
Juniata	0	$0	0	$0	0	$0	0	$0	0	$0
Lackawanna	2	$99,627	0	$0	1	$50,600	3	$264,676	6	$414,903
Lancaster	2	$32,000	1	$39,503	1	$31,328	1	$27,927	5	$130,758
Lawrence	0	$0	0	$0	1	$63,894	0	$0	1	$63,894
Lebanon	0	$0	0	$0	1	$25,970	0	$0	1	$25,970
Lehigh	3	$51,571	6	$190,302	2	$65,743	4	$97,394	15	$405,010
Luzerne	0	$0	0	$0	2	$15,000	1	$1,000	3	$16,000
Lycoming	1	$428,438	0	$0	0	$0	0	$0	1	$428,438
McKean	0	$0	0	$0	0	$0	0	$0	0	$0
Mercer	2	$48,807	0	$0	0	$0	0	$0	2	$48,807
Mifflin	0	$0	0	$0	0	$0	1	$2,066,216	1	$2,066,216
Monroe	1	$94,369	0	$0	0	$0	1	$392,039	2	$486,408
Montgomery	0	$0	4	$104,463	4	$138,868	0	$0	8	$243,331
Montour	0	$0	0	$0	0	$0	1	$48,269	1	$48,269
Northampton	3	$168,460	1	$18,992	3	$61,395	1	$60,700	8	$309,547
Northumberland	0	$0	0	$0	0	$0	0	$0	0	$0
Perry	1	$36,188	1	$17,060	0	$0	0	$0	2	$53,248
Philadelphia	22	$648,461	21	$31,908,351	8	$234,746	6	$212,083	57	$33,003,641
Pike	0	$0	0	$0	0	$0	0	$0	0	$0
Potter	0	$0	0	$0	0	$0	0	$0	0	$0
Schuylkill	0	$0	0	$0	0	$0	0	$0	0	$0

Table 4.3.31-2 Rail incidents in Pennsylvania from 2014-2017 (FRA, 2018).										
COUNTY	2014 INCIDENTS	2014 DAMAGES	2015 INCIDENTS	2015 DAMAGES	2016 INCIDENTS	2016 DAMAGES	2017 INCIDENTS	2017 DAMAGES	TOTAL INCIDENTS	TOTAL DAMAGES
Snyder	0	$0	0	$0	0	$0	0	$0	0	$0
Somerset	2	$45,340	1	$15,480	1	$29,159	2	$431,650	6	$521,629
Sullivan	0	$0	0	$0	0	$0	0	$0	0	$0
Susquehanna	0	$0	0	$0	0	$0	0	$0	0	$0
Tioga	0	$0	0	$0	0	$0	0	$0	0	$0
Union	0	$0	0	$0	0	$0	0	$0	0	$0
Venango	3	$45,482	0	$0	1	$24,000	0	$0	4	$69,482
Warren	0	$0	0	$0	0	$0	0	$0	0	$0
Washington	0	$0	1	$14,127	1	$12,390	0	$0	2	$26,517
Wayne	0	$0	0	$0	0	$0	0	$0	0	$0
Westmoreland	1	$2,323,253	0	$0	1	$14,379	0	$0	2	$2,337,632
Wyoming	0	$0	0	$0	0	$0	0	$0	0	$0
York	0	$0	2	$185,450	1	$48,744	2	$22,115	5	$256,309
Total*	**97**	**$9,504,926**	**79**	**$35,782,740**	**66**	**$6,864,800**	**54**	**$7,578,697**	**296**	**$59,731,163**

*Total incidents are based on individual accidents. Some accidents are counted in multiple counties, but the report records incidents separately based on counties.

4.3.31.4. Future Occurrence

With the volume of goods and people moving through Pennsylvania, transportation accidents will continue to occur routinely, especially passenger vehicle accidents

In the case of highway accidents, PennDOT has taken great strides to reduce the number of highway transportation accidents through programs such as the Pennsylvania Highway Safety Corridor. In this program, PennDOT designates sections of highway where traffic citation fines are doubled in the hope that higher fines will deter unsafe driving and reduce accidents.

The number of rail accidents nationally has been falling for the last four years.

Additionally, the probability of aviation accidents nationwide was 3.45 accidents per 100,000 flight hours in 2016. This accident rate has decreased each year since 2013 when it was 4.95 accidents per 100,000 flight hours (FAA, 2018). This means that the likelihood of air transportation accidents in the Commonwealth remains low.

Overall, the probability of future transportation accidents is *highly likely* as defined by the Risk Factor Methodology (see Section 4.1).

4.3.31.5. Environmental Impacts

Like the range of magnitude, the environmental impacts of transportation accidents can vary greatly. In the case of a simple motor vehicle crash, train derailment, or aviation accident, the environmental impact is minimal. However, if the accident involves any type of vehicle moving chemicals or other hazardous materials, the impact will be considerably larger and may include an explosion or the release of potentially hazardous material. For a complete discussion of the environmental impacts of hazardous materials releases, see Section 4.3.24.

4.3.31.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to highway accidents, all structures located within one-quarter mile of major Interstates, US Highways, and/or state highways, shown in Figure 4.3.31-1, were identified. For this assessment, one-quarter mile was selected as a representative distance within which death, injury, or significant property damage could occur. In addition, the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 2878, or 64.5 percent, are located within a quarter mile of an Interstate, US highway, or state highway (Table 4.3.31-3). These facilities have a combined replacement value of more than $1.48 billion, or approximately 37.8 percent of the known value of geolocated state facilities.

Table 4.3.31-3 Vulnerability of state facilities to highway accidents		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	7	78%
Department of Agriculture	9	56%
Department of Banking and Securities	1	50%
Department of Community and Economic Development	2	50%
Department of Conservation and Natural Resources	1	50%
Department of Corrections	405	58%
Department of Education	1	100%
Department of Environmental Protection	9	69%
Department of General Services	59	45%
Department of Health	35	73%
Department of Labor and Industry	40	58%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	58	59%
Department of Revenue	7	70%
Department of Transportation	1,317	78%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	7	88%
Executive Offices	1	50%
Fish and Boat Commission	86	56%
Governor's Office	1	100%
Historical and Museum Commission	21	70%
Insurance Department	0	0%
Liquor Control Board	412	75%
Public School Employees' Retirement System	2	33%
State Civil Service Commission	1	100%
State Department	**0**	0%
State Employees' Retirement System	1	25%
State Police	23	64%
State System of Higher Education	350	41%
Thaddeus Stevens College of Technology	20	100%
Treasury Department	2	100%
Total	2,878	65%

Of the 14,011 geolocated critical facilities, 6,278 or 45 percent, are located within a quarter mile of an Interstate, US highway, or state highway (Table 4.3.31-4Table 4.3.21-4). These facilities have a combined replacement value of more than $88.5 billion, or approximately 46 percent of the known value of geolocated critical facilities.

Table 4.3.31-4 Vulnerability of state critical facilities to highway accidents by facility type

TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	152	55%
Banking	2	67%
Commercial	18	67%
Communication	160	26%
Dam	848	25%
Education (colleges and universities)	82	52%
Education (public schools)	1,379	43%
Emergency Operation Center	49	71%
Energy	15	27%
Fire Station	1,698	63%
Government	6	24%
Hospital	162	47%
National Monument or Icon	1	17%
Nuclear	0	0%
Police Station	829	67%
Transportation	43	57%
Water	834	46%
Total	**6,278**	**45%**

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to air transportation accidents, all structures located within five miles of both public and private airports and heliports with more than 1,000 enplanements per year (15 facilities across state), shown in Figure 4.3.31-2, were identified. For this assessment, five miles was selected as a representative distance within which death, injury, or significant property damage could occur. In addition, the damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 225, or 5 percent, are located within five miles of an airport with more than 1,000 enplanements per year (Table 4.3.31-5). These facilities have a combined replacement value of more than $113 million, or approximately 2.9 percent of the known value of geolocated state facilities.

Table 4.3.31-5 Vulnerability of state facilities to air transportation accidents		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Attorney General	2	22%
Department of Agriculture	2	13%
Department of Banking and Securities	0	0%
Department of Community and Economic Development	2	50%
Department of Conservation and Natural Resources	1	50%
Department of Corrections	1	0%
Department of Education	0	0%
Department of Environmental Protection	1	8%
Department of General Services	1	1%
Department of Health	3	6%
Department of Labor and Industry	8	12%
Department of Military and Veterans Affairs	0	0%
Department of Public Welfare	7	7%
Department of Revenue	2	20%
Department of Transportation	126	7%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	0	0%
Executive Offices	0	0%
Fish and Boat Commission	2	1%
Governor's Office	1	100%
Historical and Museum Commission	2	7%
Insurance Department	0	0%
Liquor Control Board	47	9%
Public School Employees' Retirement System	**0**	0%
State Civil Service Commission	**0**	0%
State Department	**0**	0%
State Employees' Retirement System	1	25%
State Police	4	11%
State System of Higher Education	12	1%
Thaddeus Stevens College of Technology	**0**	0%
Treasury Department	**0**	0%
Total	**225**	**5%**

Of the 14,011 geolocated critical facilities, 874 or 6 percent, are located within 5 miles of airports with more than 1,000 enplanements per year (Table 4.3.31-6Table 4.3.21-4). These facilities have a combined replacement value of more than $11 billion, or approximately 6 percent of the known value of geolocated critical facilities.

Table 4.3.31-6 Vulnerability of state critical facilities to air transportation accidents by facility type		
TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	24	9%
Banking	1	33%
Commercial	1	4%
Communication	37	6%
Dam	103	3%
Education (colleges and universities)	13	8%
Education (public schools)	274	9%
Emergency Operation Center	3	4%
Energy	4	7%
Fire Station	199	7%
Government	1	4%
Hospital	27	8%
National Monument or Icon	0	0%
Nuclear	1	20%
Police Station	97	8%
Transportation	11	15%
Water	78	4%
Total	**874**	**6%**

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to rail transportation accidents, all structures located within a quarter mile of rail lines were identified. Rail accidents do not usually cause damage to buildings because of the fixed nature of this mode of transportation, but there still may be damage to state facilities located within one-quarter mile of rail lines. The damage to a given facility will depend on many different facility characteristics, including use, function, construction type, and age. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 948, or 21 percent, are located within a quarter mile of a rail line (Table 4.3.31-7). These facilities have a combined replacement value of more than $1.2 billion, or approximately 31 percent of the known value of geolocated state facilities.

Table 4.3.31-7 Vulnerability of state facilities to rail transportation accidents		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	4	44%
Department of Agriculture	3	19%
Department of Banking and Securities	2	100%
Department of Community and Economic Development	3	75%

Table 4.3.31-7 Vulnerability of state facilities to rail transportation accidents		
DEPARTMENT	**# OF VULNERABLE STRUCTURES**	**% OF ALL STRUCTURES FOR DEPARTMENT**
Department of Conservation and Natural Resources	1	50%
Department of Corrections	96	14%
Department of Education	0	0%
Department of Environmental Protection	6	46%
Department of General Services	47	36%
Department of Health	21	44%
Department of Labor and Industry	37	54%
Department of Military and Veterans Affairs	1	100%
Department of Public Welfare	48	49%
Department of Revenue	7	70%
Department of Transportation	316	19%
Drug and Alcohol Programs	0	0%
Emergency Management Agency	7	88%
Executive Offices	0	0%
Fish and Boat Commission	27	18%
Governor's Office	1	100%
Historical and Museum Commission	9	30%
Insurance Department	2	100%
Liquor Control Board	193	35%
Public School Employees' Retirement System	4	67%
State Civil Service Commission	1	100%
State Department	0	0%
State Employees' Retirement System	2	50%
State Police	3	8%
State System of Higher Education	106	12%
Thaddeus Stevens College of Technology	0	0%
Treasury Department	1	50%
Total	**948**	**21%**

Of the 14,011 geolocated critical facilities, 2,961 or 21 percent, are located within a quarter mile of rail lines (Table 4.3.31-8). These facilities have a combined replacement value of more than $47 billion, or approximately 24 percent of the known value of geolocated critical facilities.

Table 4.3.31-8 Vulnerability of state critical facilities to rail transportation accidents by facility type		
TYPE	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR FACILITY TYPE
Agricultural	108	39%
Banking	2	67%
Commercial	12	44%
Communication	83	13%
Dam	286	8%
Education (colleges and universities)	43	27%
Education (public schools)	540	17%
Emergency Operation Center	15	22%
Energy	18	33%
Fire Station	839	31%
Government	17	68%
Hospital	92	27%
National Monument or Icon	3	50%
Nuclear	3	60%
Police Station	414	33%
Transportation	29	39%
Water	457	25%
Total	**2,961**	**21%**

4.3.31.7. Jurisdictional Vulnerability Assessment and Loss Estimation

To assess the relative vulnerability of each county to transportation accidents, all census blocks with centers located within one-quarter mile of an Interstate highway, U.S. highway, or State highway were identified. The population, building counts, and building value of all vulnerable census blocks were then aggregated to the county scale.

For highway accidents, the counties with the highest percentage of exposed building value are Cameron, Schuylkill, Northumberland, Erie, and McKean Counties (Table 4.3.31-9). In each of these counties, more than half of the total building value is vulnerable to a highway accident. The counties with the most people exposed to highway accidents, in contrast, are the most populous counties: Philadelphia, Allegheny, and Montgomery. In each of these counties, more than 230,000 people are located within one-quarter mile of a highway. Across the state, about 37.6 percent of total building value is vulnerable to a highway accident.

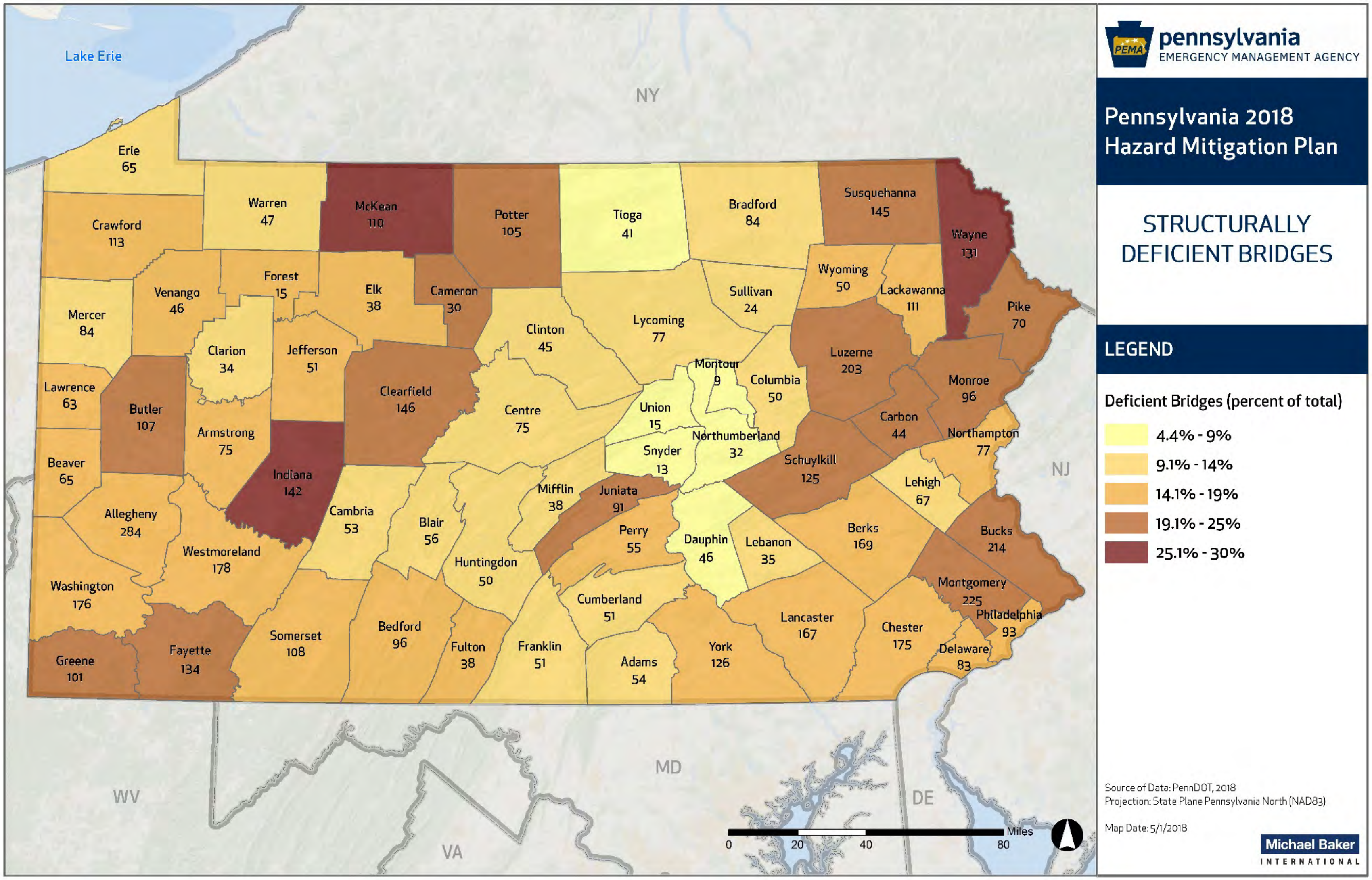
Table 4.3.31-9 Vulnerability of people and buildings to highway accidents.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Adams	38,906	15,948	$4,304,012	41%
Allegheny	336,806	140,483	$55,690,967	34%
Armstrong	24,682	11,715	$2,793,483	42%
Beaver	57,502	25,454	$7,561,296	39%

Table 4.3.31-9 Vulnerability of people and buildings to highway accidents.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Bedford	16,513	8,019	$1,734,524	38%
Berks	152,229	57,329	$18,630,125	41%
Blair	53,067	23,078	$6,325,424	49%
Bradford	18,695	7,864	$1,983,707	35%
Bucks	186,018	68,904	$27,383,107	33%
Butler	44,509	19,737	$6,977,400	33%
Cambria	50,469	24,117	$6,973,258	44%
Cameron	3,144	2,137	$526,226	59%
Carbon	21,422	10,167	$2,213,103	30%
Centre	67,889	20,608	$7,510,390	47%
Chester	178,823	65,475	$26,094,768	38%
Clarion	16,041	6,859	$1,825,068	44%
Clearfield	25,510	12,371	$2,902,671	38%
Clinton	18,709	7,606	$1,842,740	49%
Columbia	29,799	11,573	$3,153,407	44%
Crawford	29,747	14,167	$4,055,468	42%
Cumberland	86,164	34,670	$11,444,216	41%
Dauphin	89,510	36,722	$11,959,460	37%
Delaware	192,528	68,749	$24,188,447	35%
Elk	11,748	5,990	$1,728,121	42%
Erie	139,809	53,941	$15,975,269	52%
Fayette	36,202	16,100	$4,088,735	33%
Forest	1,459	1,435	$208,747	16%
Franklin	53,756	22,454	$5,672,221	39%
Fulton	3,821	1,931	$387,027	28%
Greene	12,200	4,405	$1,163,431	34%
Huntingdon	16,073	6,736	$1,423,748	34%
Indiana	31,876	12,158	$3,266,010	40%
Jefferson	18,611	8,712	$2,056,438	45%
Juniata	8,118	3,588	$816,003	39%
Lackawanna	66,917	27,622	$9,000,902	35%
Lancaster	211,918	79,875	$24,490,765	45%
Lawrence	37,957	16,906	$4,558,966	50%
Lebanon	54,760	21,385	$6,341,146	44%
Lehigh	89,597	33,469	$11,695,399	29%
Luzerne	88,845	40,121	$10,771,788	31%
Lycoming	28,387	13,356	$3,506,442	30%
McKean	20,472	8,956	$2,377,799	51%
Mercer	46,892	20,382	$6,121,098	47%

Table 4.3.31-9	Vulnerability of people and buildings to highway accidents.			
COUNTY	**VULNERABLE POPULATION**	**VULNERABLE BUILDINGS**	**EXPOSED BUILDING VALUE (THOUSAND $)**	**% OF TOTAL BUILDING VALUE**
Mifflin	16,338	7,241	$1,476,425	34%
Monroe	35,264	16,168	$4,517,478	24%
Montgomery	239,654	87,267	$38,094,759	33%
Montour	5,826	2,653	$663,747	36%
Northampton	80,104	30,240	$9,515,130	29%
Northumberland	46,225	22,599	$5,355,540	56%
Perry	14,693	6,505	$1,458,640	35%
Philadelphia	501,859	164,444	$66,422,016	40%
Pike	7,675	5,644	$1,334,170	16%
Potter	6,577	3,960	$954,095	39%
Schuylkill	77,609	37,135	$8,911,324	57%
Snyder	12,315	5,560	$1,455,466	39%
Somerset	28,049	13,409	$3,250,712	42%
Sullivan	2,172	1,680	$305,928	30%
Susquehanna	13,320	6,455	$1,425,701	34%
Tioga	14,063	6,344	$1,595,518	40%
Union	14,170	6,445	$1,808,286	44%
Venango	16,925	8,027	$1,988,109	35%
Warren	16,729	8,392	$2,241,175	47%
Washington	73,378	33,240	$9,493,240	40%
Wayne	12,271	6,107	$1,387,342	23%
Westmoreland	121,881	57,346	$16,273,864	40%
Wyoming	9,645	4,426	$998,889	38%
York	156,445	64,393	$18,935,965	40%
Total	**4,241,287**	**1,698,954**	**553,586,841**	**38%**

With highway accidents, there is an added vulnerability that stems from the age and upkeep of bridges throughout the Commonwealth. Pennsylvania has the second largest number of deficient bridges in the nation with over 4,500 structurally deficient bridges, which is nearly 20% of Pennsylvania's bridges. These bridges have a sufficiency rating of 80 or less and are in need of costly repairs (ASCE, 2017). Unrepaired deficient bridges may be more likely to break, thus leading to highway transportation damages or deaths. Figure 4.3.31-3 illustrates the distribution of structurally deficient and functionally obsolete bridges. Indiana, McKean, and Wayne counties all have at least 25% of their bridges rated as structurally deficient; Allegheny County has by far highest number of deficient bridges with 284. Dauphin, Montour. Northumberland, Snyder, and Union Counties have the lowest proportion of deficient bridges with between 4.4-9% total deficient bridges (PennDOT, 2018).

Figure 4.3.31-3 Structurally deficient bridges in Pennsylvania (PennDOT, 2018).



For air transportation accidents, the counties with the highest percentage of exposed building value are Cambria, Lehigh, and Berks Counties (see Table 4.3.31-10). The counties with the most people exposed to air transportation accidents, in contrast, are Berks, Lehigh, Delaware, and Philadelphia counties. In each of these counties, more than 100,000 people are vulnerable to an air transportation accident. Across the state, about 8.7 percent of total building value is vulnerable to these types of accidents.

Table 4.3.31-10 Vulnerability of people and buildings to air transportation accidents.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Adams	0	0	0	0%
Allegheny	57,782	22,426	$8,000,983	5%
Armstrong	0	0	0	0%
Beaver	932	418	$84,643	0%
Bedford	1,193	500	$101,528	2%
Berks	166,187	57,324	$18,476,516	41%
Blair	8,540	3,510	$805,001	6%
Bradford	0	0	0	0%
Bucks	0	0	0	0%
Butler	0	0	0	0%
Cambria	49,317	22,342	$6,679,791	42%
Cameron	0	0	0	0%
Carbon	0	0	0	0%
Centre	0	0	0	0%
Chester	0	0	0	0%
Clarion	0	0	0	0%
Clearfield	0	0	0	0%
Clinton	0	0	0	0%
Columbia	0	0	0	0%
Crawford	0	0	0	0%
Cumberland	0	0	0	0%
Dauphin	42,556	16,889	$5,225,598	16%
Delaware	122,127	42,958	$12,800,568	19%
Elk	0	0	0	0%
Erie	87,551	35,442	$10,282,873	34%
Fayette	0	0	0	0%
Forest	0	0	0	0%
Franklin	0	0	0	0%
Fulton	0	0	0	0%
Greene	0	0	0	0%
Huntingdon	215	134	$17,188	0%
Indiana	0	0	0	0%
Jefferson	3,265	1,549	$263,657	6%

Table 4.3.31-10 Vulnerability of people and buildings to air transportation accidents.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Juniata	0	0	0	0%
Lackawanna	36,535	14,837	$4,066,568	16%
Lancaster	88,379	33,793	$11,312,255	21%
Lawrence	0	0	0	0%
Lebanon	0	0	0	0%
Lehigh	162,536	55,240	$16,551,985	41%
Luzerne	33,073	15,141	$3,733,480	11%
Lycoming	38,099	15,403	$4,409,429	37%
McKean	3,158	965	$228,279	5%
Mercer	0	0	0	0%
Mifflin	0	0	0	0%
Monroe	0	0	0	0%
Montgomery	0	0	0	0%
Montour	0	0	0	0%
Northampton	75,622	27,364	$8,998,761	27%
Northumberland	0	0	0	0%
Perry	0	0	0	0%
Philadelphia	102,761	39,902	$9,114,321	5%
Pike	0	0	0	0%
Potter	0	0	0	0%
Schuylkill	0	0	0	0%
Snyder	0	0	0	0%
Somerset	422	173	$29,127	0%
Sullivan	0	0	0	0%
Susquehanna	0	0	0	0%
Tioga	0	0	0	0%
Union	0	0	0	0%
Venango	15,182	6,766	$1,657,975	29%
Warren	0	0	0	0%
Washington	0	0	0	0%
Wayne	0	0	0	0%
Westmoreland	36,673	15,436	$4,130,595	10%
Wyoming	0	0	0	0%
York	16,433	6,685	$1,667,221	3%
Total	**1,148,538**	**435,197**	**128,638,342**	**9%**

Rail accidents pose a risk to people and property in 63 of Pennsylvania’s 67 counties. Table 4.3.31-11 summarizes the exposure of people and buildings to rail accidents in each of Pennsylvania’s counties. Philadelphia County has the highest vulnerable population with over

500,000 people living in areas that could be impacted by rail accidents. Philadelphia also has the most vulnerable buildings in both relative and absolute terms. More than 170,000 buildings in Philadelphia are located in areas that could be impacted by rail accidents, representing more than 40 percent of the total building value.

Table 4.3.31-11 Vulnerability of people and buildings to rail transportation accidents.

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Adams	11,923	4,353	$1,521,958	15%
Allegheny	292,531	122,441	$46,718,244	29%
Armstrong	7,375	3,798	$995,558	15%
Beaver	35,820	15,573	$4,886,422	25%
Bedford	1,182	528	$86,662	2%
Berks	88,040	32,587	$11,196,217	25%
Blair	33,115	13,875	$4,304,016	33%
Bradford	9,369	3,923	$1,056,943	19%
Bucks	64,963	25,707	$10,621,442	13%
Butler	15,974	7,309	$2,155,855	10%
Cambria	28,387	13,842	$4,367,740	27%
Cameron	928	806	$151,525	17%
Carbon	13,635	5,983	$1,390,695	19%
Centre	8,442	3,753	$1,028,276	6%
Chester	70,068	24,970	$10,324,510	15%
Clarion	0	0	$0	0%
Clearfield	16,918	8,214	$2,176,311	28%
Clinton	10,241	3,874	$1,059,248	28%
Columbia	12,829	5,485	$1,808,145	25%
Crawford	9,425	5,056	$1,568,977	16%
Cumberland	42,822	16,501	$5,672,922	20%
Dauphin	47,609	19,513	$7,020,930	22%
Delaware	160,613	54,502	$19,316,528	28%
Elk	7,519	4,040	$1,333,219	32%
Erie	47,869	17,933	$6,141,296	20%
Fayette	23,483	10,509	$2,525,239	20%
Forest	0	0	$0	0%
Franklin	18,905	7,791	$2,325,691	16%
Fulton	0	0	$0	0%
Greene	5,080	2,223	$484,901	14%
Huntingdon	5,994	2,634	$650,826	16%
Indiana	11,647	4,974	$1,217,734	15%
Jefferson	9,611	4,502	$1,154,813	25%
Juniata	1,877	827	$176,456	8%
Lackawanna	63,012	25,076	$8,564,930	33%

Table 4.3.31-11 Vulnerability of people and buildings to rail transportation accidents.				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	EXPOSED BUILDING VALUE (THOUSAND $)	% OF TOTAL BUILDING VALUE
Lancaster	56,200	22,314	$7,889,353	14%
Lawrence	9,798	4,799	$1,457,969	16%
Lebanon	22,942	8,354	$2,800,722	20%
Lehigh	48,238	17,390	$6,432,850	16%
Luzerne	86,207	37,632	$10,159,745	29%
Lycoming	20,406	8,241	$2,662,734	22%
McKean	9,828	4,806	$1,250,737	27%
Mercer	16,029	6,830	$2,519,114	19%
Mifflin	9,438	4,699	$1,179,236	27%
Monroe	7,223	2,774	$805,606	4%
Montgomery	155,035	56,037	$25,327,791	22%
Montour	3,434	1,427	$359,966	19%
Northampton	39,768	14,661	$4,589,420	14%
Northumberland	30,993	14,537	$3,797,664	40%
Perry	5,896	2,696	$611,275	15%
Philadelphia	501,986	173,775	$67,050,141	40%
Pike	677	525	$97,476	1%
Potter	38	30	$3,902	0%
Schuylkill	30,731	14,924	$3,526,803	23%
Snyder	5,403	1,960	$743,513	20%
Somerset	12,916	6,077	$1,350,319	17%
Sullivan	0	0	$0	0%
Susquehanna	5,433	2,336	$500,905	12%
Tioga	1,830	828	$160,688	4%
Union	7,042	2,349	$902,297	22%
Venango	8,973	4,070	$1,061,630	19%
Warren	8,102	3,831	$1,137,886	24%
Washington	41,839	19,778	$6,016,886	25%
Wayne	3,775	1,935	$543,956	9%
Westmoreland	67,689	31,552	$8,733,677	21%
Wyoming	3,085	1,546	$371,021	14%
York	53,592	19,013	$7,029,453	15%
Total	**2,451,752**	**964,828**	**$335,078,964**	**23%**

Pennsylvania’s metropolitan areas like Greater Philadelphia and the Pittsburgh region maintain the largest risk of both highway transportation and rail transportation accidents due to the high number of railway tracks, roadway miles, and vehicle miles traveled coupled with high population and economic activity densities.

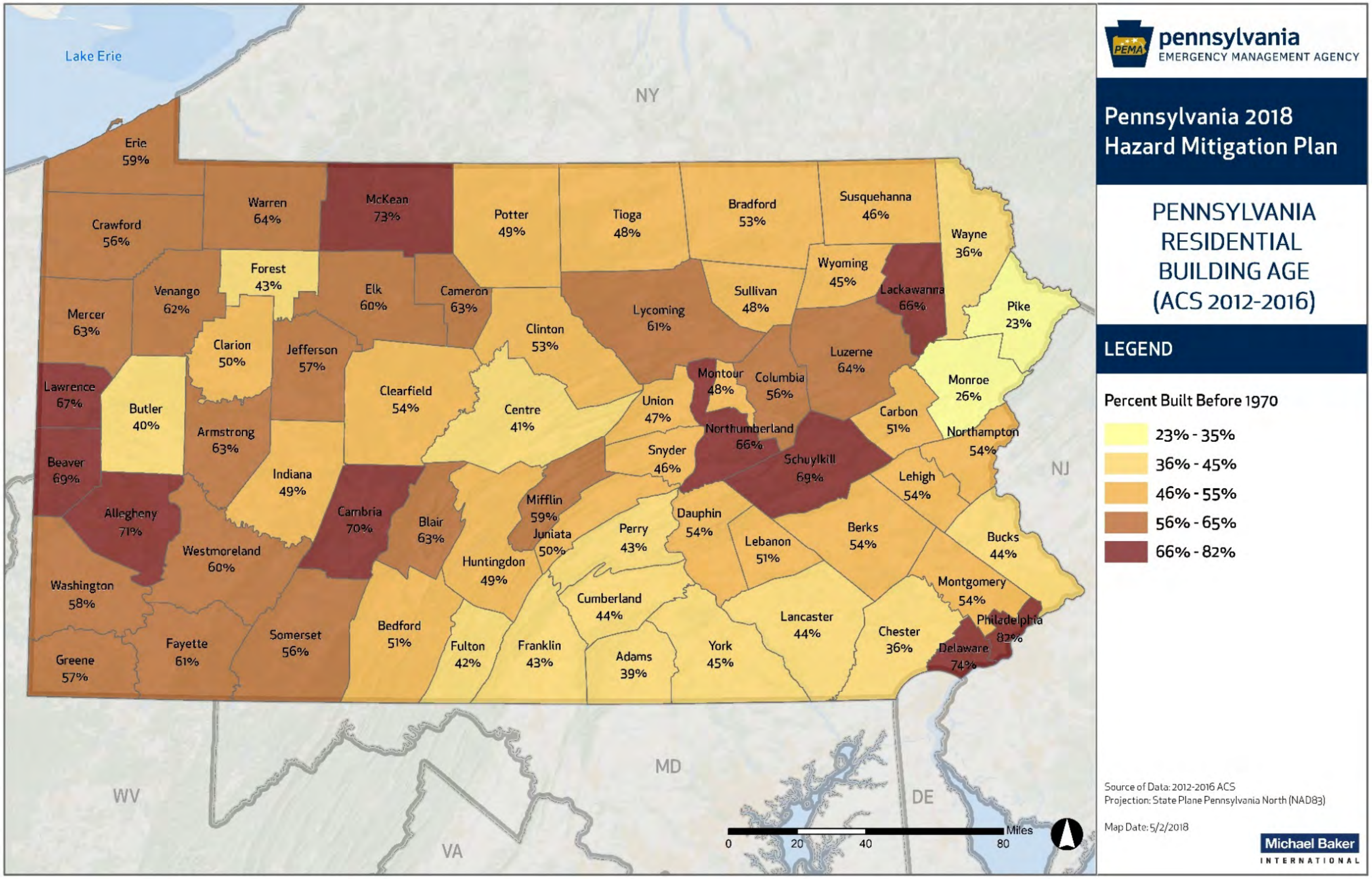
4.3.32. Urban Fire and Explosion

4.3.32.1. Location and Extent

Urban fire and explosion hazards include vehicle and building/structure fires as well as overpressure rupture, overheat, or other explosions that do not ignite. This hazard occurs in denser, more urbanized areas statewide and most often occurs in residential structures. Nationally, fires cause over 3,000 deaths and approximately 16,000 injuries each year (U.S. Fire Administration, 2018). Urban fires can more easily spread from building to building in denser areas. Furthermore, urban fires are a more significant threat in the many areas of the Commonwealth with a significant proportion of buildings built before 1970. Figure 4.3.32-1 illustrates the concentration of residential structures built before 1970 in Pennsylvania.

Urban fires and explosions often begin as a result of other hazards—particularly storms, lightning strikes, drought, transportation accidents, hazardous materials releases, criminal activity (arson), and terrorism.

Figure 4.3.32-1 Percent of residential buildings built before 1970 (ACS 2012-2016).



4.3.32.2. Range of Magnitude

In general, the extensive networks of roads and streets coupled with the number of local fire departments should provide swift access to fire events. It is anticipated that blockage by damage, debris, and operations will be localized and temporary. However, urban fires have the potential to cause extensive damage to residential, commercial, or public property. Damage ranges from minor smoke and/or water damage to the destruction of buildings. People are often displaced for several months to years depending on the magnitude of the event. Urban fires and explosions can also cause injuries and death. In Pennsylvania, the fire mortality rate is approximately 3.5 deaths and 14.6 injuries per 1,000 fires. This is higher than the national average which is 2.3 deaths and 10.4 injuries per 1,000 fires. As of May 2018, 72 fatalities caused by home fires have been reported by the U.S. Fire Administration, and in 2017, 112 deaths were caused by home fires. Between 1990 and 2017, 230 on-duty firefighter deaths were reported, and as of May 2018, four deaths have been reported (U.S. Fire Administration, 2018).

In the most serious urban fire events, the extreme heat of a fire event can damage the underlying infrastructure. For example, in 1996, an eight-alarm tire fire ignited in Philadelphia under Interstate 95. The extreme heat of the fire caused the bridge to buckle and forced two months of repairs to the bridge. The governor declared this event a disaster shortly after it occurred.

The worst-case urban fire or explosion event in Pennsylvania occurred in February 1991, when a fire broke out in the One Meridian Plaza skyscraper in Philadelphia. The fire started on the 22nd floor and burned for 18 hours, gutting eight floors and causing an estimated $100 million in property loss. This event also caused the windows in the building to break, granite to crack, and other structural weakening.

4.3.32.3. Past Occurrence

Urban fire events occur daily in communities across Pennsylvania. According to the U.S. Fire Administration, structural fires, including residential and nonresidential buildings, caused 79.4 percent of reported fires in 2018, vehicle fires caused 12.7 percent, and outside fires caused 1.6. percent. From 2010-2012, there were 51,743 building fires, 10,560 vehicle fires, and 1,925 explosions reported to the Pennsylvania Fire Information Reporting System (PennFIRS). Since 2015, PennFIRS partnered with Emergency Reporting, and this information is no longer available to the public.

In addition, PEMA's incident management system, PEMA-KC, tracks major structure fires, vehicle fires, and explosions. Table 4.3.32-1 summarizes the reported urban fire and explosion events from 2012-2018.

Table 4.3.32-1 Urban fire and explosion events, 2012-2018 (PEMA-KC, 2018)

	2012	2013	2014	2015	2016	2017	2018*
Structure Fires	151	620	808	822	729	862	285
Vehicle Fires	22	76	123	124	129	155	42
Explosions	0	3	1	2	0	1	1

Table 4.3.32-1 Urban fire and explosion events, 2012-2018 (PEMA-KC, 2018)							
	2012	**2013**	**2014**	**2015**	**2016**	**2017**	**2018***
Urban Fire and Explosion Hazards - totals	***470***	***560***	***556***	***684***	***1124***	***1139***	***642***
**Events totaled through April 2018*							

PEMA's State Disaster History lists a number of significant fire events resulting in disaster declarations. An April 1978 fire in East Stroudsburg resulted in a President's Declaration of Major Disaster. A tire fire in March 1997 in Washington County triggered a Gubernatorial Proclamation of Disaster Emergency, as did a fire in McKeesport, Allegheny County in 1976 and a refuse bank fire in August 1972 in Plymouth, Luzerne County. Additionally, many fire events warranted Small Business Administration Disaster Declarations. For more details, see Section 4.2.1.

4.3.32.4. Future Occurrence

Many factors contribute to the cause of urban fires and explosions. Due to the various factors, urban areas in Pennsylvania are considered at risk to one degree or another. Minor urban fires can be expected every day in Pennsylvania. Major fires will continue to occur several times a year, particularly in dense, urban areas with aging building stock. However, the probability of future occurrences may decrease with the construction of new buildings to building codes that address fire prevention, detection, and extinguishment. Also, continued efforts to increase public awareness of the dangers of urban fires will help to mitigate injury, death, and property loss. The probability of future occurrence may increase in communities whose populations are growing and where new areas are developed.

4.3.32.5. Environmental Impacts

The impact of urban fire and explosion events vary based on the size of the incident and the population and structure density where it occurs. There may be environmental impacts related to hazardous materials when a fire event or explosion releases dangerous materials.

There are additional economic consequences related to this hazard. Urban fires and explosions may result in lost wages due to temporarily or permanently closed businesses, destruction and damage involving business and personal assets, loss of tax base, recovery costs, and lost investments in destroyed property.

The secondary effects of urban fire and explosion events relate to the ability of public, private, and non-profit entities to provide post-incident relief. Human services agencies (community support programs, health and medical services, public assistance programs and social services) can be affected by urban fire and explosion events as well. Effects may consist of physical damage to facilities and equipment, disruption of emergency communications, loss of health and medical facilities and supplies, or an overwhelming load of victims who are suffering from the effects of the urban fire, including loss of their home or place of business.

4.3.32.6. State Facility Vulnerability Assessment and Loss Estimation

To assess the vulnerability of state-owned or leased facilities and critical infrastructure to urban fires and explosions, all structures located in high risk census tracts were identified. Urban fire hazard was characterized based on the share of the residential building stock built before 1970. All census tracts in which more than 60 percent of housing units were built before 1970 were defined as high hazard census tracts, and all structures within these census tracts were identified as vulnerable facilities. Note that the magnitude of fire losses will depend on many different conditions, including the nature of the fire, meteorological conditions, and building characteristics. The results of this assessment represent the potential impacts to state assets based on location, but do not account for these other factors.

Of the 4,460 geolocated state facilities, 1,561, or 35 percent, are located within census tracts characterized by high urban fire hazard (Table 4.3.32-2). These facilities have a combined replacement value of nearly $2.5 billion, or approximately 63 percent of the known value of geolocated state facilities.

Table 4.3.32-2 Vulnerability of state facilities to urban fire and explosion

DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Attorney General	4	44%
Department of Agriculture	3	19%
Department of Banking and Securities	2	100%
Department of Community and Economic	4	100%
Department of Conservation and Natural Resources	0	0%
Department of Corrections	201	29%
Department of Education	0	0%
Department of Environmental Protections	6	46%
Department of General Services	37	28%
Department of Health	30	63%
Department of Labor and Industry	50	72%
Department of Military and Veterans Affairs	1	100%
Department of Public Welfare	62	63%
Department of Revenue	9	90%
Department of Transportation	562	33%
Drug and Alcohol Programs	1	100%
Emergency Management Agency	7	88%
Executive Offices	2	100%
Fish and Boat Commission	2	1%
Governor's Office	1	100%
Historical and Museum Commission	11	37%
Insurance Department	2	100%
Liquor Control Board	314	58%

Table 4.3.32-2 Vulnerability of state facilities to urban fire and explosion		
DEPARTMENT	# OF VULNERABLE STRUCTURES	% OF ALL STRUCTURES FOR DEPARTMENT
Public School Employees' Retirement System	3	50%
State Civil Service Commission	0	0%
State Department	1	100%
State Employees' Retirement System	1	25%
State Police	13	36%
State System of Higher Education	210	25%
Thaddeus Stevens College of Technology	20	100%
Treasury	1	50%
Total	**1,561**	**35%**

Of the 14,011 geolocated critical facilities, 5,243**,** or 37 percent, are located within census tracts characterized by high urban fire hazard (Table 4.3.32-3). These facilities have a combined replacement value of approximately $63.4 billion, or 33 percent of the known value of geolocated facilities.

Table 4.3.32-3 Vulnerability of critical facilities to urban fire and explosion		
TYPE	NUMBER OF VULNERABLE STRUCTURES	PERCENT OF TOTAL STRUCTURES BY TYPE
Agricultural	115	42%
Banking	1	33%
Commercial	10	37%
Communication	205	33%
Dam	613	18%
Education (colleges and universities)	90	57%
Education (public schools)	1,606	51%
Emergency Operation Center	36	52%
Energy	11	20%
Fire Station	1,227	45%
Government	16	64%
Hospital	208	61%
National Monument or Icon	3	50%
Nuclear	0	0%
Police Station	644	52%
Transportation	28	37%
Water	430	24%
Total	**5,243**	**37%**

4.3.32.7. *Jurisdictional Vulnerability Assessment and Loss Estimation*

To assess the relative vulnerability of each county to urban fire hazards, the population, building counts, and building value of all high hazard census tracts were aggregated to the county scale (Table 4.3.32-4). As in the state vulnerability assessment, high hazard census tracts were defined as those in which more than 60 percent of the residential building stock was built before 1970. The counties with the highest percentage of exposed building value are McKean, Philadelphia, Schuylkill, and Delaware counties. In each of these counties, more than three quarters of the total building value is vulnerable to urban fire or explosion. The counties with the most people exposed to this hazard are Philadelphia, Allegheny, and Delaware counties.

Table 4.3.32-4 Vulnerability of people and buildings to urban fire and explosion

COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Adams	7,643	2,453	$971,895	9%
Allegheny	855,952	361,900	$106,451,496	66%
Armstrong	37,243	17,382	$3,612,651	55%
Beaver	105,510	46,323	$12,340,845	64%
Bedford	6,406	3,055	$717,757	16%
Berks	139,480	48,668	$14,254,420	32%
Blair	64,716	27,468	$7,179,471	55%
Bradford	15,474	6,413	$1,757,680	31%
Bucks	185,705	67,861	$22,303,480	27%
Butler	22,705	8,978	$2,648,607	12%
Cambria	101,573	48,649	$11,614,481	73%
Cameron	2,010	1,017	$352,329	40%
Carbon	31,907	14,842	$3,254,485	44%
Centre	24,374	5,441	$2,062,797	13%
Chester	79,238	26,509	$10,181,685	15%
Clarion	11,232	5,895	$1,110,826	27%
Clearfield	25,435	11,863	$3,189,888	41%
Clinton	12,756	5,749	$1,477,485	39%
Columbia	18,016	7,134	$2,108,510	30%
Crawford	23,194	9,064	$2,998,627	31%
Cumberland	62,175	24,511	$7,837,214	28%
Dauphin	98,734	39,747	$11,740,594	36%
Delaware	441,556	154,791	$51,289,131	75%
Elk	14,045	6,879	$2,097,413	50%
Erie	132,000	49,938	$14,382,958	47%
Fayette	67,245	29,062	$6,273,155	50%
Forest	0	0	$0	0%

Table 4.3.32-4 Vulnerability of people and buildings to urban fire and explosion				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Franklin	18,453	6,856	$1,906,936	13%
Fulton	0	0	$0	0%
Greene	15,068	6,562	$1,349,797	40%
Huntingdon	9,463	3,553	$1,006,063	24%
Indiana	13,732	5,972	$1,631,051	20%
Jefferson	14,421	6,552	$1,719,892	38%
Juniata	0	0	$0	0%
Lackawanna	139,559	54,420	$15,813,366	62%
Lancaster	119,518	40,967	$12,626,457	23%
Lawrence	53,701	24,565	$6,295,353	69%
Lebanon	48,256	17,476	$4,955,722	35%
Lehigh	169,160	58,267	$17,320,844	43%
Luzerne	174,475	76,758	$18,982,270	54%
Lycoming	49,846	19,346	$5,705,068	48%
McKean	42,609	21,145	$4,665,899	100%
Mercer	51,888	21,608	$6,121,985	47%
Mifflin	10,305	4,518	$1,108,027	25%
Monroe	5,486	2,097	$794,942	4%
Montgomery	358,828	125,472	$49,152,378	43%
Montour	4,664	2,099	$485,639	26%
Northampton	120,987	43,492	$13,020,234	39%
Northumberland	53,525	25,104	$5,502,225	57%
Perry	4,761	2,099	$451,852	11%
Philadelphia	1,414,955	496,127	$141,720,805	85%
Pike	3,429	1,690	$462,138	5%
Potter	0	0	$0	0%
Schuylkill	108,161	50,122	$11,756,349	76%
Snyder	5,810	1,632	$595,002	16%
Somerset	27,658	13,398	$2,687,160	34%
Sullivan	0	0	$0	0%
Susquehanna	5,731	2,625	$516,003	12%
Tioga	7,117	3,333	$823,320	20%
Union	9,412	1,785	$625,589	15%
Venango	21,702	9,714	$2,383,768	42%
Warren	23,276	12,509	$2,887,843	61%
Washington	93,349	40,817	$10,558,382	45%

Table 4.3.32-4 Vulnerability of people and buildings to urban fire and explosion				
COUNTY	VULNERABLE POPULATION	VULNERABLE BUILDINGS	DOLLAR VALUE OF EXPOSED BUILDINGS, THOUSAND $	PERCENT OF TOTAL COUNTY BUILDING VALUE
Wayne	4,258	1,987	$580,810	9%
Westmoreland	155,779	73,464	$18,598,864	45%
Wyoming	0	0	$0	0%
York	97,436	37,718	$11,531,167	24%
Total	**6,043,102**	**2,347,441**	**$680,553,080**	**46%**

4.3.33. Utility Interruption

4.3.33.1. Location and Extent

Utility interruption includes any impairment of the functioning of telecommunication, gas, electric, water, or waste networks. These interruptions or outages occur because of geomagnetic storms, fuel or resources shortage, electromagnetic pulses, information technology failures, transmission facility or linear utility accident, and major energy, power, or utility failure. The focus of utility interruptions as a hazard lies in fuel, energy, or utility failure; this hazard is often secondary to other natural hazard events, particularly transportation accidents, lightning strikes, extreme heat or cold events, and coastal and winter storms.

Utility interruptions occur throughout the Commonwealth but usually are small-scale, localized incidents. Utility interruptions are possible anywhere there is utility service. Figure 4.3.33-1 and Figure 4.3.33-2 illustrate the geographic extent and mileage of liquid pipelines and gas pipelines per county.

Figure 4.3.33-1 Liquid pipeline mileage per county (NPMS, 2018).

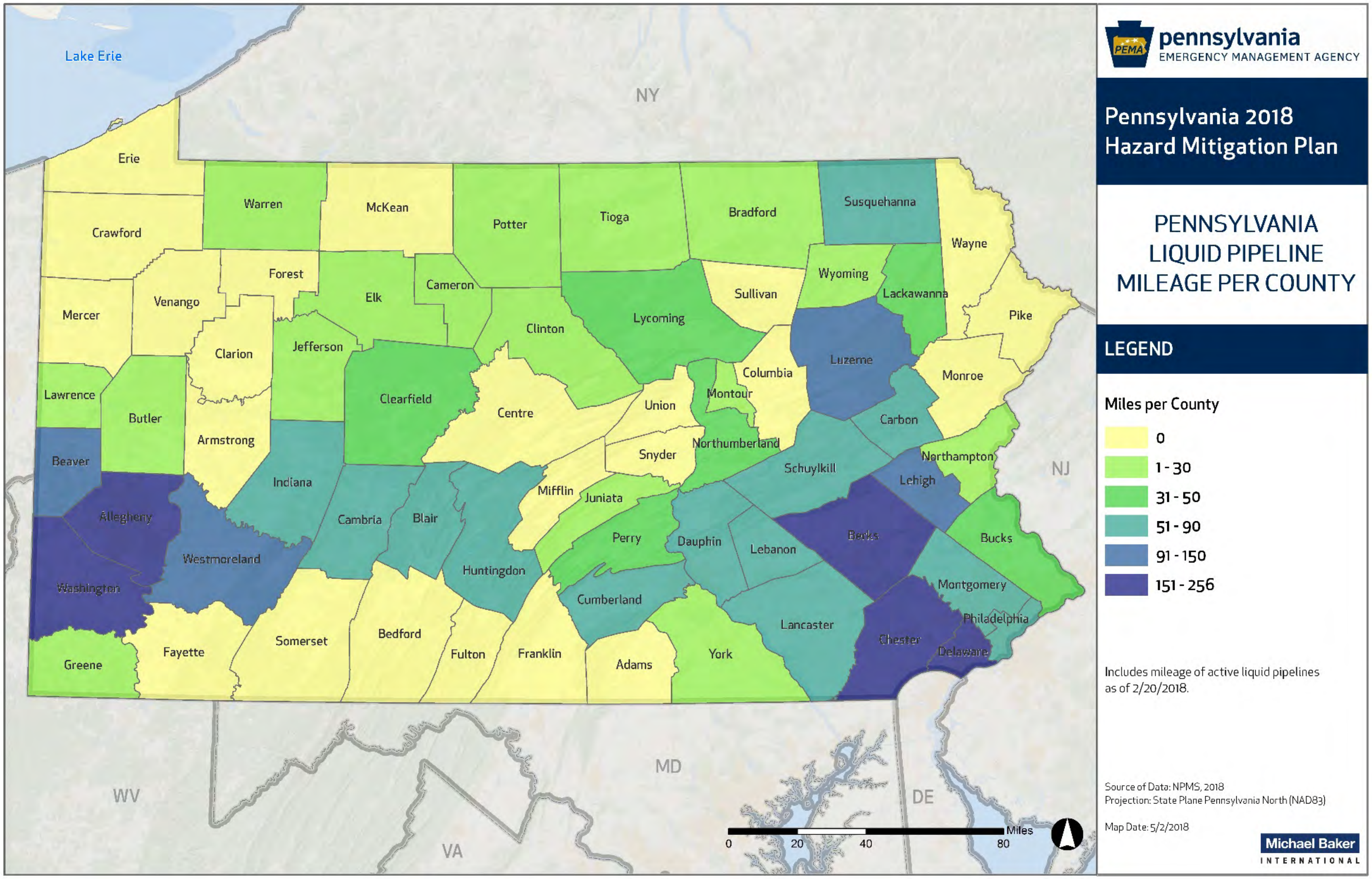
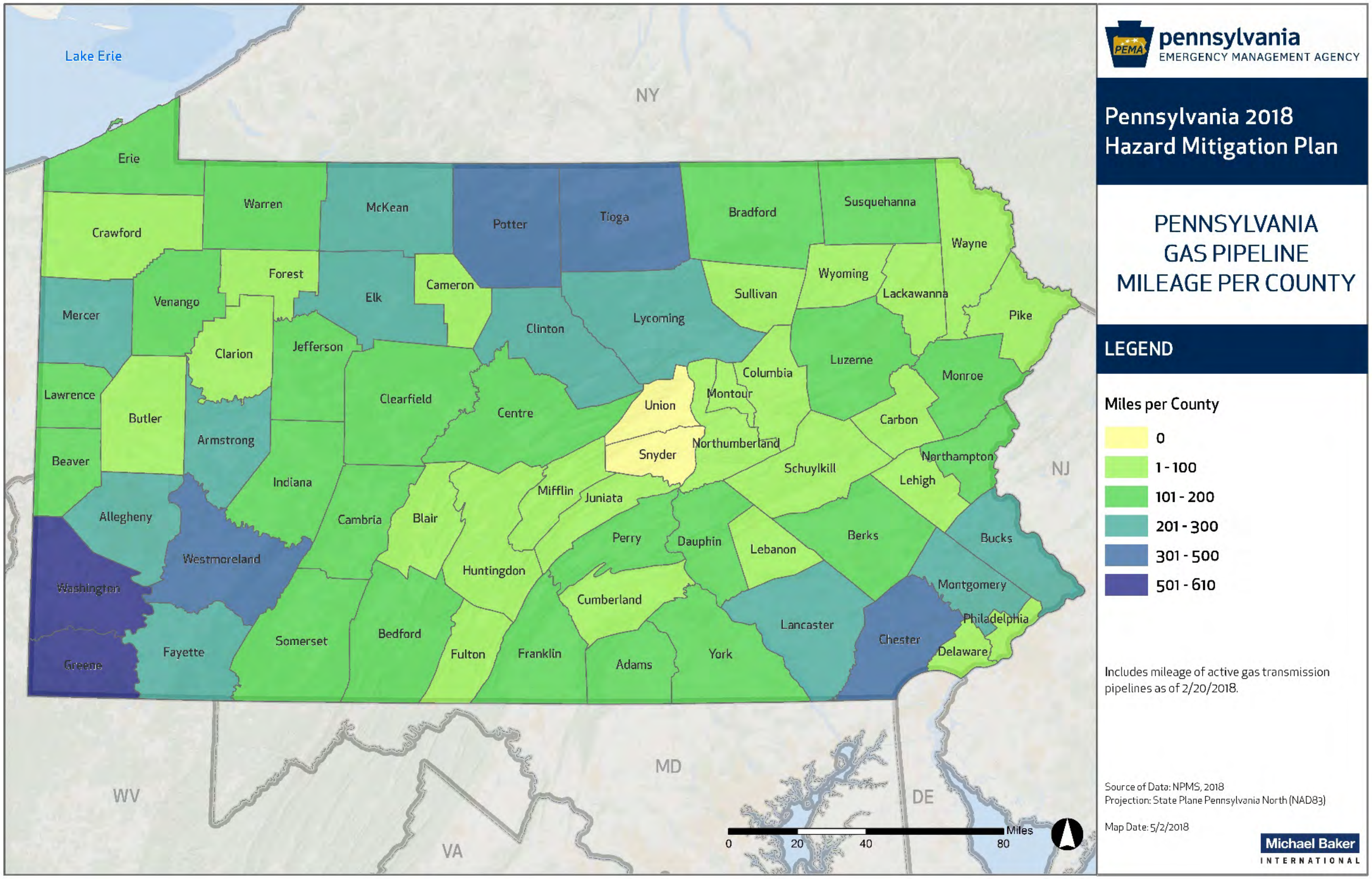


Figure 4.3.33-2 Gas pipeline mileage per county (NPMS, 2018).



This hazard has the potential to affect a significant number of Pennsylvanians. According to the 2016 estimates of the American Community Survey, there are 5.6 million occupied housing units in the Commonwealth. The U.S. Energy Information Administration (EIA) estimates that 51 percent of these households use natural gas as their main heating fuel, while 22 percent use electricity to heat their home, and 18 percent use fuel oil (EIA, 2017). This means that should a utility interruption occur statewide, nearly 4.6 million households could be without heat or cooling.

An emerging utility concern is the overall dependence on internet access. Telecommunications companies operate throughout the Commonwealth; each of these is subject to outages of a few minutes to weeks.

4.3.33.2. Range of Magnitude

The most severe utility interruptions will be regional or widespread power and telecommunications outages. With the loss of power, electrical powered equipment and systems will not be operational. Examples may include: lighting; HVAC and ancillary support equipment; communication (e.g., public-address systems, telephone, computer servers, and peripherals); ventilation systems; fire and security systems; refrigerators, sterilizers, trash compactors, office equipment; and medical equipment. Power outages can cause food spoilage, loss of heat or air conditioning, basement flooding (sump pump failure), lack of light, loss of water (well pump failure), lack of phone service, or lack of internet service. However, this is most often a short-term nuisance rather than a catastrophic hazard.

The severity of a utility interruption can be compounded with extreme weather events, especially winter weather events. Interruptions can also be more severe for special needs populations that are dependent on electronic medical equipment. Utility interruptions can significantly hamper first responders in their efforts to provide aid in a compound disaster situation, especially with losses of telecommunications and wireless capabilities. Telecommunications interruptions will also hinder first responders' efforts. Additionally, an internet outage could be crippling to the economy of the state; for example, the Department of the Treasury no longer cuts checks except when absolutely necessary. Instead, payroll and invoicing is done electronically.

In a possible worst-case scenario, a winter storm event causes widespread power outages, leaving citizens without heat in the midst of subzero temperatures. The power outage also means that elderly populations or others at risk of health problems due to the lack of heat are unable to call for assistance or leave their homes. Power lines are unable to be repaired because of the magnitude of the storm, and the power outage lasts for several days.

4.3.33.3. Past Occurrence

Utility interruptions are largely minor, routine events, but there have been several Presidential and Gubernatorial Disaster Declarations in which a utility interruption was a major component of a disaster. A series of bankruptcies in 1972 led the major steam heat provider in Lower Merion Township to cut off heat to residents with no intention of resuming service in the wintertime; the governor declared the event a disaster. December 1974 brought heavy snow that led to widespread power outages in the Southwestern Counties, leading to a Gubernatorial Disaster Declaration. In January 1977, the nation's gas shortage coupled with severe winter weather led to a President's Declaration of Emergency. In March 2018, four nor'easters struck southeastern Pennsylvania, affecting Philadelphia, Delaware, Montgomery, Chester, Lehigh, Pike, Carbon, and Northampton counties. The storms' high winds and heavy snowfall caused down trees and powerlines, leaving an estimated 500,000 customers without power (PEMA, 2018).

According data compiled by the Pennsylvania Public Utility Commission (PUC), rain and high winds are the most common cause of utility interruptions. In 2016, for example, 17 of the 20 electricity interruption events reported to PUC were caused by rain and high winds. These 20 events affected a total of 784,602 electricity customers in the course of the year (Table 4.3.33-1).

Table 4.3.33-1 Electricity interruption events reported to Pennsylvania Public Utilities Commission in 2016 (PUC, 2017)

ELECTRIC DISTRIBUTION COMPANY	OUTAGE DATE	NUMBER OF CUSTOMERS AFFECTED	CAUSE
PECO	2/24/2016	72,118	Rain and high winds
Met-Ed	2/24/2016	52,175	Rain and high winds
PPL	2/24/2016	28,191	Rain and high winds
Penelec	4/2/2016	24,168	Rain and high winds
PECO	4/2/2016	89,051	Rain and high winds
PPL	4/2/2016	59,284	Rain and high winds
Met-Ed	4/2/2016	41,292	Rain and high winds
PECO	6/8/2016	96,373	Rain and high winds
West Penn	6/16/2016	26,417	Thunder storm and wind
PECO	7/18/2016	30,920	Rain and high winds
Penelec	7/25/2016	25,122	Rain and high winds
PPL	7/25/2016	27,843	Rain and high winds
PECO	7/25/2016	72,983	Rain and high winds
Duquesne	8/16/2016	23,590	Rain and high winds
West Penn	8/16/2016	20,897	Rain and high winds
West Penn	8/28/2016	13,707	Rain and high winds
PPL	11/19/2016	25,401	Snow and high winds
West Penn	10/20/2016	22,038	Rain and high winds
Duquesne	12/17/2016	12,500	Freezing rain and high winds
West Penn	12/17/2016	20,532	Freezing rain and high winds
Total Customers Affected		**784,602**	

Table 4.3.33-2 illustrates past occurrences of gas distribution and transmission incidents and hazardous liquid incidents as reported to the Pipeline and Hazardous Materials Safety Administration (PHMSA, 2018).

Table 4.3.33-2 Utility interruption events reported to Pipeline and Hazardous Materials Safety Administration 2010 to 2017 in Pennsylvania (PHMSA 2018)

GAS DISTRIBUTION INCIDENTS			
YEAR	**INJURIES**	**FATALITIES**	**TOTAL COST AS REPORTED ($)**
2010	0	1	$4,966
2010	1	0	$87,962
2011	7	6	$2,592,795

Table 4.3.33-2 Utility interruption events reported to Pipeline and Hazardous Materials Safety Administration 2010 to 2017 in Pennsylvania (PHMSA 2018)

GAS DISTRIBUTION INCIDENTS			
YEAR	**INJURIES**	**FATALITIES**	**TOTAL COST AS REPORTED ($)**
2012	0	0	$0
2013	0	0	$521,399
2014	1	1	$1,017,026
2015	1	0	$411,679
2016	4	0	$563,967
2017	5	1	$1,483,322
Total	**19**	**8**	**$6,678,150**
GAS TRANSMISSION INCIDENTS			
YEAR	**INJURIES**	**FATALITIES**	**TOTAL COST AS REPORTED ($)**
2010	0	0	$122,819
2011	0	0	$23,709,144
2012	1	0	$435,776
2013	0	0	$564,402
2014	0	0	$2,941,426
2015	0	0	$1,482,612
2016	1	0	$20,893,540
2017	0	0	$213,330
Total	**2**	**0**	**$50,363,049**
HAZARDOUS LIQUID INCIDENTS			
YEAR	**INJURIES**	**FATALITIES**	**TOTAL COST AS REPORTED ($)**
2010	0	0	$101,000
2011	0	0	$1,383,678
2012	0	0	$525,463
2013	0	0	$1,600,967
2014	0	0	$1,555,228
2015	0	0	$637,475
2016	0	0	$2,903,161
2017	0	0	$405,431
Total	**0**	**0**	**$9,112,403**

4.3.33.4. Future Occurrence

Utility interruptions will continue to occur annually with minimal impact. Widespread utility interruption events usually occur approximately once every five years, usually as a secondary effect of an extreme weather event. These interruptions should be anticipated and first responders should be prepared during severe weather events. Research by the National Oceanic and Atmospheric Administration (NOAA) suggests that climate change may cause more extreme storms, like the March 2018 nor'easters, to occur in Pennsylvania (NOAA, 2018).

Aging infrastructure also adds to the risk of potential utility interruptions. Population growth, urbanization and climate change can put strain on existing assets used to deliver utilities. In many utility systems, significant portions of the equipment and facilities date from the growth periods of the 1950's and 1960's that followed World War II. As this equipment ages, it deteriorates from the constant wear and tear of service. As it ages, it reaches a point at which it will either fail on its own or as a result of outside forces (storms, loads it was designed to handle but no longer can, etc.). These failures cause service interruptions and can require expensive emergency repairs. In addition, as repairs have taken place along transmission routes, there is often a mix of new and old equipment along the line, as repair and not replacement is generally the choice made to resolve an issue.

The wholesale replacement of a system is not a feasible solution for utility companies. This would require the interruption of services while the replacement occurs, as well as accessing the existing system (which may lay under roads, private property, or other inconvenient places). Utility companies face the challenge of managing the issue of the aging infrastructure. They are tasked with reducing the effects of aging equipment while also controlling the deterioration of the existing system as much as possible. This balance will be tenuous as transmission equipment continues to age and break down. These breakdowns will likely lead to more frequent utility disruptions as time goes by.

4.3.33.5. Environmental Impacts

The most significant impact associated with utility interruptions is when the interruption involves a release of hazardous materials. This hazardous material may be released in a pipeline accident or when a material is in transit. For a complete discussion on the impacts of a hazardous materials release, see Section 4.3.23. Utility pipelines carrying flammable materials also have the possibility of exploding or starting a fire.

There are a number of secondary impacts associated with utility interruptions. First, interruptions could affect the ability of the government to function, especially if backup power generation/supply is inadequate or unavailable. Utility interruptions also can reduce the efficient and effective communication that is essential to first responders. Heating loss and severe cold can also impact the health and safety of at-risk populations like young children, the elderly and disabled individuals.

4.3.33.6. State Facility Vulnerability Assessment and Loss Estimation

All state facilities are somewhat vulnerable to utility interruptions. Some key indicators of increased vulnerability to utility interruption include the presence of ground- or basement-level utilities, reliance on electronic banking, like the Department of the Treasury, or facilities located in isolated or in wooded areas where a downed tree might cause a utility interruption. According to Carnegie Mellon University’s CyLab, locations with publicly accessible or shared computer workstations are more vulnerable to malicious internet outages.

Facilities that have independent generators are less vulnerable to the effects of utility interruption. Additionally, efforts by DGS to complete COOP and COG plans for state agencies will help to reduce overall state facility/state agency vulnerability to utility interruptions, as these plans take into account situations in which an agency might need to move to an alternate location due to a utility outage. Other statewide efforts that will help prepare state entities for utility interruptions include trainings on the Homeland Security Exercise Evaluation Program, trainings for the Office of Administration/IT staff, and trainings with PJM, a regional transmission organization that coordinates the movement of electricity in 13 states and the District of Columbia.

Also, the 55 energy facilities and 1,798 water facilities in the inventory of state critical facilities may experience greater revenue losses as the Commonwealth's utility providers. There is added vulnerability for state facilities located in jurisdictions that are prone to severe weather events.

4.3.33.7. Jurisdictional Vulnerability Assessment and Loss Estimation

All jurisdictions are vulnerable on some level to utility interruptions, but because this hazard often occurs in conjunction with other hazards, jurisdictions that have been identified as more vulnerable to winter storms, temperature extremes, tornado, hail events, and lightning strikes may be more vulnerable to a utility interruption.

In the majority of utility interruption events, jurisdictional losses will be minimal. However, long-term and widespread outages can cause significant economic losses stemming from lost income, costs to government and social services agencies, costs to the utility provider, and the cost of spoiled commodities. For example, the Anderson Economic Group estimated that the August 14, 2003 blackout that caused more than 50 million people to lose power for 31 hours had a total economic cost of between $4.5 and $8.2 billion. While this was a regional event that impacted most of the Northeast and parts of Canada, it indicates how significant utility interruptions can be. Additionally, a significant reduction in the supply of any energy resource would impose serious personal and economic hardship on individuals, businesses, and industry. Escalating energy cost compounded with prolonged winter weather conditions could place adequate home heating fuel beyond the reach of elderly and low-income individuals. Also, in more prolonged utility interruption events, there may be illnesses and deaths related to heat or cold exposure.

4.4. Development Trends and Vulnerability

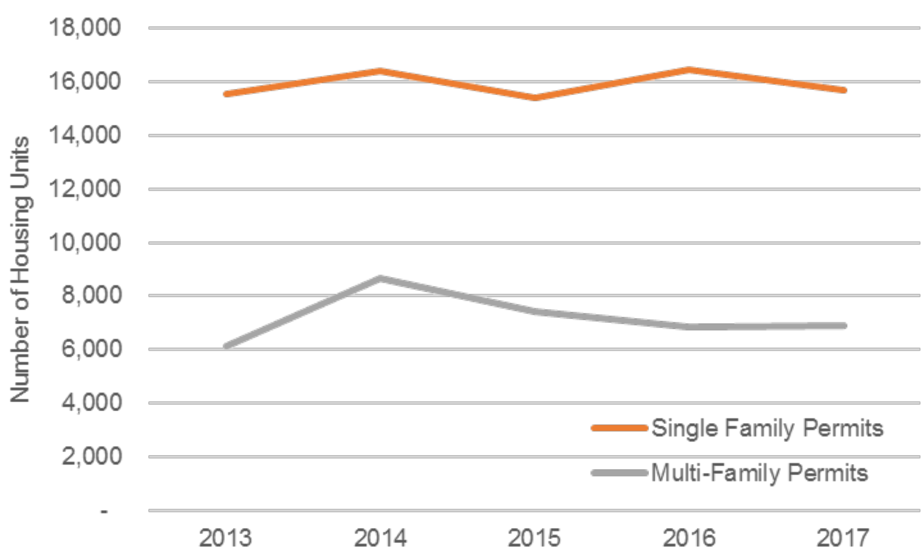
This plan recognizes that vulnerability to hazard events is not static. As development patterns in the Commonwealth evolve, the distribution of at-risk people and property will change, and the magnitude and frequency of certain hazard events will evolve as well. Flooding, for example, is exacerbated by the conversion of fields and forests to roads, roofs, and parking lots. As less rainfall is absorbed and more drainage infrastructure is added, runoff volumes and rates are amplified. This can lead, in turn, to more frequent and extreme flash flooding.

The following sub-sections present data that describes development trends based on Census Bureau's Building Permits Survey, National Land Cover Database, and PA DEP Population Projections. Review shows that permits and land cover trends and population trends do not align throughout the Commonwealth. Areas with projected population decline like Lackawanna, Luzerne, and Lycoming Counties and Allegheny and three of its surrounding counties have an increase in permits and urbanized land. Increases in new housing permits while population is projected to decline can be a result of more land consumption or 'green field' development. This typically leads to more exposure to natural hazards like flooding and wildfire, and in the case of flooding increased impact with less open space to absorb water. The differences in the data can also be linked to the strength of the projections; it is possible that with the 2020 US Census that trends from population will change in these areas so that the population projections 'catch-up' with the more recent permit data. The permit, land use, and population growth trends align in the rest of the Commonwealth such that Southeast and South Central, Lehigh Valley, and the counties of Butler, Centre, Erie, Monroe, and Washington have growth shown across the statistics. The difference between data sources and possible implications will be described in detail in the updated SOG, so that counties will consider how these trends apply to risk and mitigation in their communities.

4.4.1. Development Trends Between 2013 and 2018

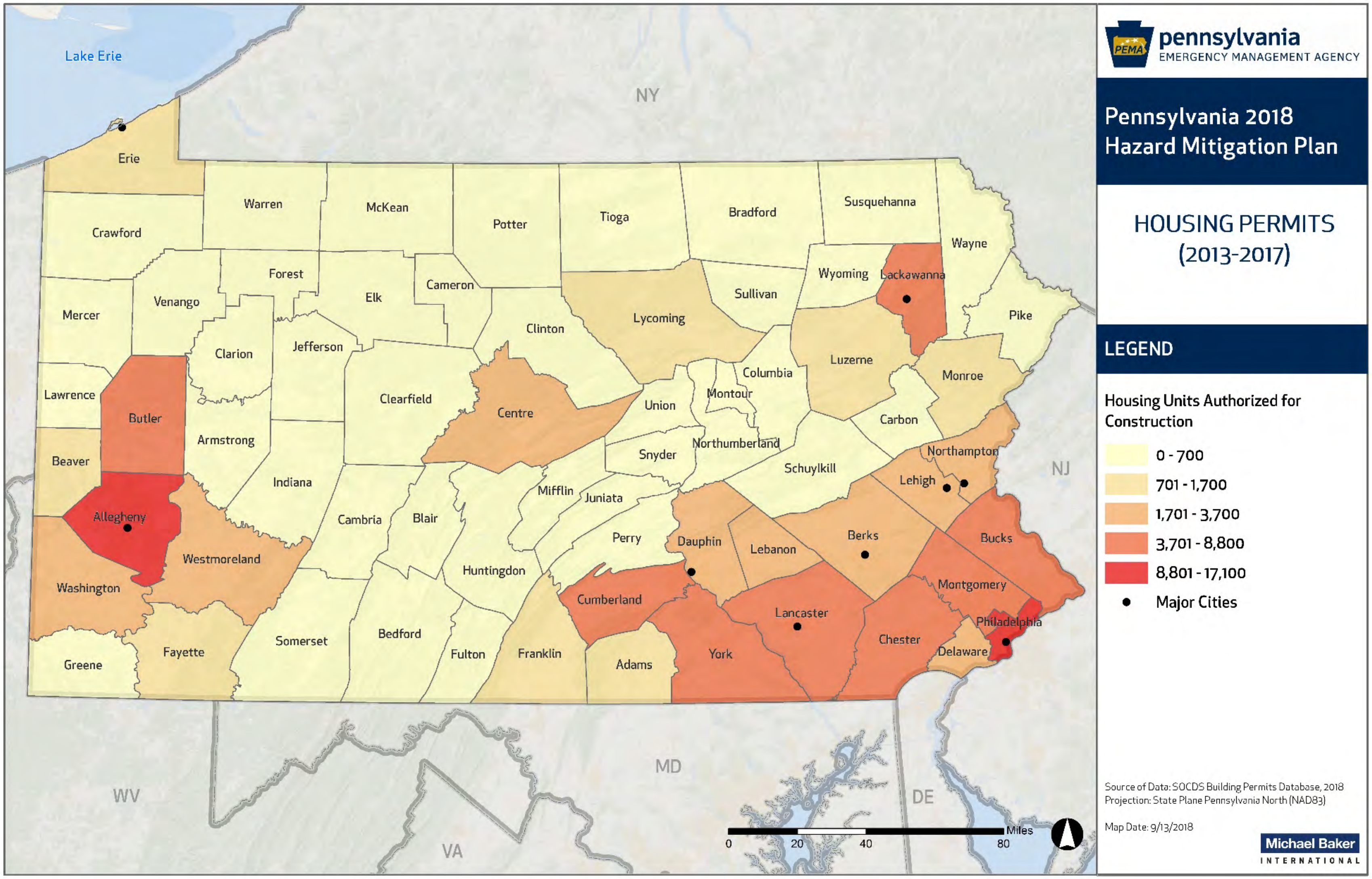
Building permit and land cover data provide some of the best information on recent development trends at the state scale. For building permits, the most comprehensive source of data is the Census Bureau's Building Permits Survey, which compiles data on residential construction permits issued by about 21,000 jurisdictions across the nation. According to the data for 2013-2017, the rate of new residential construction in Pennsylvania has been relatively stable since the 2013 SSAHMP. As shown in Figure 4.3.23-3, approximately 16,000 single-family units and 7,000 multi-family units were authorized for construction each year.

Figure 4.4.1-1 Housing Units Authorized for Construction in Pennsylvania, 2013-2017 (Census, 2018).



The rate of new residential construction in Pennsylvania has varied significantly from county to county. As shown in Figure 4.4.1-2, the number of housing units authorized for construction between 2013 and 2017 ranged from less than 700 in some counties to more than 17,000 in others. The counties experiencing the highest rate of residential development were Allegheny and Philadelphia Counties. Moderate development rates were seen in Lackawanna, Butler, Cumberland, York, and Lancaster counties and in the counties surrounding Philadelphia.

Figure 4.4.1-2 Housing units authorized for construction by county from 2013 to 2017 (Census, 2018).

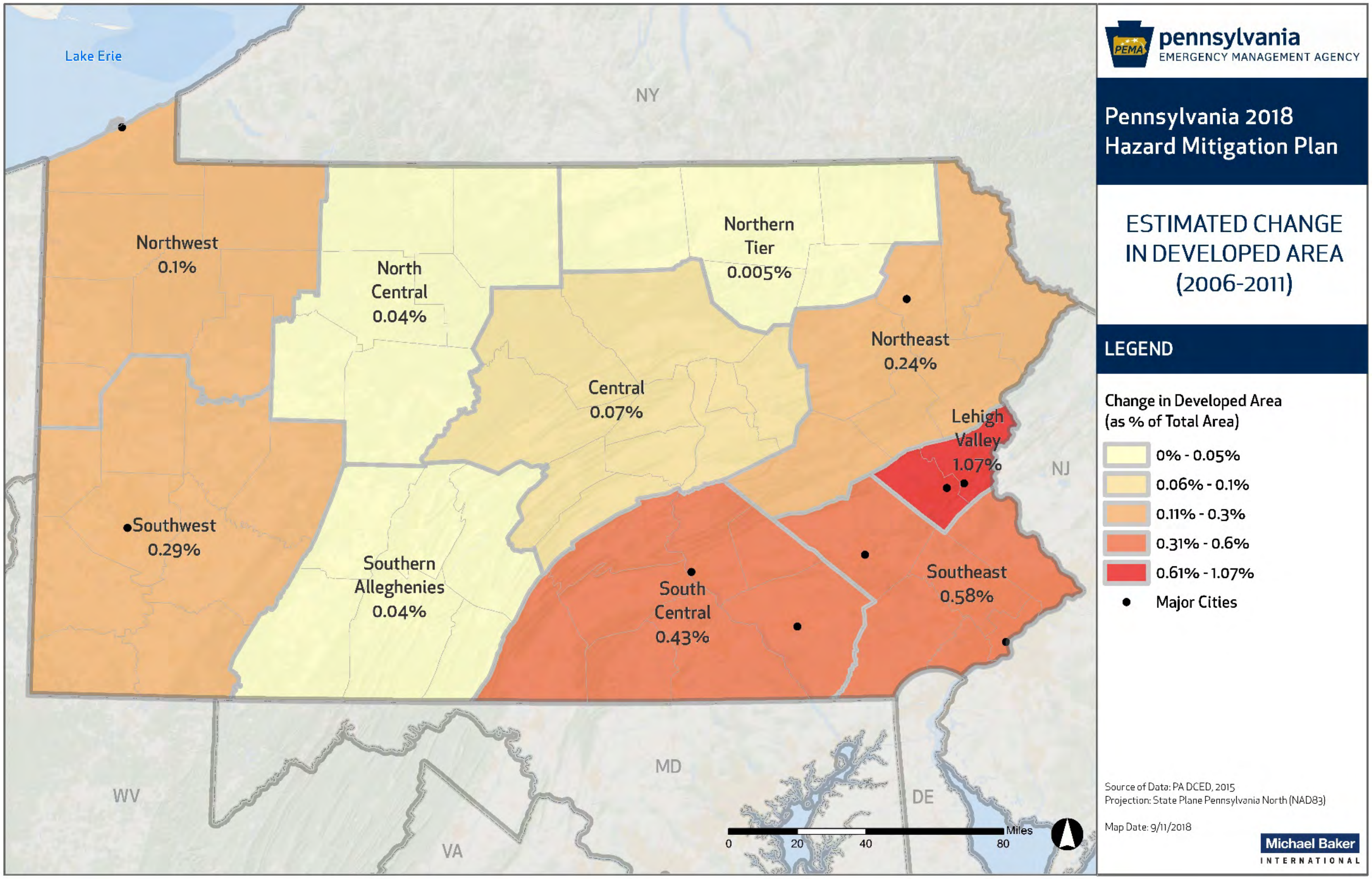


Another important measure of changes in development patterns is land cover data. The most comprehensive source of land cover data at the state scale is the Multi-Resolution Land Characteristics Consortium's National Land Cover Database (NLCD). The NLCD uses satellite data to map land use and land cover across the nation at 30-meter resolution. While permit records indicate where development has been approved to move forward, the NLCD shows were development has occurred. The 2016 NLCD dataset is not scheduled for release until December 2018, and therefore cannot be used to confirm the trends suggested by the 2013-2017 permit records. The development trends revealed by the 2006 and 2011 NLCD datasets, however, support the patterns seen in the 2013-2017 permit records. Figure 4.4.1-3 illustrates how the newly developed land area between 2006 and 2011 varied across the state. The regions experiencing the highest growth in developed area were the Lehigh Valley and Southeast Pennsylvania, while the regions experiencing the lowest growth were the Southern Alleghenies and the Northern Tier (NLCD, 2006 and 2011). Across the state, newly developed land consumed 0.2 percent of all land area between 2006 and 2011. In the Lehigh Valley, however, the rate of land consumption was more than five times the state average. Conversely, in the Northern Tier, the rate of land consumption was about 5 percent of the state average.

Taken together, building permit and land cover data for the state of Pennsylvania show that the state's **high growth building areas are concentrated in and around Allegheny and Philadelphia Counties, in the Lehigh Valley, and in Lackawanna County**. Conversely, these data show that **low growth rates prevail in the Northern Tier, North Central, and Southern Alleghenies regions**.

In addition to the urban development trends reflected in building permit and land cover data, Pennsylvania is experiencing rapid growth in unconventional natural gas extraction. The Marcellus Shale, the largest U.S. natural gas field, follows the arc of the Appalachian Mountains and underlies about three-fifths of the state. With the advent of unconventional drilling methods, Pennsylvania's natural gas production increased by almost tenfold between 2010 and 2017 (U.S. EIA, 2017). According to the Governor's Infrastructure Task Force (PITF) Report, in the coming years Pennsylvania "will undergo a substantial pipeline infrastructure build-out to transport gas and related byproducts from thousands of wells throughout the state" (PITF, 2016). The impacts of Marcellus Shale development on population growth, however, are less clear. According to a report developed by the Center for Rural Pennsylvania, the relationship of population change to Marcellus activity has not shown any consistent trends to date. While some counties with high levels of Marcellus activity have experienced accelerating population decline, others have experienced a turnaround to population growth (Center for Rural Pennsylvania, 2013). This is echoed in the divergent trends of increased permits with decreased population projections in Lackawanna, Luzerne, and Lycoming,

Figure 4.4.1-3 Percent of land area newly developed from 2006 to 2011 (DCED, 2015).



4.4.2. Projected Population

Population projections extrapolate from past trends to predict how population will change in the future. These projections give an indication of where development is likely to occur in the future, and how the people, property, and infrastructure exposed to hazard events will evolve with time. Table 4.4-1 illustrates how the population of the Commonwealth is expected to change through 2040. According to this projection, Pennsylvania is expected to experience a nearly 10 percent increase in population between 2010 and 2040. It is important to note that these population figures are projections derived from birth rates, death rates, and migration information and may not fully anticipate economic and social dynamics. The population projections are also based on older data from the 2010 US Census which could contribute to the difference between permit and population trends presented in this section.

Table 4.4-1 Population Projections of Pennsylvania Counties (PA DEP, 2012)

COUNTY	2010 CENSUS POPULATION	2020 PROJECTED POPULATION	2030 PROJECTED POPULATION	2040 PROJECTED POPULATION	PERCENT (%) CHANGE BETWEEN 2010 & 2040
Adams	101,407	112,355	122,794	133,523	31.67
Allegheny	1,223,348	1,179,072	1,155,460	1,136,415	-7.11
Armstrong	68,941	67,049	64,823	62,788	-8.93
Beaver	170,539	164,862	157,895	151,666	-11.07
Bedford	49,762	50,857	51,200	51,952	4.40
Berks	411,442	444,991	480,374	514,836	25.13
Blair	127,089	125,409	123,517	121,747	-4.20
Bradford	62,622	63,708	64,319	65,201	4.12
Bucks	625,249	662,439	693,715	728,370	16.49
Butler	183,862	196,325	205,865	217,076	18.06
Cambria	143,679	136,812	131,401	124,494	-13.35
Cameron	5,085	4,762	4,381	4,033	-20.69
Carbon	65,249	67,562	70,987	73,777	13.07
Centre	153,990	166,921	182,921	197,168	28.04
Chester	498,886	552,006	607,694	661,915	32.68
Clarion	39,988	39,396	38,625	37,957	-5.08
Clearfield	81,642	83,541	83,351	84,355	3.32
Clinton	39,238	40,127	41,395	42,447	8.18
Columbia	67,295	69,295	71,986	74,287	10.39
Crawford	88,765	90,493	90,385	91,326	2.89
Cumberland	235,406	254,802	275,462	295,400	25.49
Dauphin	268,100	283,087	298,465	313,620	16.98
Delaware	558,979	562,848	567,327	571,458	2.23
Elk	31,946	30,920	28,953	27,523	-13.85
Erie	280,566	283,031	283,942	285,742	1.84

Table 4.4-1 Population Projections of Pennsylvania Counties (PA DEP, 2012)					
COUNTY	2010 CENSUS POPULATION	2020 PROJECTED POPULATION	2030 PROJECTED POPULATION	2040 PROJECTED POPULATION	PERCENT (%) CHANGE BETWEEN 2010 & 2040
Fayette	136,606	133,578	127,240	122,794	-10.11
Forest	7,716	8,665	9,823	10,861	40.76
Franklin	149,618	163,024	180,267	195,318	30.54
Fulton	14,845	15,338	16,123	16,573	11.64
Greene	38,686	38,605	37,858	37,492	-3.09
Huntingdon	45,913	46,905	47,740	48,518	5.67
Indiana	88,880	88,458	87,959	87,504	-1.55
Jefferson	45,200	44850	44,287	43,846	-3.00
Juniata	24,636	26,669	28,577	30,556	24.03
Lackawanna	214,437	211,584	211,150	209,334	-2.38
Lancaster	519,445	567,331	615,323	663,255	27.69
Lawrence	91,108	89,083	87,057	85,032	-6.67
Lebanon	133,568	142,898	154,224	164,409	23.09
Lehigh	349,497	374,744	403,711	430,553	23.19
Luzerne	320,918	316,833	316,271	313,696	-2.25
Lycoming	116,111	115,313	113,437	112,176	-3.39
McKean	43,450	41,801	39,863	38,090	-12.34
Mercer	116,638	115,521	114,429	113,323	-2.84
Mifflin	46,682	46,948	47,224	47,495	1.74
Monroe	169,842	195,103	221,427	247,144	45.51
Montgomery	799,874	851,171	900,477	950,920	18.88
Montour	18,267	18,567	18,713	18,946	3.72
Northampton	297,735	320,507	345,538	369,278	24.03
Northumberland	94,528	93,744	93,513	92,966	-1.65
Perry	45,969	48,372	50,788	53,197	15.72
Philadelphia	1,526,006	1,530,000	1,536,544	1,541,630	1.02
Pike	57,369	66,868	76,604	86,205	50.26
Potter	17,457	17,924	17,798	18,010	3.17
Schuylkill	148,289	146,579	145,376	143,883	-2.97
Snyder	39,702	41,121	42,961	44,560	12.24
Somerset	77,742	77,872	76,855	76,493	-1.61
Sullivan	6,428	6,629	6,654	6,780	5.48
Susquehanna	43,356	44,987	46,389	47,922	10.53
Tioga	41,981	42,361	42,873	43,309	3.16
Union	44,947	48,195	51,486	54,752	21.81
Venango	54,984	53,118	50,963	48,974	-10.93

Table 4.4-1 Population Projections of Pennsylvania Counties (PA DEP, 2012)					
COUNTY	**2010 CENSUS POPULATION**	**2020 PROJECTED POPULATION**	**2030 PROJECTED POPULATION**	**2040 PROJECTED POPULATION**	**PERCENT (%) CHANGE BETWEEN 2010 & 2040**
Warren	41,815	10,455	38,815	37,335	-10.71
Washington	207,820	209,198	213,722	216,448	4.15
Wayne	52,822	58,386	63,105	68,307	29.32
Westmoreland	365,169	363,665	363,832	361,236	-1.08
Wyoming	28,276	28,423	28,599	28,758	1.70
York	434,972	477,643	523,716	567,845	30.55
PA TOTAL	***12,702,379***	***13,101,704***	***13,536,552***	***13,964,799***	***9.94***

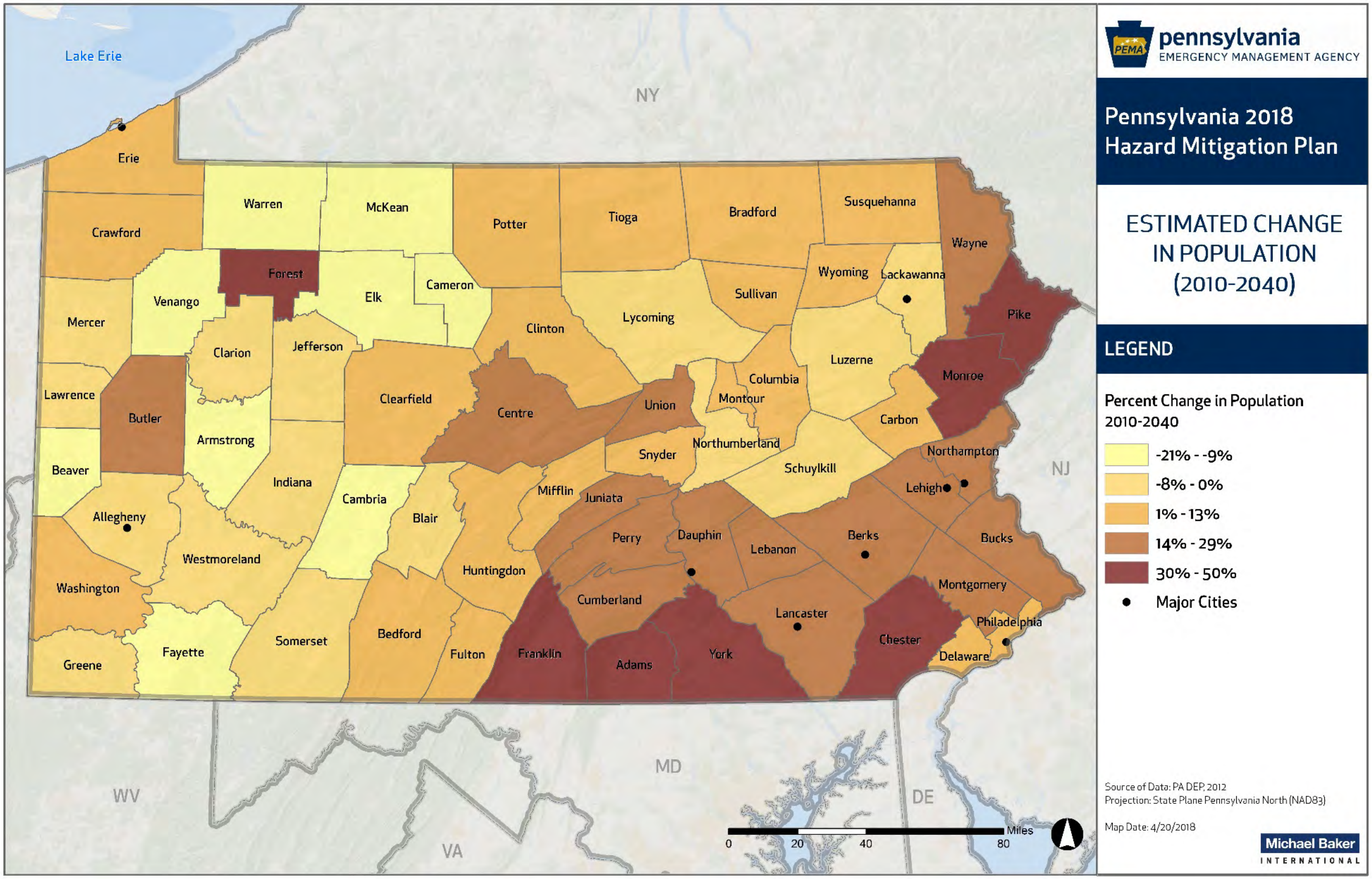
As shown in Table 4.4-1 and Figure 4.4.2-1, Pennsylvania's overall growth is not evenly spatially distributed. In general, the Northeast region is expected experience very rapid growth (greater than 40%) due to development pressure from the greater New York City metropolitan area. Pike and Monroe Counties are expected to have the highest population growth rates in the Commonwealth, with population increases of 50% and 45.5%, respectively. Forest County in the Northwest region is also expected to experience very rapid growth (40.76%). Possible drivers for Forest County's growth include Marcellus Shale development and growth in the population of incarcerated persons housed at State Correctional Institute in Forest County (SCI-Forest) in Jenks Township. Forest County also has one of the smallest populations in Pennsylvania with 7,716 in 2010, so that a small change has a big impact on the percent change.

In general, the South Central and Southeast regions are expected to experience rapid growth (greater than 25%) between 2010 and 2040. The nine counties expected to experience growth rates greater 25% and less than 40% are Adams, Berks, Centre, Chester, Cumberland, Franklin, Lancaster, Wayne and York. Most of these counties are in the South Central and Southeast regions of the Commonwealth. These high growth counties are experiencing a similar phenomenon to Northeast Pennsylvania. Development pressure and exurban sprawl around Baltimore, MD, Washington, DC, and Philadelphia is fueling population growth and land conversion from farmland to developed land. Beyond the Southeast and South Central regions, Centre County in the Central region and Wayne County in the Northeast region are also expected to experience rapid growth.

On the other side of the spectrum, many counties in Pennsylvania are expected to lose population or experience only slight growth between 2010 and 2040. These declines are typically in rural areas in the Northern Tier region and in the area surrounding Pittsburg with Allegheny and many of its surrounding counties. In Allegheny, Armstrong, Beaver, Cambria, Cameron, Elk, Fayette, McKean, Venango, and Warren counties, population is expected to decline by 7% or more. The rates of decline range from 7.1% in Allegheny County to 20.7% in Cameron County. In the rural counties, population loss coupled with a strong statewide push to preserve prime agricultural land through the Commonwealth's Agricultural Land Preservation Policy (2003) and the PA Wilds Initiative may decrease or stabilize hazard vulnerability. In the urban to suburban areas around Pittsburgh population decline would have a more mix impact on hazards; for instance, exposure to some natural hazards could decrease while the risk of building and infrastructure collapse increases.

Taken together with building permit and land cover data for the state, population projections for Pennsylvania show that the state's **high growth areas are likely to be concentrated in Southeast and South Central, Lehigh Valley, and the counties of Butler, Centre, Erie, Monroe, and Washington**. **Data is mixed in the Southwest for Allegheny, Beaver, Fayette, and Westmoreland, as well as, in Lackawanna, Luzerne, and Lycoming** where permits and land cover increase while population is projected to decrease. Data aligns to show **decline and/or low growth rates are likely to prevail in the Northern Tier, North Central, and Southern Alleghenies regions**.

Figure 4.4.2-1 Projected population change by county (PADEP, 2012).



4.4.3. Impacts of Development Trends in High Growth Areas

When a hazard event occurs, the amount of damage and loss is largely determined by the amount of development in harm's way. This section discusses how development in Pennsylvania's high growth areas is likely to increase vulnerability to some of the state's highest-ranked hazards.

- **Flooding**: Flooding is Pennsylvania's most widespread natural hazard and poses a risk to every community in the state. As new greenfield development in Pennsylvania's high growth counties converts more forest land and farmland to impervious cover, the amount of runoff generated by a given storm will increase, and the risk of flooding and flash flooding will grow. The high permit growth counties that have historically experienced the most frequent flooding in Pennsylvania (according to the Storm Events Database) are the counties in the Greater Pittsburgh area, the counties in the Greater Philadelphia area, and York and Lancaster counties. These are areas where flood vulnerability is already high and can be expected to increase with further development.

- **Winter Storm**: As sprawling development patterns continue to play out in high-growth suburban and rural areas, people in these areas will become more vulnerable to disruptions to the transportation network caused by winter storms. The closing of secondary roads due to snow and ice can prevent emergency vehicles from reaching people in need and can cause significant economic disruption. The high growth counties that have historically experienced the highest average annual snowfall are Wayne County, northern Pike and Monroe counties. These are the areas where winter storm vulnerability is most likely to increase with further development.

- **Hazardous Materials Release**: Several of Pennsylvania's high growth counties are also home to growing levels of unconventional gas development. These include counties in the Greater Pittsburgh area and Centre county. As new pipeline infrastructure is developed to transport growing volumes of natural gas and natural gas byproducts, the risk of hazard materials release will increase.

- **Wildfires**: Two of the highest growth counties in Pennsylvania, Pike and Monroe Counties, are also two of the counties with the highest risk of wildfires. New construction in previously rural areas is likely to expand the wildland urban interface, increasing exposure to wildfires.

- **Subsidence and Sinkholes**: Several of the high growth counties in Pennsylvania (including the Greater Pittsburgh area, the Lehigh Valley region, and Centre County) are also among the counties with the most karst area and the highest risk of sinkholes and subsidence. If not properly sited, new construction in these areas could be vulnerable to damage from long-term subsidence or abrupt sinkhole formation.

4.4.4. Impacts of Development Trends in Low Growth Areas

When a hazard strikes, the condition of the property and infrastructure in harm's way also affects the amount of damage and loss. This section discusses how conditions in declining areas could increase vulnerability to hazards.

- **Building and Structure Collapse:** Section 4.3.17 shows the distribution of housing units built prior to 1960 and structurally-deficient bridges in Pennsylvania. Based on this data, some of the low-growth counties with the structures and infrastructure that are likely to be in the poorest condition are McKean, Cambria, Northumberland, and Schuylkill. Structures and infrastructure that are in poor condition are more susceptible to collapse when stressed by environmental factors or other hazards.

- **Utility Interruption:** Low growth and declining jurisdictions generally have limited tax revenue to reinvest in aging infrastructure, including utilities such as telecommunication, gas, electric, water, or waste networks. These jurisdictions are therefore more vulnerable to utility interruptions caused by mechanical failures, environmental factors, or other hazards.

4.5. Consequence Analysis

The EMAP standard for a hazard identification and risk assessment (HIRA) requires states to include a consequence analysis for the hazards identified in state HIRAs. The consequence analysis assesses the impact on the Commonwealth's systems after a hypothetical or scenario hazard event. A *consequence* is defined as *something produced by a cause or necessarily following from a set of conditions.* Consequences from hazard events are usually negative, but could be positive.

For this analysis, local, state, and federal agencies and organizations throughout the Commonwealth were asked to identify natural and human-made hazards that would have the largest consequences on their agency or organization and to provide comments regarding the impacts of certain hazards identified as having large consequences. A total of 19 agencies and organizations participated. Table 4.5-1 provides a summary of which natural and human-made hazards each agency or organization determined to be most consequential.

With respect to natural hazards, flooding and severe storms such hurricanes, tropical storms and nor'easters were most frequently identified as having large consequences by the 19 participating agencies and organizations. Winter storms, pandemic, and earthquakes were also commonly identified as significantly consequential. Of the 17 human-made hazards, cyber-terrorism, nuclear incident, traffic incidents, and utility interruption were most commonly identified as most consequential. A total of 14 of the 19 agencies and organizations recognized the potential severe consequences of cyber-terrorism, making it the most frequently identified hazard with the largest consequences. However, several agencies specifically noted that their interpretation of the term cyber-terrorism included any significant event that posed a threat to cyber security. Many of the above-listed hazards were identifies as being most consequential due to potential widespread consequences and the impact on public health and safety, critical resources, and ongoing operations.

Table 4.5-1 Hazards with the Largest Consequences on Local, State, and Federal Agencies and Organization in the Commonwealth

HAZRD	PA DEPT. OF AGRICULTURE	PA DEPT. OF BANKING & SECURITIES	PA DEPT. OF CONSERVATION & NATURAL RESOURCES	PA DEPT. OF HUMAN SERVICES	PA DEPT. OF LABOR & INDUSTRY	PA DEP BUR. OF RADIATION PROTECTION	PA DEP COASTAL REOURCES MANAGEMENT	PEMA	PHFA	PHMC STATE HISTORIC PRESERVATION OFFICE	PA OFFICE OF HOMELAND SECURITY	PA PUC	USGS PAWSC	US DEPT. OF HOMELAND SECUIRTY	REGIONAL PLANNING AGENCY: NTRPDC	MPO: DVRPC	PENN STATE UNIVERSITY	COUNTY PLANNING DEPT.	COUNTY DEPT. OF EMERGENCY SERVICES
NATURAL HAZARDS																			
Coastal Erosion							✓			✓									
Drought			✓										✓					✓	
Earthquake					✓	✓			✓			✓		✓					
Extreme Temperature													✓	✓					✓
Flood, Flash Flood, Ice Jam			✓	✓					✓	✓			✓	✓				✓	✓
Hailstorm																			
Hurricane, Tropical Storm, Nor'easter			✓	✓			✓		✓	✓		✓	✓	✓				✓	✓
Invasive Species			✓				✓												
Landslide																			
Lightning Strike													✓	✓					✓
Pandemic and Infectious Disease	✓			✓				✓				✓		✓			✓		
Radon Exposure						✓						✓							

Table 4.5-1 Hazards with the Largest Consequences on Local, State, and Federal Agencies and Organization in the Commonwealth

HAZRD	PA DEPT. OF AGRICULTURE	PA DEPT. OF BANKING & SECURITIES	PA DEPT. OF CONSERVATION & NATURAL RESOURCES	PA DEPT. OF HUMAN SERVICES	PA DEPT. OF LABOR & INDUSTRY	PA DEP BUR. OF RADIATION PROTECTION	PA DEP COASTAL REOURCES MANAGEMENT	PEMA	PHFA	PHMC STATE HISTORIC PRESERVATION OFFICE	PA OFFICE OF HOMELAND SECURITY	PA PUC	USGS PAWSC	US DEPT. OF HOMELAND SECUIRTY	REGIONAL PLANNING AGENCY: NTRPDC	MPO: DVRPC	PENN STATE UNIVERSITY	COUNTY PLANNING DEPT.	COUNTY DEPT. OF EMERGENCY SERVICES
Subsidence, Sinkhole									✓										
Tornado, Windstorm													✓	✓					
Wildfire			✓															✓	
Winter Storm			✓						✓					✓				✓	✓
HUMAN-MADE HAZARDS																			
Building and Structure Collapse					✓				✓	✓				✓			✓		
Civil Disturbance		✓						✓	✓										
Cyber-Terrorism		✓	✓	✓	✓	✓		✓			✓	✓	✓	✓	✓		✓	✓	✓
Dam Failure			✓											✓					
Environmental Hazard – Coal Mining										✓									
Environmental Hazard – Conventional Oil and Gas Wells			✓							✓									
Environmental Hazard – Gas and Liquid Pipeline			✓				✓			✓				✓					✓
Environmental Hazard – Hazardous Materials Releases					✓	✓				✓				✓					✓
Environmental Hazard – Unconventional Wells			✓							✓									

Table 4.5-1 Hazards with the Largest Consequences on Local, State, and Federal Agencies and Organization in the Commonwealth

HAZRD	PA DEPT. OF AGRICULTURE	PA DEPT. OF BANKING & SECURITIES	PA DEPT. OF CONSERVATION & NATURAL RESOURCES	PA DEPT. OF HUMAN SERVICES	PA DEPT. OF LABOR & INDUSTRY	PA DEP BUR. OF RADIATION PROTECTION	PA DEP COASTAL REOURCES MANAGEMENT	PEMA	PHFA	PHMC STATE HISTORIC PRESERVATION OFFICE	PA OFFICE OF HOMELAND SECURITY	PA PUC	USGS PAWSC	US DEPT. OF HOMELAND SECUIRTY	REGIONAL PLANNING AGENCY: NTRPDC	MPO: DVRPC	PENN STATE UNIVERSITY	COUNTY PLANNING DEPT.	COUNTY DEPT. OF EMERGENCY SERVICES
Levee Failure														✓					
Mass Food and Animal Feed Contamination	✓					✓												✓	
Nuclear Incident	✓					✓		✓				✓		✓					
Opioid Addiction Response									✓										
Terrorism						✓		✓				✓		✓					
Transportation Accidents						✓	✓		✓					✓		✓			✓
Urban Fire and Explosion									✓	✓				✓					
Utility Interruption	✓				✓	✓			✓		✓			✓				✓	✓

As part of the consequence analysis, local, state, and federal agencies and organizations were also asked to describe how the hazard identified as having the largest consequences impacts the following:

1. Public and Responders
2. Continuity of Operations and Program Operations
3. Property, Facilities, and Infrastructure
4. Delivery of Services
5. Public's Confidence in Jurisdiction's Governance
6. Economic Condition
7. Environment

The following provides a summary of the significance of these impacts, as well as highlights the responses provided by the 19 participating agencies and organizations.

Impact on the Public and Responders

The impact of hazards on the public relates to the geographic extent of a hazard and its impact (minor, limited, critical, catastrophic). Based on the risk assessment and risk factor ranking of hazards in Pennsylvania, there are no hazards whose impact could be considered catastrophic on a statewide level, where there would be a high number of casualties and deaths, more than half the state would be impacted, and where state facilities would be shut down for a month or more. However, flooding hazards along with coastal storms, nuclear incidents, dam failure, utility interruption, pandemic, and cyber-terrorism or terrorism events could have critical impacts in terms of the number of individuals adversely affected. For example, widespread or long-term utility interruption, as well as a pandemic, could jeopardize the continuity of the food supply affecting public health. A consequence of a cyber-terrorism event could be the release of private public data that could lead to identify theft and threaten public safety. Public safety is also a major concern in the event of a nuclear incident where thousands of residents may need to be evacuated. With respect to flooding and severe storms, the widespread halt to the day-to-day lives of Pennsylvanians was most closely seen during Tropical Storms Lee and Irene, when massive areas of the Commonwealth were flooded and people were stuck in their homes or in shelters for many days. Flooding and severe storm events mainly cause transportation issues and closings, utility interruptions, and property damage.

Hazard events in the Commonwealth are unlikely to be catastrophic in nature, so municipalities and counties should be able to enact mutual aid mechanisms in the event of a disaster. As a result, the impact on first responders during hazard events should be fairly low. First responders are specifically trained to reduce negative consequences on their ability to do their jobs. The hazards that can have the highest impact on first responders will most likely be a pandemic disease outbreak or a mass food contamination event. During times of widespread disease or illness, the DOH expects that mutual aid will not be able to be rendered because the event would affect the response capability of most jurisdictions, even across state and county lines. With respect to a cyber-terrorism event, a limited number of OIT staff or other professional staff could influence the timing of response.

Impact on Continuity of Operations and Program Operations

Commonwealth agencies and communities develop Continuity of Operations Plans (COOP) to prepare for events when facilities and agencies are impacted by a hazard event. There will be severe consequences on the continuity of government operations to function in hazard events that strike the heart of the Commonwealth's people and buildings. These hazard events often include civil disturbances, terrorism events, and pandemic disease threats as well as instances of natural disasters that strike areas with a high concentration of government functions, particularly Harrisburg. Closing of roadways and mass transit operations, utility interruption, and housing and facility impacts leading to office disruption or closure can affect continuity of operations during natural disasters, such as flooding or severe storms.

Impact on Property, Facilities, and Infrastructure

The consequences of a given hazard event on Commonwealth property, facilities, and infrastructure will depend on whether the hazard in question is likely to cause structural and/or property damage. Past occurrences indicate that the consequences for property, facilities, and infrastructure are highest for flood and winter storm events. These past events have led to both property damage, leading to relocation or restoration, and utility interruption. However, the Commonwealth has attempted to assess vulnerability and estimate losses for each natural and human-made hazard that has the potential to impact Pennsylvania. In many cases, these vulnerability and loss estimates involve the impact on property, facilities, and infrastructure; please refer to these subsections of Section 4.3 for the potential impacts associated with each hazard. It is important to note that these loss estimates are for comparison purposes in this SHMP; it is unlikely that any single hazard event would inflict the maximum damages estimated in Section 4.3 in all vulnerable jurisdictions.

Impact on Delivery of Services

The consequences of a hazard event on an agency's ability to deliver service corresponds with the severity of the event and the type of agency affected. An event with potential widespread consequences could impact an agency's ability to deliver and perform all its services and non-essential services may be delayed or postponed. For example, in the event of a widespread pandemic, agencies may only be able to deliver essential services. During a cyber-terrorism event, services may be interrupted while responders research the cause and implement mitigation strategies to prevent further losses. Similar to the impact on the continuity of operations, severe storms and flooding can lead to closing of roadways, utility interruption, and office disruption or closure. However, depending on the location and the area impacted, some agencies may operate at a satellite location to ensure delivery of services.

Impact on Public's Confidence in Jurisdiction's Governance

Public confidence in governance is tightly linked to citizens' expectations of government action and response to hazard events. Confidence is higher when the Commonwealth is seen as taking action in the event of a severe hazard event. Therefore, the provision of essential services during these events can be critical in managing public confidence. However, in the case of hazards like severe winter storms where there is a longer-term visible reminder of the event, public confidence can be lower. Public confidence can also be lowered if not all populations, especially any impaired populations, are properly informed or helped. Additionally, public confidence can be swayed by the characterization of mitigation and response in the popular press. For example, the extensive duration and widespread geographic extent of the opioid epidemic, as well as recent media coverage, will be linked to public perception of and confidence in the state's addiction response efforts. The hazards most likely to have statewide impacts on public confidence are those that also have widespread or statewide impacts, those that have high or even catastrophic impacts, and those that have little warning time. Using these criteria and the results of the Risk Factor Analysis (see Section 4.1), the hazards that can have the most significant consequences for public confidence in governance are drought, winter storms, flooding, severe storms, utility interruption, nuclear incidents, cyber-terrorism events, hazardous materials release, and pandemic disease outbreaks.

Impact on Economic Condition

With the expectation that few hazard events will be catastrophic in nature, the consequences of hazard events on the Commonwealth's economy, while potentially severe in the short-term, should be recoverable. Past occurrences have shown the economic impact to be limited, and federal and state funding helped mitigate consequences. The diversity of Pennsylvania's economy aids in lowering the economic impact of a disaster event; while a hazard event could cripple one sector of the economy, it is unlikely that all sectors will be simultaneously impacted. Geographically, hazards, such as flooding and utility interruptions, that impact greater Philadelphia, the greater Pittsburgh region, and the greater Harrisburg area could have a more significant impact on economic conditions because of the concentration of economic activity in these metropolitan areas. Additionally, some hazards disproportionately affect certain sectors in the Pennsylvania economy. For example, droughts, hailstorms, and invasive species hazards could cause widespread consequences for the Commonwealth's sizeable agricultural sector. Hazard events affecting the Harrisburg area could have severe consequences on economic conditions because of the area's importance in processing government payments and grant programs for the entire Commonwealth. With respect to other state facilities, long-term public closure of state parks or other facilities can impact tourism, leading to economic loss for state agencies and local communities. Finally, cyber-terrorism events can jeopardize the personal information of state agencies and the public, which can lead to identify theft and loss of assets.

Impact on the Environment

As evidenced in this plan's risk assessment (Section 4.3), nearly all hazards identified and profiled have the potential for some kind of environmental impact. For example, drought hazards can cause decreases in air quality and soil productivity as well as adverse impacts on water supplies. Flood events can result in the pollution of streams and rivers due to combined sewer overflows or flooding in SARA Title III facilities. Nuclear incidents can contaminate air and land with unsafe levels of radiation for thousands of years. Wildfire events can reduce biodiversity and increase erosion after a fire event. The hazards with the potential for the highest consequences on the environment are environmental hazards, flooding, and nuclear incident (either intentional or accidental).

5 Capability Assessment

5. Capability Assessment

5.1. Update Process Summary

The purpose of conducting a capability assessment is to determine the ability of the Commonwealth to implement a comprehensive mitigation strategy and to identify potential opportunities for establishing or enhancing specific mitigation policies, programs, or projects. The capability assessment provides an opportunity to highlight the positive mitigation measures already in place or being implemented throughout the Commonwealth, which should continue to be supported and enhanced if possible through future mitigation efforts.

This section provides an assessment of state and local hazard mitigation capabilities and touches on some of the federal hazard mitigation programs most relevant in Pennsylvania. At the state level, a summary of the tools available to the Commonwealth for pre- and post-disaster hazard mitigation efforts is provided as well as development management. Federal, state, local and private funding sources are provided in Section 5.3.3. The State Capability Assessment in the 2007 SSAHMP focused primarily on the presence of the Commonwealth's Emergency Operations Plan. The 2010 SSAHMP expanded the assessment to comprehensively describe other tools available related to hazard mitigation and development in hazard-prone areas. The 2013 SSAHMP included the following significant updates and additions:

- Addition of "Legal Context" section
- Addition of "Federal Programs Supporting Hazard Mitigation in Pennsylvania" section
- Updates to the BORM staff text such as job descriptions, trainings, conferences, exercises, etc.
- Updates to the organizational charts for PEMA and BORM
- Addition of "Other State and Multi-Agency Programs in Pennsylvania" section
- Addition of "Hazard Mitigation Land Use Measures in Pennsylvania" section
- Additions to the "PA Emergency Operations Center" section
- Updates to the "Status of Local Hazard Mitigation Plans" section text and mapping
- Updates to the "Summary & Evaluation of Local Mitigation Capability" section text and mapping
- Addition of a CRS, Firewise, and StormReady information
- Addition of a more robust program and plan integration section

The 2018 update improved and updated information through Section 5. Edits to 5.5 were a focus of the update to improve the information on plan integration and better graphically represent how it is accomplished in Pennsylvania. Edits were made throughout Section 5 to describe plans for PEMA and DCED collaboration on NFIP management.

A comprehensive list of existing planning policies, programs, and capabilities which support hazard mitigation activities is included in Section 5.3.1. This assessment was prepared based on information gathered from the SPT and county staff and through coordination with BORM staff. Opportunities to review draft information were provided to the SPT, county staff, and others who attended the public forums. Section 5.2 below provides additional information on federal, state, and local laws that influence the Commonwealth's hazard mitigation capability.

5.2. Legal Context

The following is a summary of the federal, state, and local disaster mitigation and emergency management laws. Many of these laws are referenced and/or described in more detail throughout this chapter or in other areas of the plan.

5.2.1. Federal Laws

Presidential Policy Directive 8 and Related Requirements

The Threat and Hazard Identification and Risk Assessment (THIRA) is a requirement for Homeland Security Grants and Emergency Management Performance Grants. The State Preparedness Report (SPR) is a self-assessment of preparedness conducted via a standardized survey and is required by the Post Katrina Emergency Management Reform Act of 2006 (PKEMRA). PEMA uses the THIRA and the SPR together to assess threats and hazards, examine the consequences associated with their impact, and select planning and preparedness activities that build core capabilities among the five mission areas (prevention, protection, mitigation, response, recovery) identified within the National Preparedness Goal (NPG). These products are all related to the Department of Homeland Security and Presidential Policy Directive 8: National Preparedness of 2011 (PPD-8), which details the national approach to preparing for threats and hazards posing a national security risk (PEMA, 2018).

Robert T. Stafford Disaster Relief and Emergency Assistance Act

The Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988 authorizes technical, financial, logistical, and other assistance from the federal government to state and local governments during declared major disasters and emergencies.

Disaster Mitigation Act

The Disaster Mitigation Act of 2000 amended the Stafford Act and the Public Works Act, which provides grants for economic development, to require local governments to prepare hazard mitigation plans as a precondition for receipt of Hazard Mitigation Grant Program project funds. The Disaster Mitigation Act encourages communities to reduce preventable, repetitive disaster losses by mitigating natural hazards, vulnerability, and risk.

National Flood Insurance Act

The National Flood Insurance Act of 1968 established the National Flood Insurance Program (NFIP), which allows residents of participating communities to purchase flood insurance in exchange for the implementation and enforcement by state and local communities of floodplain management ordinances. Over 21,000 communities participate in the NFIP.

Biggert-Waters Flood Insurance Reform Act and the Homeowner Flood Insurance Affordability Act of 2014

The Biggert-Waters Flood Insurance Reform Act of 2012 made significant changes to the NFIP. This act requires the NFIP to raise subsidized insurance rates to actuarial rates in an effort to make the program more financially stable. The Act implemented rate increases for owners of subsidized policies on non-primary/secondary residences, to owners of subsidized policies on property that has experienced severe or repeated flooding, and on business/non-residential properties in a Special Flood Hazard Area. Primary residences in the SFHA would keep their existing subsidized rates until the property is sold, the policy lapses, a new policy is purchased, or the property suffers severe, repeated flood losses. Grandfathered rates would be phased out at a rate of 20% increase per year for five years when a community adopts a new, updated FIRM.

The Homeowner Flood Insurance Affordability Act of 2014 (HFIAA) addressed criticism of the Biggert-Waters Act by making the transitions to paying more for insurance more gradual. The HFIAA restored aspects of grandfathering by limiting annual rate increases providing time for property owners to mitigate and budget for insurance costs. HFIAA also introduced an annual surcharge to all policyholders to help support the fiscal soundness of the program.

The NFIP Reauthorization is currently in consideration of the US Congress and additional changes may be made. The summary for communities and policy holders is that the cost of insurance is likely to rise and that the investment in mitigation is likely to see additional benefits in both safety and savings. In response to these changes, FEMA is encouraging communities to consider joining the Community Rating System (CRS) or to increase their CRS activities to lower premiums for residents and also to consider pursuing FEMA grants through the Commonwealth. DCED and BORM staff have been educating the public about these important changes to the NFIP by addressing flood insurance reform in community trainings.

Pandemic and All-Hazards Preparedness Act

The Pandemic and All-Hazard Preparedness Act of 2006 had broad implications for the Department of Health and Human Service's' preparedness and response activities, including providing new authorities for programs such as development and acquisition of medical countermeasures and the establishment of a quadrennial National Health Security Strategy. The act was reauthorized in March 2013.

Nationwide Programmatic Environmental Documents

In order to receive federal funding, projects must comply with the National Environmental Policy Act (NEPA) of 1969, which requires federal agencies to consider the effects of proposed projects on the natural and human environment. To eliminate repetitive discussions, nationwide programmatic environmental documents have been developed. If a given project meets the scope, impacts, and mitigation covered in the related programmatic environmental document, then no further NEPA documentation will be required. Programmatic environmental documents relevant to the Commonwealth of Pennsylvania include (FEMA, 2018):

- Programmatic Environmental Impact Statement for the NFIP (Final – September 1976)
- Programmatic Environmental Assessment for Integrated Public Alert and Warning System Construction Projects (Final – June 2010) (radio stations)
- Programmatic Environmental Assessment for the Grant Programs Directorate Programs (Final – July 2010)
- Programmatic Environmental Assessment for Hazard Mitigation Safe Room Construction (Draft – March 2011)

Administrative Directives

Federal guidelines are in place to assist state and local governments with mitigation, preparedness, response, and recovery programs. Relevant federal guidelines include the National Incident Management System, which provides standard procedures for incident command; the National Response Framework, which provides response and recovery guidelines; and the National Disaster Recovery Framework, which provides a recovery framework.

5.2.2. State Laws

Pennsylvania Flood Plain Management Act (DCED)

The *Pennsylvania Flood Plain Management Act* (Act 166) encourages sound land us practices within the floodplain. The Act requires which municipalities with SFHAs to participate in the NFIP meeting the minimum standards. The Act establishes higher regulatory standards for hazardous materials and high-risk land uses and currently designates DCED as the State NFIP Coordinator.

PEMA and DCED have established a new partnership to manage the NFIP in Pennsylvania. Now both agencies and specifically BORM within PEMA will support the NFIP responsibilities for the Commonwealth. As this partnership continues and grows the agency location of the State NFIP Coordinator may change if it is determined that NFIP management in the Commonwealth would be improved by amendments to Act 166.

Pennsylvania Hazardous Material Emergency Planning and Response Act (DEP, PEMA, PA DLI, and Local Emergency Planning Committees, or LEPCs)

The Superfund Amendments and Reauthorization Act 165 of 1986 and amended in 2011 (SARA) combats only one specific type of disaster - hazardous materials. The law has several provisions, including requirements for reporting releases of chemicals and requirements for the protection of responders. However, SARA Title III (i.e. the Federal Emergency Planning and Community Right-to-Know Act), relating to emergency planning and community right-to-know, has the greatest impact on local governments.

SARA Title III requires every facility, public or private, that routinely has on-hand more than a threshold quantity of certain acutely hazardous chemicals to report the name, amount, and location of the chemical to the county, state, and federal environmental protection agencies. This includes many municipal swimming pools, waste treatment plants, and most industrial facilities in the Commonwealth. It then requires facilities to develop an on-site emergency response plan. The key groups in these emergency response plans are the local emergency planning committees (LEPCs), appointed to receive the information from facilities and develop an off-site emergency plan for every facility which reported having threshold quantities of extremely hazardous substances. These LEPCs must include elected officials; fire, police, civil defense, and public health professionals; environmental, hospital, and transportation officials, as well as representatives of the facilities, community groups, and the media. The LEPC evaluates available resources for preparing for and responding to a potential chemical accident, providing an essential pre-disaster capability to communities that host SARA Title III facilities.

These federal requirements are implemented at the state level through Act 165 (i.e. Pennsylvania Hazardous Material Emergency Planning and Response Act, 1990-165). Act 165 creates a strong working relationship between business and industry, the Commonwealth, counties, and local municipalities to protect citizens from the dangers of hazardous materials. The history of the program indicates that the interest of elected officials who participate on LEPCs is effective.

PEMA estimates that there are more than 3,200 SARA facilities throughout the Commonwealth with 97% of these facilities having emergency plans in place that have been reviewed by PEMA and were found to adequately provide for the health and safety of public and the environment (PEMA, 2018)

Pennsylvania Radiation Protection Act (PEMA and DEP, Bureau of Radiation Protection)

Act 147 (i.e. Pennsylvania Radiation Protection Act, 1984-147) deals specifically with radiation, control of radioactive sources, and accidental releases of radiation from any of the nuclear-powered electric generating facilities in Pennsylvania. The act was most recently amended in 2007 with Act 31. This law empowers the DEP to implement a comprehensive statewide radiation protection program, and also enables PEMA to develop a radiological emergency response program with plans for each fixed nuclear power generating facility. In implementing the radiological emergency response program, PEMA has planned for evacuation or protection of persons in the area immediately surrounding a given facility with a ten-mile radius. Each of the affected municipalities has a plan that addresses accidental releases of radiation at the facility. The law requires periodic exercise of these plans; every two years there is a full-scale exercise involving several hundred people to test the plan and response capabilities.

Act 147 also created a Radiation Emergency Response Fund and a Radiation Transportation Emergency Response Fund, which receives money from nuclear facility operators, spent fuel storage facilities, and spent nuclear fuel shippers. PEMA then distributes this money to affected counties where it is then distributed to municipalities. Funds are distributed based on grant applications submitted by counties to reimburse expenses involved in preparing plans, providing equipment, and involved in training and exercising the radiological emergency response program.

Counterterrorism Planning, Preparedness and Response Act (PEMA, OHS, PSP, and DOH)

Act 227 (i.e. the Counterterrorism Planning, Preparedness and Response Act of December 16, 2002, P.L. 1967, No. 227 35) provides for counterterrorism planning, preparedness, and response; imposing powers and duties on PEMA, DOH, counties, and municipalities; and providing for the organization of various response teams. Act 227 states the responsibilities of regional counter-terrorism task force groups, the urban search and rescue task force, and specialized response teams, and also provides immunity from liability.

Public Safety Emergency Telephone Act (PEMA and PUC)

Act 78 (i.e. the Public Safety Emergency Telephone Act, 1990-78), as amended, is designed to provide a toll-free standard number (911) accessible from both land and cellular phones for any individual in the Commonwealth to gain rapid, direct access to emergency services. The act was amended in 1998 with Act 17. The act places responsibility for developing a 911 system on county government. The act also allows for end-user contributions based on the number of lines of telephone service. Act 78 establishes technical, training, and certification guidelines and minimum standards to be met in developing the county 911 system. Additionally, the act encourages the development of enhanced 911 systems and constant improvement of existing systems.

Pennsylvania Construction Code Act (Department of Labor & Industry and Office of the Fire Commissioner)

The Pennsylvania Construction Code Act (Act 45) of 1999 (as amended) establishes the basic requirements for the Uniform Construction Code (UCC), which applies to the construction, alteration, repair, demolition, or change of occupancy of buildings. Utilization of the UCC provides for the protection of life, health, property, and the environment on a daily basis as well as during disasters by establishing construction standards. Pennsylvania is protected by the guidelines set forth in the UCC, with the majority of municipalities administering compliance locally (DLI, 2018).

Storm Water Management Act (DEP)

The Storm Water Management Act (Act 167) was enacted in 1978 to counter the effects of land development on storm water runoff. Act 167 requires all counties in Pennsylvania to prepare and adopt watershed-based storm water management plans and requires municipalities to adopt and implement ordinances to regulate development in a way which is consistent with the local Act 167 plan.

Marcellus Shale Drilling Regulations (DEP, Bureau of Oil and Gas Management)

The Bureau of Oil and Gas Management in the Pennsylvania Department of Environmental Protection along with county conservation districts and either the Susquehanna River Basin Commission or the Delaware River Basin Commission have authority to regulate the oil and gas industry in Pennsylvania to protect the environment and citizens of the Commonwealth. Permits and bonds must be provided at various stages including prior to pad construction, pipeline construction, drilling of the well, withdrawal or disposal of water, and impoundment of water. Oil and gas exploration in Pennsylvania is regulated through the Oil and Gas Act, the Coal and Gas Resource Coordination Act, the Oil and Gas Conservation Law, the Clean Streams Law, the Dam Safety and Encroachments Act, the Solid Waste Management Act, and the Water Resources Planning Act (PA House of Representatives, unknown publication date).

The Oil and Gas Act (Act 13 of 2012) presented major changes to the oil and gas industry in Pennsylvania, including the authorization for local governments to adopt an impact fee and the provision of stronger environmental protections. For example, oil and gas well pad setbacks from private water wells, streams, and buildings increased; bond amounts for catastrophic accidents increased; and public accessibility of information related to chemicals used onsite improved (Pittsburg Post-Gazette, 2012). 60% of the revenue stays at the local level, going to counties and municipalities hosting wells. The rest goes to various state agencies involved in regulating drilling and to the Marcellus Legacy Fund, which gets distributed to the state for environmental and infrastructure projects (PA PUC, 2012).

Local governments can use their shares of the funds on various expenses related to natural gas development, including:

- Construction, repair and maintenance of roads, bridges and other public infrastructure
- Water, storm water, and sewer system construction and repair
- Emergency response preparedness, training, equipment, responder recruitment
- Preservation and reclamation of surface and subsurface water supplies
- Records management, geographic information systems and information technology
- Projects which increase the availability of affordable housing to low-income residents
- Delivery of social services, including domestic relations, drug and alcohol treatment, job training and counseling
- Offsetting increased judicial system costs, including training
- Assistance to county conservation districts for inspection, oversight and enforcement of natural gas development
- County or municipal planning

Other statewide initiatives that can be funded with impact fee funds are:

- Acid mine drainage, abatement and cleanup
- Orphaned or abandoned oil and gas well plugging
- Compliance with PA Sewage Facilities Act
- Planning, Acquisition, development and repair of greenways, recreational trails, open space, parks and beautification projects
- Programs to establish baseline water quality data on private water supplies
- Watershed programs and related projects
- Up to 25% of funds for flood control project

5.2.3. Local Ordinances

It is important to note that Pennsylvania adopted Home Rule Law in 1972. Home Rule impacts how municipal governments interact with the county and state government. With Home Rule, municipalities have the authority to exercise governance in any area not specifically limited by state law, rather than in a non-Home Rule state where municipalities act only where specified by state law. An example of where Pennsylvania state law does set requirements for municipalities is the Municipal Planning Code.

Pennsylvania Municipalities Planning Code Act (DCED)

Per the Pennsylvania Municipalities Planning Code Act, P.L. 805, No. 247 (Act 247) of 1968, boroughs, townships, and counties have the authority to individually or jointly prepare zoning, subdivision, land development, floodplain management, and other ordinances, as well as official zoning maps, all of which can be used as tools to guide growth and minimize development in hazard prone areas. Act 247 also requires counties to create and adopt a comprehensive plan and encourages municipalities to adopt municipal or joint municipal comprehensive plans generally consistent with the county comprehensive plan.

5.3. State Capability Assessment

5.3.1. Pre-disaster Capability

Federal capability for some agencies is listed in the state capability section to illustrate how the Commonwealth is leveraging federal programs to increase state capability.

5.3.1.1. Federal Programs Supporting Hazard Mitigation in Pennsylvania

There are a number of federal programs that support hazard mitigation in Pennsylvania from a variety of agencies and entities. This section provides a summary of the most relevant federal agency programs that directly support PEMA and FEMA's hazard mitigation efforts.

United States Geological Survey

The United States Geological Survey works with the National Weather Service, the United States Army Corps of Engineers (USACE), and FEMA through the Flood Inundation Mapping Program (https://water.usgs.gov/osw/flood_inundation/) to help communities understand flood risks and make cost-effective mitigation decisions. The flood inundation library contains a series of maps which illustrate where flooding will occur at various river levels, and during a flood event these maps can be combined with real-time USGS streamflow data and NWS flood forecasts to provide real-time and forecasted mapping. These maps can be used for preparedness, mitigation, and planning; environmental and ecological assessments; timely response; and recovery.

The USGS also provides flood-related information through the following programs and resources:

- WaterAlert service (http://water.usgs.gov/wateralert)
- WaterWatch (http://waterwatch.usgs.gov)
- WaterNow (http://water.usgs.gov/waternow)
- StreamStats (http://streamstats.usgs.gov)
- USGS Flood Information (http://water.usgs.gov/flood)

Additionally, the USGS provides data to the Department of Environmental Protection for drought determinations, participates in the Emergency Operations Center calls when needed, coordinates with FEMA following an event to document the effects, and has a Continuity of Operations plan in place.

United States Army Corps of Engineers

The USACE, in addition to their leadership role in the Silver Jackets, plays a role in flood risk management as well as dam and levee safety, planning, engineering, and emergency management. The USACE partners with the Department of Environmental Protection for annual levee safety workshops and conducts table-top drills with partners.

United States General Services Administration

The United States General Services Administration’s (GSA) role in hazard mitigation and disaster response is to support state and local governments in supply and logistics by training users in the use of GSA’s e-tools for product and service contracting coverage, pricing, and requests for quotes. Additionally, GSA staff practice table-top drills.

Office of Infrastructure Protection

The United States Department of Homeland Security’s (DHS) Office of Infrastructure Protection serves a key role in hazard mitigation. Protective Security Advisors serve as liaisons among DHS and other federal agencies, state and local governments, and the private sector on security compliance/enforcement matters related to the protection of critical infrastructure and assets. There are three Protective Security Advisors assigned to Pennsylvania in Pittsburgh, Harrisburg, and Philadelphia, and the regional director is also located in Philadelphia. These Protective Security Advisors meet with site security personnel to review protection plans and identify requirements for protection support; monitor information on threats; develop and implement local policies; coordinate requests for federal training and assistance; and conduct workshops, forums, and conferences. This office works to identify and prioritize assets, conduct assessments in support of special events, conduct threat-based outreach, serve in emergency operations centers and joint field offices, and conduct/assist in Office of Bombing Prevention improvised explosive device threat and risk mitigation training. Trainings facilitated by Protective Security Advisors include the IED Awareness/Bomb Threat Management Workshop, the IED Search Procedures Workshop, the Protective Measures Course, the Surveillance Detection Course for Law Enforcement & Security Professionals, the IED Counterterrorism Workshop, the Counter-IED/Bomb Threat Management Workshop, Active Shooter Training, Workplace Violence Incidents Training, Soft Target Awareness, and the Bomb Making Awareness Program. These trainings serve private sector owners and operators as well as first responders and emergency management personnel.

5.3.1.2. Pennsylvania Emergency Management Agency

PEMA Pre-disaster Capability Overview

Pennsylvania’s Emergency Management Service Code, Title 35, covers PEMA’s overall legal responsibilities for emergency management. PA CS Title 35 Section 7102 defines emergency management as “the judicious planning, assignment and coordination of all available resources in an integrated program of prevention, mitigation, preparedness, response and recovery for emergencies of any kind, whether from attack, manmade or natural sources.” Section 7311 establishes that PEMA was created “to assure prompt, proper and effective discharge of basic Commonwealth responsibilities relating to civil defense and disaster preparedness, operations and recovery.” Title 35 addresses PEMA’s responsibilities before, during, and after disaster.

Mitigation is managed through the BORM, which capably provides and participates in hazard mitigation and disaster trainings, disaster exercises, and conferences. BORM staff support the identification and implementation of potential mitigation projects, and also provide various tools and technical assistance for local agencies on PEMA’s Hazard Mitigation webpage and in-person. RL and SRL property mitigation is consistently prioritized in pre- and post-disaster efforts. The readiness for disaster is maintained by adhering to the Pennsylvania State Emergency Operations Plan and by maintaining EMAP accreditation.

PEMA's outreach and citizen engagement efforts are also a key component of the agency's pre-disaster capability. The primary components of these efforts are ReadyPA, Citizen Corps, and the Community Emergency Response Team (CERT) program. As a program, ReadyPA is a tool used by Citizen Corps and CERT, as well as government and non-profit organizations to assist Pennsylvania citizens in preparing for disaster. Citizen Corps was created to help coordinate volunteer activities that will make our communities safer, stronger, and better prepared to respond to any emergency situation. It provides opportunities for people to participate in a range of measures to make their families, their homes, and their communities safer from the threats of crime, terrorism, and disasters of all kinds. Citizen Corps is coordinated nationally by FEMA. In this capacity, FEMA works closely with other federal entities, state and local governments, first responders, emergency managers, the volunteer community, and the Corporation for National & Community Service.

The overall goal of the various projects undertaken and funded through the Citizen Corps Grant Program is to ensure that the residents of the Commonwealth are prepared at home, school, work, and when they travel throughout the state. In 2008, Pennsylvania kicked off the ReadyPA Campaign urging all Pennsylvanians to "Be Informed. Be Prepared. Be Involved." The funds spent to date are being used to build private/public partnerships and use those partnerships to reach as many residents as possible as they go about their daily lives. PEMA has leveraged partnerships during National Preparedness Month to distribute information and to hand out materials at PETCO, Home Depot, Lowes, and most recently Target.

PEMA has distributed ReadyPA/Pennsylvania Citizen Corps bookmarks to almost 2,000 Pennsylvania libraries; and preparedness message tent cards and ReadyPA tri-fold brochures to the 131- and 545-member institutions of the Pennsylvania Association of Community Banks and the Pennsylvania Credit Union Association, respectively. The staff has developed a Hispanic Outreach Plan that was implemented in 2011 and translation for the web of ReadyPA materials into Russian, Korean, Chinese, and Vietnamese.

PEMA supports the CERT Program, which educates people about disaster preparedness for hazards that may impact their area and trains them in basic disaster response skills such as fire safety, light search and rescue, team organization, and disaster medical operations. Using the training learned in the classroom and during exercises, CERT members can assist others in their neighborhood or workplace following an event when professional responders are not immediately available to help. CERT members also are encouraged to support emergency response agencies by taking a more active role in emergency preparedness projects in their community.

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PEMA has conducted CERT Train-the-Trainer classes as well as CERT Basic classes. The train-the-trainer classes allow those individuals with prior teaching experience the opportunity to be trained so that they can teach others about Basic CERT in their respective community. PEMA also supports and encourages individual counties with their CERT efforts as well. CERT trained volunteers have been able to help with local response and recovery initiatives throughout the Commonwealth.

Additionally, the Pennsylvania Hazardous Material Emergency Planning and Response Act; the Pennsylvania Radiation Protection Act; and the Counterterrorism Planning, Preparedness and Response Act assist in supporting PEMA's capabilities. Additional funding and staff would be helpful in expanding PEMA's and BORM's pre-disaster capability. The most prominent emerging policy or program impacting pre-disaster capability is the trend to improve pre-disaster capabilities through partnerships. By partnering with FEMA and ASFPM, BORM will be able to provide more training; by partnering with USACE, BORM will be able to most robustly continue the SPT, and by partnering with counties and communities, more projects will be implemented. PEMA would like to partner with Risk MAP staff and FEMA Region III's Outreach Staff to increase hazard mitigation outreach within the Commonwealth. Also, the Silver Jackets program has been instrumental in promoting interagency coordination. Strong partnering has significant potential to improve mitigation capabilities in Pennsylvania.

PEMA and DCED have established a new partnership, so that PEMA will substantially increase its role in management the Commonwealth's NFIP responsibilities. BORM, within PEMA, will support two full-time positions for NFIP program management. The positions will be an Administrative Officer 2 hire in Commonwealth fiscal year 2019 that will have the option to promote to Administrative Officer 3 in the following year. Then the second position will be an Administrative Officer 2 hire for fiscal year 2020. These positions and support from the State Hazard Mitigation Officer (SHMO) and other staff within BORM will significantly increase the capacity of the Commonwealth's NFIP management. The first position will be hired when notice of the subgrant for Community Assistance Program –State Support Services Element (CAP-SSSE) is received. Then additional funding support is plan through the Cooperating Technical Partners (CTP) and Commonwealth funding.

The PEMA and DCED partnership for NFIP management will continue and transition more responsibilities from DCED to PEMA over time. In the Commonwealth fiscal year ending June 30, 2019, DCED has $50,000 to support NFIP and mapping related training. Then in the Commonwealth fiscal year 2020, $80,000 is planned for PEMA to support FIRM due process meeting attendance, community outreach, housing and maintenance of the Pennsylvania Flood Zone Map online tool, and training.

PEMA is looking forward to growing the capacity of NFIP management for the Commonwealth. There are numerous synergies from managing NFIP and hazard mitigation programs in one department. The CTP program and related funding will grow the capacity in coming years, particularly years 2021-2023 between SHMP updates. The key theme efforts planned by PEMA is to use the CTP to drive mitigation action. This effort is in line with supporting FEMAs moonshots of increased insurance coverage and mitigation investment.

PEMA plans to pursue insurance studies or analysis address why specifically flood insurance is decreasing in Commonwealth. PEMA will work with Pennsylvania Insurance Department and private insurers to see how much the decrease is captured by alternate policies, understanding that this information may be held as private information. Therefore PEMA will track progress of other states and FEMA to capture private insurance information even in generalized ways.

Increasing mitigation action and investment is tied to the Risk Reduction Consultation priority communities. These communities have characteristics that represent the full Commonwealth, such that pilots and best practices will be repeatable and lessons learned will be applicable from one location to another. The following table shows the priorities communities for pilot and test projects for the Commonwealth to maximize lessons learned. Please see Table 6.2.4-2 for more information on the integration of the risk Reduction and SHMP processes.

Table 5.3.1-1 PA Risk Reduction Priority Communities

Types of Communities	Specific Locations
• Remote rural communities without infrastructure • Susquehanna river towns • Moderate-sized metro cities • Northeast PA river communities • Delaware River Communities • Heritage Corridors and Historic Communities	• Lycoming County • Athens Borough • Bloomsburg • Shickshinny • Muncy Borough • Blakely Borough • Luzerne County • Pike County • Harrisburg • New Castle • Greensburg • Wilkes-Barre area

Additional initiatives for PEMA as they increase NFIP management capability are to build on existing initiatives the intersect with the NFIP. BORM plans to develop Commonwealth mapping priorities to provide input into FEMA planning process and to develop potential projects for future CTP funding. They are already engaged in a statewide LiDAR project, the State GeoBoard, and with SPT partners and fellow map makers from DEP and DCNR. They will further collaboration to have informed recommendations for future studies that respond to locally and state known problem areas, for instance areas where recent flooding is not reflected on the FIRM. PEMA will continue collaboration with PHMC for the NFIP. There are opportunities to work together to find suitable pilot projects that protect the historic structures from flooding while also maintaining their historic character. There is also interest in examining how these strategies, such as floodproofing impact flood insurance premiums. Another area for collaboration and growth is the nexus of stormwater management, local floodplain management, and DEP regulation to leverage each other’s programs and funding for success. These ideas will build and become additional mitigation actions in the SPT’s annual review of the mitigation strategy.

PEMA Staff

PEMA coordinates state agency response, including the Office of the State Fire Commissioner and Governor's Office of Homeland Security, to support county and local governments in the areas of civil defense, disaster mitigation and preparedness, planning, and response to and recovery from human-caused or natural disasters. Figure 5.3.1-1 provides an overview of PEMA's organizational structure and the current mitigation staffing within BORM. PEMA's Bureau of Administration provides funding for the Commonwealth's mitigation program while BORM performs pre-disaster activities such as administration of Hazard Mitigation Assistance grants and technical assistance and expertise for mitigation plan development. BORM's post-disaster responsibilities are summarized in Section 5.3.2.

Tom Hughes is the State Hazard Mitigation Officer (SHMO). As SHMO, he is responsible for hazard mitigation grant administration, state and local hazard mitigation planning, mitigation training and emergency response, and disaster and Joint Field Office support duties. The SHMO is supported by the State Hazard Mitigation Planner and normally has other permanent staff consisting of an engineer and two project officers. Two new NFIP management staff are planned to join the permanent staff in fiscal year 2019 and 2020. The permanent and disaster related staff engage in the following cycle of hazard mitigation activities:

1. Conduct Training and Outreach activities to educate people on best practices and funding opportunities for hazard mitigation and the NFIP.
2. Assist counties, municipalities, agencies, and organizations with identification of potential hazard mitigation projects and preparation of letters of intent and grant applications.
3. Assist municipalities with NFIP management, especially in the FIRM update due process. Work with FEMA to support communities in understanding the importance of providing data and information during Discovery, reviewing and commenting on FIRMs during the Flood Risk Review and Preliminary Release, understanding and submitting data for appeals when need, and updating ordinances after the Letter of Final Determination.
4. Support technical assistance and development of the Commonwealth's Local Floodplain Managers. Collaborate and support partners in floodplain management from County department, Conservation Districts, insurance and builder associations, and other organizations and agencies to build NFIP capacity in Pennsylvania.
5. Process grant applications and coordinate with FEMA counterparts to ensure effective administration of programs.
6. Serve as project officer during life of grant to ensure compliance with all laws, regulations, and effective stewardship of resources.
7. Prepare briefings for State and other officials on progress of hazard mitigation and NFIP activities.
8. During disasters work in State EOC or Disaster Response Centers.
9. Conduct Preliminary Damage Assessments in conjunction with FEMA.

10. Coordinate with FEMA and other government and private agencies to achieve unity of effort.

In addition, FEMA Region III provides personnel and resource support as directed by the Federal Coordinating Officer. Together, PEMA and FEMA have formed a Joint Field Office in Harrisburg to address hazard mitigation and disaster recovery and mitigation activities.

Ernie Szabo, the current State Hazard Mitigation Planner, develops, reviews, and evaluates state, county, and local hazard mitigation plans in connection with state and federal laws, regulations, and programs aimed at reducing repetitive losses from natural disasters. The State Hazard Mitigation Planner serves as project officer to administer FEMA hazard mitigation planning grants for development of county hazard mitigation plans. Julie Yu, the division Engineer, provides technical support.

The State Hazard Mitigation Project Officers administer up to 40 separate hazard mitigation projects and ensure compliance with all state and federal regulations. They are responsible for project quarterly/monthly reports, FEMA reporting, administration, and closeout of Hazard Mitigation Assistance-funded projects. Project officers review and process requests for advances and reimbursements, select and develop research methodology for project development and review, and determine appropriate data sources. Project Officers are encouraged to use new and improved methodologies, techniques, and applications. This will include support necessary to ensure that the SRL strategy is updated annually in the Commonwealth's 322 plan. Project Officers conduct research into physical, economic, social, and demographic phenomena; analyze and interpret data; and prepare graphic and narrative reports of findings of significance and applications of such information to effective hazard mitigation implementation. They also meet with local and regional planning boards or commissions, civic groups and associations, and the general public to render direct technical advice and assistance, explain hazard mitigation and associated topics, and answer questions. The exact location dates and number of attendees for outreach and technical assistance after recent DRs are not available. Please note that a Measure of Success for Action 3-2c is to, "track training and technical assistance location, date, and attendance for next SHMP update," so more complete and detailed statistics will be available in the next plan. Project Officers develop presentations for commissions and boards, civic groups and associations, and the general public, and work closely with state and federal agencies to coordinate hazard mitigation efforts and objectives. Finally, Project Officers assist in the execution of the FEMA Unified Hazard Mitigation Assistance grant program. Two new GIS computers have been purchased for BORM staff to utilize for tasks including project identification and tracking.

Additionally, cross-attached clerical personnel are temporarily stationed at the Joint Field Office to assist BORM. Contact information for the main points of contact for the SHMP are provided in the table below:

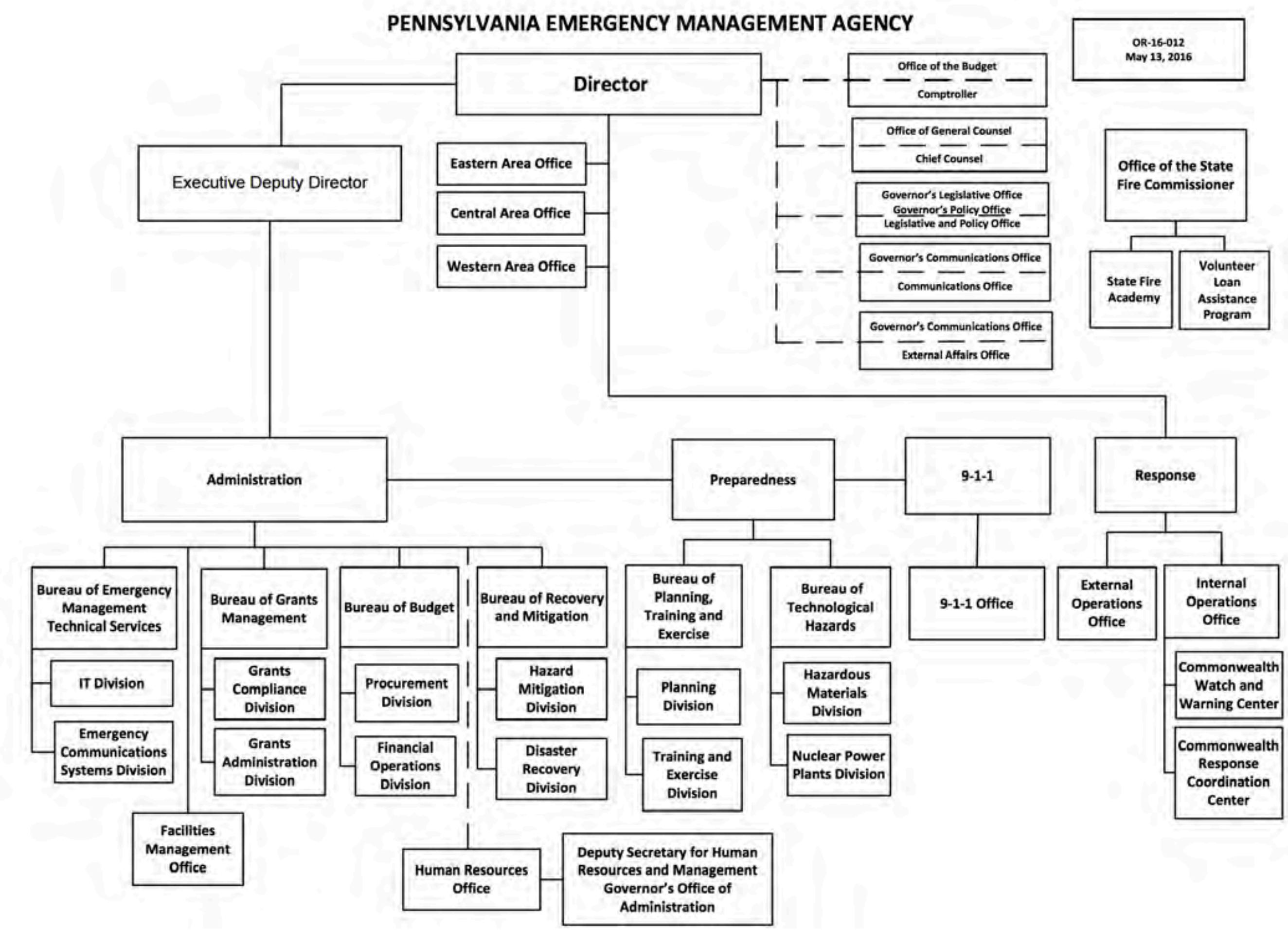
Table 5.3.1-2 State Hazard Mitigation Plan Contact Information

Name	TITLE	EMAIL	PHONE NUMBER
Thomas Hughes	State Hazard Mitigation Officer	thughes@pa.gov	717-651-2726
Ernie Szabo	State Hazard Mitigation Planner	erszabo@pa.gov	717-651-2159
---	Western Area Office	---	724-357-2990 or 800-972-7362
---	Central Area Office	---	717-651-7060 or 800-272-7362
---	Eastern Area Office	---	610-562-3003 or 800-372-7362

The nationwide recession has impacted all levels of government within Pennsylvania. In general, the budget crisis' impact on state agencies, counties, and municipalities has meant less funding to support programs and to fill vacant positions. As a result, PEMA will continue to reach out to federal partners, including FEMA and USACE, to support mitigation efforts as appropriate. PEMA was able to work with FEMA on the Environmental and Historic Preservation Screening Form released by the FEMA Grant Programs Directorate in June 2011 so that the form content fulfills the data needs of both agencies during grant application review. PEMA routinely coordinates with the USACE to use the Silver Jackets initiative as a mechanism to continue holding meetings with the SPT members and to work on implementing mitigation actions. USACE staff can support the Silver Jackets initiative by preparing invitations, materials, presentations, and minutes for meetings. Also, PEMA will build on the success of the SPT to leverage coordination and funding for mitigation efforts between other Commonwealth agencies when appropriate. BORM's goal is to increase staff capacity by adding two permanent project managers in the near future. The agency has already implemented a program to bring reservists to Joint Field Offices during disaster events in order to save about one million dollars per month while increasing assistance availability throughout the Commonwealth.

BORM also coordinates with other departments within PEMA for technical expertise during shared missions and non-emergent activities. Commonly, BORM coordinates with the Bureau of Strategic and Operational Plans (Bureau of Plans). The Bureau of Plans staff has access to data sources and information that is valuable in making the SHMP stronger. The analysis in the complete SHMP will also be shared with the Bureau of Plans to assist in integrating the SHMP into other Commonwealth planning mechanisms.

Figure 5.3.1-1 Organizational structure for the Pennsylvania Emergency Management Agency (updated May 13, 2016).



PEMA Hazard Mitigation, NFIP Management, and Disaster Trainings

PEMA provides various trainings and presentations to community officials and local emergency management staff in support of local hazard mitigation, NFIP management, and disaster preparedness. Many of the training events that PEMA supports are courses developed by the Emergency Management Institute (EMI) in Emmitsburg, MD. PEMA sends its own personnel and facilitates the attendance of county and municipal emergency management personnel to courses in Emmitsburg, MD and hosts courses locally following EMI guides and tailoring training as appropriate to local needs. PEMA holds three two-day trainings each quarter in the east, west, and central regions of Pennsylvania, which are typically attended by county emergency managers. Other attendees include local emergency managers, other emergency management staff, and related planners.

The following is a list of training hosted locally or promoted for Pennsylvania municipal, county, and state staff to attend at EMI. Please note that a Measure of Success for Action 3-2c is to, “Track training and technical assistance location, date, and attendance for next SHMP update”, so more complete and detailed training statistics will be available in the next plan. NFIP focused training has been added to the list since the last plan update based on PEMA’s new role in NFIP management. Training for local floodplain managers is particularly important in Pennsylvania due to the large number of municipalities. The large number of municipalities means communities tend to be smaller and have staff and volunteers that hold multiple positions and are often new to floodplain management. Targeting NFIP training across the Commonwealth will help build capacity and ultimately more Certified Floodplain Managers.

- **Annual State Training and Exercise Planning Workshop:** Workshop for state representatives to update the Multiyear Training and Exercise Plan for the Commonwealth of Pennsylvania 2017-2022. The workshop was led and coordinated by PEMA.
- **EMI EO212: Hazard Mitigation Assistance Program: Developing Quality Application Elements:** Training is geared towards local government agencies along with PEMA and FEMA representatives. The four-day workshop focuses on project management and provides an overview of the process for Hazard Mitigation Assistance (HMA) applications and the overall HMA Grant program.
- **EMI EO213: Hazard Mitigation Assistance: Application Review and Evaluation:** Training is provided to PEMA, FEMA, or other support staff responsible for assisting with HMA supplicants. The two-day workshop focuses on grant application and subapplication review. An overview of the grant award process is also included.
- **EMI EO214: Hazard Mitigation Assistance: Project Implementation and Closeout:** Training is provided to PEMA, FEMA, or other support staff responsible for assisting with HMA supplicants. The two-day workshop focuses on implementation and closeout of a project.
- **EMI GO318: Mitigation Planning for Local Governments:** Training is provided to local communities. This two-day workshop covers the fundamentals of the mitigation planning requirements for communities to develop new or updated Local Mitigation Plans that address community priorities and needs and meet requirements established in 44 CFR 201.6. This workshop describes the planning process, the requirements for stakeholder involvement, and the relationship between multi-hazard mitigation planning requirements and elements of the Community Rating System (CRS) to assess risks and develop

effective mitigation strategies. Finally, the basic elements of the plan review, approval, and update cycle are discussed, including tips for implementing and maintaining an approved plan, tracking performance, keeping stakeholders involved, and preventing plans from lapsing or expiring.

- **EMI ISO318: Mitigation Planning for Local and Tribal Communities:** Training is designed for plan writers and reviewers. The twelve-hour long course provides an overview of the regulations governing hazard mitigation plans and the plan development process required to write them.
- **EMI Independent Study:** PEMA encourages Independent Study course through EMI. The following list shows the titles of several mitigation related Independent Study courses:
  - IS0030.b: Mitigation eGrants for the Subgrant Applicant
  - IS0031.b: Mitigation eGrants for the Grant Applicant
  - IS0032.a: Mitigation eGrants Internal System
  - IS0212.B: Introduction to Unified Hazard Mitigation Assistance
  - IS0318: Mitigation Planning for Local and Tribal Communities
  - IS0323: Earthquake Mitigation Basics for Mitigation Staff
  - IS0328: Plan Review for Local Mitigation Plans
  - IS0393.b: Introduction to Hazard Mitigation
- **FEMA R3 NFIP/SHMO Conference***:* Provides the opportunity for SHMO and NFIP officers from each state in Region III meet to share best practices, resources, and success stories.
- **Hazus:** Training is provided for individuals seeking to gain better knowledge of the Hazus program. Completion certificates are available for “Hazus Professional” or “Hazus Practitioner”. Courses are available for focus on hurricane, flood, or earthquake modeling in Hazus as well as focused courses for emergency managers or floodplain managers. Each course is four days in length.
- **E0190: ArcGIS for Emergency Managers:** Training is designed to train emergency management professionals in basic skills in ArcGIS necessary for utilizing the HAZUS loss estimation program. The workshop is four days in length and is intended for staff members who currently use or plan to use GIS and Hazus.
- **E0276: Benefit-Cost Analysis: Entry-Level:** Taught PEMA and local HM planners the basic of the benefits/cost Analysis process and use of FEMA software.
- **E0273: Managing Floodplain Development through the National Flood Insurance Program:** This course provides 4-days of training geared towards local floodplain manager and officials involved in floodplain management, covering the NFIP, FIRM and related mapping products, ordinance and other floodplain management concepts.
- **Best Practices of the NFIP**: This Region III designed training covers the concepts in the EO273 course in 4-6 hours. The abbreviated course increases the reach of the information since more people have time for a half to one-day training and provides resources for attendees to access additional information.
- **Advanced Floodplain Management Training**: Advanced floodplain management training offerings include E0282: Advanced Floodplain Management Concepts II, E0284: Advanced Floodplain Management Concepts III, and E0291: Community Dam Safety, Preparedness and Mitigation.

- **Natural Hazard Mitigation Association (NHMA) Legal Workshop for Mitigators:** training is for local emergency managers, legal experts, floodplain managers and anyone else involved in community development. The length of the workshop is two days.
- **PEMA HMA Application Development Workshop:** This training assists floodprone communities in developing successful applications for HMA grant funding.
- **PEMA Quarterly Training:** This training targeted at County Emergency management staff provides an opportunity for BORM to brief on hazard mitigation.
- **Silver Jackets Non-Structural Flood Proofing Workshops:** This workshop for public officials and municipal representatives. The workshops provided an overview of non-structural options and examples for flood proofing properties.

PEMA also promotes training from other organizations and agencies easily when it addresses a topical hazard mitigation issue. PEMA will be promoting US Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety (US DOT PHMSA OPS) training webinars as appropriate (http://primis.phmsa.dot.gov/comm/pipa/pipa_webinars.htm). The webinars are available on demand and address the following topics of relevance to Pennsylvania:

- Energy Pipelines 101
- Energy Pipelines in Pennsylvania
- Why are pipelines important?
- Who regulates pipeline safety?
- Roles local governments can play in pipeline safety?
    - Land planning near pipelines
    - Emergency response
    - Excavation damage prevention
    - Hazard mitigation planning
- PIPA recommended practice examples
- Pipeline resources for local governments

In addition, there are numerous trainings which PEMA staff attends. Examples of some of the trainings BORM staff participate in are provided below. While these trainings apply only to BORM staff, PEMA as a whole serves the Commonwealth both pre- and post-disaster. Other departments within PEMA have similar training exercises. Organization of the trainings is flexible and works effectively in both pre- and post-disaster operations:

- Each BORM staff member is required to have two hours of Emergency Operations Center training each quarter
- Professional courses including one Emergency Management Institute course per year and optional ASFPM courses offered once per quarter;
- CPR-AED certifications maintained
- Human resources courses (i.e. equal opportunities, bio-hazard, etc.) are required once a month

BORM would like to increase both internal and external staff trainings in the future, as staff availability and budget allow. Accordingly, BORM established three training goals in 2013. The first goal is to improve coordination between BORM and the PEMA Training Department. The second goal is to have all staff attend trainings for unified hazard mitigation assistance (E212), project development and implementation (E213), and project closeout (E214). The third goal is to provide the revamped Hazard Mitigation Handbook to all BORM staff in conjunction with an internal mentoring program.

PEMA Disaster Exercises

BORM and other PEMA staff participate in numerous exercises to prepare for more effective disaster response. Exercises may be conducted as table-top exercises or as field drills. All exercises serve to have staff practice response-related responsibilities. Issues identified during the exercises as needing improvement may direct planning, preparedness, and other activities in order to improve response during actual disaster events. Exercises are regularly held for weather emergencies and nuclear power plants, and additional exercises will be organized as disasters are closed out and staff have more availability.

PEMA Identification and Implementation of Potential Mitigation Projects

Mitigation projects are identified at the local level and rolled up to the Commonwealth's Mitigation Project Inventory. This inventory is tracked by PEMA and contains a variety of projects including proposed property acquisition, elevation of buildings, storm water management (i.e. culvert or sewer repairs), stream channel restorations, etc. BORM staff members conduct joint field surveys with municipalities to assist with Benefit-Cost Analyses (BCAs). BORM's in-house survey equipment saves time in determining whether a property will meet the BCA by checking first floor elevations quickly and allowing BORM and municipalities to focus efforts on properties that will match grant requirements. The in-house survey equipment may be viewed in Figure 5.3.1-2. In some cases, inventorying and assessing the condition of structures both before and after a disaster event provides the flexibility to promote improved conditions either through a mitigation grant or through a disaster recovery grant.

DCED and PEMA, acting under their respective responsibilities to coordinate hazard mitigation planning at the county level, discuss with counties the Commonwealth's preference for the counties and their local jurisdictions to address RL properties as projects under the hazard mitigation planning process.

The identification and/or implementation of potential projects are critical to mitigation efforts in Pennsylvania. More information on the inventory and support provided to local communities in implementing mitigation projects is provided in Section 6.3.1. Project prioritization practices are discussed in Section 6.3.1.3. In addition, Section 5.3.3 discusses federal, state, local, private, and nonprofit sources of funding and technical assistance for local mitigation projects.

Figure 5.3.1-2 Mitigation staff using in-house survey equipment (BORM photos Summer 2013).

PEMA Repetitive Loss and Severe Repetitive Loss Capability

RL and SRL property mitigation is addressed in Hazard Mitigation Assistance (HMA) funding streams available both before and after disaster. BORM staff support RL and SRL mitigation using a continuous 12-month approach to increase grant applications and the mitigation of RL and SRL properties. This continuous approach includes outreach, technical assistance, grant support, and tracking. The activities that support pre- and post- disaster RL and SRL capabilities are primarily explained in Section 6.4.

The BORM staff serves as a repository of information for counties and municipalities regarding RL and SRL properties. PEMA routinely distributes information about the HMGP to provide insight into the program regarding RL and SRL property mitigation. PEMA also created a supplemental packet which contains FEMA guidance materials. This packet is sent out to all interested applicants. The BORM staff has updated the PEMA website to include information on the SRL and RFC grant programs. PEMA will also hold seminars at the request of a county and/or municipality to provide guidance for the application and the HMGP process as a whole. With BORM's expanded role in NFIP management there will be additional opportunities for integration planning and communications for RL and SRL properties within the map update meetings, floodplain management training and technical assistance, CAVs, and hazard mitigation. The link of risk identification and reduction in one department with assist with moving forward on mitigating these properties.

The Director of PEMA provides yearly notifications to emergency management officials and planners about the fiscal availability of HMA Funds. The Circular may be found in Appendix C and the full RL/SRL inventory is in Appendix F. HMA funding is described in more detail in Section 5.3.3. The BORM staff also provides an information session at their quarterly trainings. In addition to the annual notification and quarterly trainings, PEMA provides the counties a list of RL and SRL properties and will disseminate additional information to those counties which are interested in either the SRL or RFC program. PEMA staff work with counties and municipalities to identify RL and SRL properties for mitigation; identification criteria include identifying projects that are likely to be cost-effective, environmentally sound, and technically feasible.

PEMA is the State Applicant and essentially functions as a clearinghouse for all the non-disaster grant applications. PEMA also provides technical assistance and quality control for the sub-applicants. For example, once a sub-applicant submits their application, PEMA will review the application to ensure that it meets all requirements established by FEMA. PEMA's review evaluates and prioritizes RL and SRL projects that are cost-effective, environmentally sound, and technically feasible. If an application for an RL or SRL property is submitted that does not meet FEMA criteria, PEMA staff will provide technical assistance to the community to re-envision the project and re-submit an application. If the application cannot meet FEMA criteria, it will not be submitted to FEMA. Once the application meets all criteria and is complete, it is sent to FEMA for review.

BORM also monitors and tracks projects that are underway and those which have been completed. In order to maintain accurate records of all projects that have received FEMA mitigation grants, FEMA requires the submission of Form AW-501, NFIP Repetitive Loss

Update Worksheet (OMB #1660-0022). It is a local responsibility to complete the AW-501 form with appropriate documentation to shows any changes in the status of a property (e.g., elevation certificate). This form, along with the transmittal sheet or other document signed by an authorized community official, must be submitted for each property mitigated with HMA funds prior to project closeout. Sometimes, PEMA is able to support the completion of AW-501 forms, particularly with the staff available after a Disaster Declaration; however, AW-501 form completion remains a locally responsibility.

PEMA Hazard Mitigation Webpage

A webpage is maintained by PEMA that provides timely information to local community officials and citizens throughout the Commonwealth. Information provided through the webpage includes but is not limited to: advisories and alerts, upcoming meeting and training announcements, guidance on mitigation grant programs, forms and documents, risk assessment information (i.e. Hazus reports), and program and service information.

PEMA also regularly uses project-based websites to promote hazard mitigation planning. These websites are tailored to projects and offer information on hazard mitigation with links to partner agencies including FEMA, calendars for meetings, meeting materials, surveys, and draft plans for review; people may sign up for alerts to be notified when the page is updated.

Pennsylvania Flood Zone Map Online Tool

The management of the Pennsylvania Flood Zone Map online tool will move to PEMA in Commonwealth fiscal year 2020. The initial plans are for management to move from DCED to PEMA. Then as the new BORM NFIP Administrative Officers are working with communities they will likely identify improvements and additions to the tool for following fiscal years.

Pennsylvania State Emergency Operations Plan

The Pennsylvania Emergency Management Council, acting through the PEMA, develops and maintains the SEOP and implements the plan during incident response. The Pennsylvania SEOP describes the procedures to be followed in disaster response and assigns responsibilities to various departments and agencies of the Commonwealth government. It incorporates the principles of the National Incident Management System (NIMS), including the Incident Command System (ICS). NIMS provides standards that ensure compatible equipment, training, and procedures for all Pennsylvania responders. All government departments and agencies of Pennsylvania are directed by the Governor to use NIMS and the associated ICS for all emergency responses within Pennsylvania.

5.3.1.3. Other State and Multi-Agency Programs in Pennsylvania

The following provides a description of commonly engaged agencies. Complementary information is also available in Section 5.5.1.

Silver Jackets

The Silver Jackets program is a volunteer-based organization, which is focused on promoting interagency collaboration in order to combine resources such as funding, programs, and technical expertise. Members of the Silver Jackets represent local, state, and federal agencies, as well as other non-governmental groups with an interest in hazard mitigation, response, and recovery. The Pennsylvania Silver Jackets are led by the USACE and are focused primarily on flooding. The Pennsylvania Silver Jackets hold two webinars and one live meeting each quarter and invite participants from non-member organizations when the program may align with their interests. The Silver Jackets also assist FEMA with the High-Water Mark Initiative, which helps communities to remind residents of past flooding in the area and to encourage residents to take steps to mitigate against future flood losses. The SHMO, Tom Hughes, is an active member of the Silver Jackets.

ReadyPA

ReadyPA is an outreach program, which was launched in September 2008. ReadyPA is a statewide campaign supported by PEMA, Pennsylvania Citizen Corps, DOH, and volunteer organizations aiming to motivate Pennsylvanians to take action to prepare for a disaster. This program encourages all Pennsylvanians to “Be Informed, Be Prepared, and Be Involved.” ReadyPA is coordinated between the Citizen Corps and the PEMA Press Office, which in turn coordinate with the counties, local government, state agencies, DHS, and other organizations and agencies. The website, www.readypa.org, provides the latest guidance on disaster and emergency preparedness for the general public, children, individuals with disabilities, older residents, pet owners, etc. To reach those communities that speak other languages, many of the materials have been translated and are available in Spanish; the guide itself is available in Chinese. It disseminates risk information and tools such as an emergency preparedness guide that includes supply kit checklists, emergency contact forms, and other printable information which can be used to reduce the risk of damage, injury, and death during a disaster event. The site also provides valuable information about making emergency plans and how people can become involved with their local Citizen Corps Councils or register to assist during a disaster through the State Emergency Registry of Volunteers in Pennsylvania. The ReadyPA website, www.readypa.org, went live at the end of December 2012.

Pennsylvania Insurance Department

The Pennsylvania Insurance Department’s role in hazard mitigation is to educate the public on resources that may be available for hazard mitigation such as insurance and FEMA grants. In pursuit of this goal, the Pennsylvania Insurance Department posts fact sheets and press releases on their website on how to prepare and respond to disasters.

Pennsylvania Department of Community & Economic Development

As discussed throughout this section, PEMA and DCED will collaborate on NFIP management with PEMA’s responsibilities increasing over time. Act 166 sets DCED as the State NFIP Coordinator. As the collaboration between the agencies grows and changes there may be efforts to amend the Act in the future to change the agency that hosts the State NFIP Coordinator to PEMA or to not be defined in the Act. The current State NFIP Coordinator works for DCED and is Marita Kelley. Marita Kelley has training and program responsibilities through Commonwealth fiscal year 2019. Then moving forward DCED will continue in a supporting role to PEMA for NFIP programs and FEMA reporting in its role as State NFIP Coordinator.

Pennsylvania Department of General Services

The Pennsylvania Department of General Services attempts to provide built-in hazard mitigation for new or retrofit construction via the Bureau of Engineering and Architecture and attempts to avoid leasing facilities in hazardous areas via the Bureau of Real Estate.

Pennsylvania Housing Finance Agency

The Pennsylvania Housing Finance Agency staffs the Joint Field Office, serves on the statewide disaster planning committee, and partners with PEMA, DCED, and DPW on an apartment locator service.

Pennsylvania State System of Higher Education

Each university in the Pennsylvania State System of Higher Education has a university-specific hazard mitigation plan, and Millersville University includes a Center for Disaster Research and Education.

Pennsylvania Treasury

The Pennsylvania Treasury evaluates the financial risk and consequences that can occur after a major disaster. The department also considers hazards that could put essential functions, such as payment processing, at risk. Also, staff members attend and practice table-top drills and exercises and train employees on emergency roles and home preparedness.

Pennsylvania Department of Transportation

The Pennsylvania Department of Transportation (PennDOT) coordinates transportation projects and maintains state-owned infrastructure across the Commonwealth. Their role in hazard mitigation is to promote safety and implement plans, procedures, and projects that mitigate transportation accidents. PennDOT maintains the Pennsylvania Mobility Plan, PA Transportation Security Plan, and Winter Services Strategic Plan.

Pennsylvania DLI/Bureau of Occupational & Industrial Safety

The Pennsylvania DLI's Bureau of Occupational & Industrial Safety serves as the data repository for the Pennsylvania Tier II System (PATTS) Hazardous Chemical Reports available to PEMA and the county LEPC's that participate in the online PATTS Enterprise Program. Numerous facilities also upload their emergency response plans to this system.

Pennsylvania Construction Codes Academy

The Pennsylvania Construction Codes Academy offers training tailored to becoming certified as a Building Code Official (BCO). The program provides interactive education focused on the practical application of the Uniform Construction Code (UCC) regulations. Courses are held both in-person and online and address a number of building related topics.

Pennsylvania Department of Environmental Protection

The DEP has a comprehensive mission to address many aspects of environmental protection and health and safety. The DEP partners with individuals, organizations, governments, and businesses to prevent pollution and restore our natural resources. The DEP's mission is integral to hazard mitigation in Pennsylvania as it implements flood control projects, monitors and conducts outreach for radon, participates emergency response, and regulates safe practices for several industries.

The DEP Bureau of Waterways, Engineering, and Wetlands plans, designs, and manages the construction of flood control projects. Completed projects are inspected annually by either DEP or USACE, and DEP reviews H20 and flood mitigation grant applications for DCED. DEP also has numerous fact sheets on their programs and hosts annual flood protection workshops for municipal sponsors. DEP is in the process of finalizing Emergency Action Plan Guidelines for flood protection projects.

The DEP Bureau of Radiation Protection provides expertise in radiation protection and nuclear safety and possesses the equipment and personnel for radiation monitoring. Hazard mitigation is integrated into the Bureau's plans and procedures. This Bureau also participates in training programs, drills, and exercises, and has a public outreach program regarding radon.

The DEP Environmental Emergency Response provides response/monitoring, emergency contracting, technical assistance, policy/rulemaking, and support of the state emergency response. This Bureau has an Emergency Operations Plan and a Continuity of Operations Plan. The Bureau sends representatives to the PEMA Emergency Operations Center; participates in PEMA/FEMA trainings, drills, and conferences; shares incident notification reports; has partnerships with neighboring states; and provides public outreach.

DEP's partnerships with individuals, organizations, governments, and businesses often comes in the form of training and providing technical assistance in the process of monitoring and inspection. During monitoring and inspection, DEP provides information on safe practices and what partners can do to meet and exceed regulations that will keep employees, residents, and the environment safe now and into the future. The inspections and plan reviews that DEP conducts mitigate dam failure, hazardous materials release, mine collapse, and radon exposure. It also mitigates pollution from impacting individuals' health. The following is a list of additional DEP programs:

- **Dam Safety**: DEP approves dam emergency action plans, inspects dams for safety, and requires dams to be upgraded or repaired when warranted.
- **Natural Gas Safety**: DEP conducts unconventional well inspections.
- **Mine Safety**: DEP conducts a mine safety program which inspects mines and equipment to ensure compliance with laws and safety standards.
- **Energy Technology**: DEP provides incentive and rebate opportunities for fleet conversions and alternative fuel generation. Improving use of alternative energy can reduce both pollution and climate change.
- **Air Quality**: DEP's monitoring aids in reducing hazardous air pollutants.
- **Brownfields**: DEP supports cleanups under the Environmental Cleanup and Brownfield's Voluntary Cleanup Program.

Hazard Mitigation Land Use Measures in Pennsylvania

Local comprehensive plans provide a vision for the physical design and development of a community, and the principles in comprehensive plans are typically implemented via zoning ordinances, subdivision regulations, and capital improvement programs. Therefore, integrating hazard mitigation into the comprehensive plan helps to guide the community's development in a way that does not lead to increased hazard vulnerability. For instance, future development can be guided away from areas with known hazards, and design standards to withstand potential hazards can be created for new or improved construction.

There are several programs in place in Pennsylvania to promote land use controls as a means of hazard mitigation. For example, the Land Use Planning and Technical Assistance Program (LUPTAP) available through the DCED provides grants and technical assistance for preparation of community comprehensive plans, zoning ordinances, and subdivision regulations. The Community Assistance Program (CAP) is funded by FEMA and implemented through DCED to provide technical assistance to local governments for ordinance updates and administration as well as floodplain map interpretation and enhancement. Similarly, the Local Floodplain Management Reimbursement Program and the Risk MAP program help DCED fund ordinance compliance updates when new FEMA flood maps are issued. Additionally, the DCNR Community Conservation Partnership Program is in place to provide technical assistance and funding for land acquisition, park rehabilitation and development, and small community development projects.

5.3.2. Post-disaster Capability

As discussed in Section 5.3.1.2, Title 35 addresses PEMA's responsibilities before, during, and after a disaster.

PEMA's post-disaster capability is also built on staff and the training they receive to know and practice their post-disaster responsibilities. PEMA and BORM staff has access to multiple technical and communication tools, including the Pennsylvania Emergency Operations Center, that support their ability to respond effectively in post-disaster situations. The Public Safety Emergency Telephone Act supports identification of disaster needs to emergency responders and managers. The Hazard Mitigation Grant Program Administrative Plans play a large part in identifying and implementing processes that will effectively target and access post-disaster funding for the Commonwealth. The Hazard Mitigation Grant Program Community Outreach is effective in starting the dialogue with potential local grantees about how to access funding. BORM staff members are cross-trained to fulfill multiple roles in the post-disaster environment. RL and SRL property mitigation is prioritized in the HMGP state application review. As stated in Section 5.3.1.2, in any time period of limited budgets and staffing, additional funding and staff would be helpful in expanding PEMA and BORM's post-disaster capability. The most prominent emerging policy or program impacting post-disaster capability is the program to regularly host training and exercises of post-disaster capability. Participation in two hours of EOC training per quarter and participation in exercises allow BORM staff to be ready when they need to respond. BORM is developing a second version of the HMPO Handbook that was completed in September of 2013; the second version will improve and standardize training of HMPOs in the Joint Field Office (JFO).

Technical and Communication Tools

PEMA is capable of assisting all levels of government in post-disaster situations. The agency has technical expertise and communication tools to provide disaster-related coordination and support. Hazus (http://water.usgs.gov/osw/flood_inundation/toolbox/HAZUS.html), Geographic Information Systems, a 24-hour call center, WebEx, and video telecommunication are all used in post-disaster situations. Within BORM, all staff members are cross-trained and capable of performing multiple tasks depending on the status of the Emergency Operations Center. In addition to pre-disaster responsibilities discussed in Section 5.3.1, the BORM staff also performs several post-disaster activities:

- Emergency Operations Center duties – BORM staff provide infrastructure and human services support in the event the Emergency Operations Center is activated.
- Field duties – BORM staff are trained and have safety equipment to perform field work after a disaster. They often assess locations that were heavily impacted by a disaster and identify opportunities for mitigation. BORM staff also may be called upon to staff disaster assistance centers in the field.
- Field briefings – BORM staff conduct field briefings to municipalities on Pennsylvania disaster funding, how it may be used, and how municipalities can fund eligible projects.
- Continuity of Operations duties – BORM staff maintains their regular pre-disaster duties during a disaster to maintain continuity of operations.
- Post Flood Recovery - Damage Checklist -This Region III developed tool is distributed by PEMA is coordination with FEMA post-disaster. It reminds municipalities what they should be doing and concerned about after a disaster for floodplain management, floodplain insurance, grants, and individual and public assistance.
- Preliminary damage assessment – BORM PA and IA project officers and FEMA staff help counties and municipalities to document preliminary damage assessments in order to quickly determine whether or not the event qualifies as a disaster meriting financial assistance.
- Lessons learned briefings – BORM compiles a list of “lessons learned” following each disaster.

Additional coordination mechanisms for outreach exist between the PSATS, Pennsylvania State Association of Boroughs, the Pennsylvania League of Cities and Municipalities, KEMA, the American Planning Association, Greenway Associations, and borough and township officials. These organizations also help PEMA distribute public information after disasters, as well as before disasters.

Pennsylvania Emergency Operations Center (EOC)

The Commonwealth EOC is a technologically-advanced facility staffed and operated 24-hours a day by highly-trained personnel. Representatives from each of the 15 Emergency Support Functions (ESF) are required to staff the EOC during declared emergencies or disasters and exercises, and non-governmental organizations may also send representatives. The ESF include transportation; communications; public works and engineering; firefighting; emergency management; mass care, housing, and human services; resources support; public health and medical services; urban search and rescue; oil and hazardous materials response; agriculture and natural resources; energy; public safety and security; long-term community recovery and mitigation; and external affairs (U.S. Department of Health and Human Services, 2012). As of February 2105, the state agencies coordinating the 15 ESFs include: Pennsylvania Department of Administration, Pennsylvania Department of Transportation, Pennsylvania Department of Aging, Pennsylvania Department of General Services, Pennsylvania Department of Health, Pennsylvania Emergency Management Agency, Pennsylvania Department of Health, Pennsylvania Department of Environmental Protection, Pennsylvania State Police, Pennsylvania Department of Agriculture, Governor's Office of Communication and Press, and the Pennsylvania Department of Human Services,

At the county and local levels, EOCs are also the central coordination point for response and recovery efforts. These county and local facilities range from large and highly-sophisticated to small and simple.

Hazard Mitigation Grant Program Administrative Plans

In the event of a Presidential Disaster Declaration, the Hazard Mitigation Grant Program Administrative Plan is edited and updated. Edits may be extensive and may require new sections to be developed depending on the regulatory changes between disaster declarations. Administrative Plans document the process for the administration of HMGP and the project management of the mitigation measures to be funded under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act of 1988. The revised Administrative Plan establishes agency guidance for HMPOs on the eligibility, development, submission, review, and recommendation of IA, PA and HMGP applications relative to federal disaster declarations. Topics including responsibilities and staffing, identification and evaluation of mitigation projects, application procedures, and financial management are addressed.

Repetitive Loss and Severe Repetitive Loss Capability

As stated in Section 5.3.1.2, BORM staff has a continuous 12-month approach to mitigating RL and SRL properties. This continuous approach supports both pre- and post-disaster grant funding streams. RL structures are structures covered by a contract for flood insurance that have incurred flood-related damage on two occasions during a ten-year period in which the cost of repair on average equaled or exceeded 25% of the value of the structure at the time of the flood event. SRL is defined as properties which are single-family properties covered under NFIP flood insurance that: have at least four flood-related damages claims payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000; or for which at least two separate claim payments (building payments only) have been made with the cumulative amount of the building portion of such claims exceeding the market value of the building. For both instances, at least two of the reference claims must have occurred within any ten-year period and must be greater than ten days apart.

The HMGP program selects mitigation projects that are cost-effective, environmentally sound, and technically feasible. Following a disaster, the mitigation of RL and SRL properties is a priority for the State Review Team when reviewing HMGP applications. The State Review Team is comprised of Commonwealth employees from various agencies and offices that are tasked with reviewing HMGP applications and assigning a numeric ranking to the mitigation projects based on the projects being cost-effective, environmentally sound, and technically feasible.

Pennsylvania Voluntary Organizations Active in Disaster (PaVOAD)

The PaVOAD supports disaster preparedness, response and recovery by linking needs to available resources from independent member organizations. PEMA serves as the coordinating office and monitor for the PaVOAD. PaVOAD member organizations act independently during a disaster to provide services in line with their organization's mission. They collaborate to decrease duplication of services and to reduce un-met needs. Like the national VOAD, the PaVOAD works for the principles of cooperation, coordination, communication and collaboration. The services provided during VOAD members typically fall in the category of mass care and include food and water, shelter, and blankets. Member organizations often have volunteers training in first aid and disaster mental health; religious organization members may also provide spiritual care during disaster events. Many of the member organizations provide services and care on a daily basis; this ongoing support in communities also supports the long-term recovery process.

Pennsylvania State Animal Response Team (PASART)

PASART works to coordinate between a network of organizations, businesses, federal, state, county and local government agencies, and individuals that supports the prevention, preparedness, response, and recovery for emergencies affecting animals. PASART also supports County Animal Response Teams (CARTs) across the Commonwealth. The services provided by the PASART and CARTs includes recruiting and training volunteers to care for animals during disasters; coordinating locations that are appropriate to shelter pets with and near family members; coordinating locations to shelter larger animals and livestock; coordinating the purchase and donation of food, water, and supplies needed to care for animals; preventing the spread of diseases that affect animals during disasters; and supporting the long-term recovery of individuals and the local economy by protecting animals during disaster.

5.3.3. Funding and Technical Assistance Capability

Each local hazard mitigation plan includes mitigation actions and projects. This section includes an identification and discussion of current and potential sources of federal, state, local, or private funding and technical assistance available to implement these mitigation activities identified in local hazard mitigation plans.

5.3.3.1. Federal-Level Funding and Technical Assistance

FEMA Hazard Mitigation Assistance Program

FEMA administers three hazard mitigation grant programs, known collectively as the Hazard Mitigation Assistance (HMA) programs. As stated in the FEMA's *Hazard Mitigation Assistance Guidance* (February 2015), "The Hazard Mitigation Grant Program (HMGP) may provide funds to States, Territories, Indian Tribal governments, local governments, and eligible private non-profits (PNPs) following a Presidential major disaster declaration. The PDM, Flood Mitigation Assistance (FMA), Repetitive Flood Claims (RFC), and Severe Repetitive Loss (SRL) programs may provide funds annually to States, Territories, Indian Tribal governments, and local governments." The HMA guidance replaces previous guidance and more efficiently manages hazard mitigation grants under one umbrella. Three FEMA hazard mitigation grants of the HMA program include:

Flood Mitigation Assistance (FMA) Program

As stated in the FEMA's *Hazard Mitigation Assistance Guidance* (February 2015), "The FMA program is authorized by Section 1366 of the National Flood Insurance Act of 1968, as amended (NFIA), 42 U.S.C. 4104c, with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). The Biggert-Waters Flood Insurance Reform Act of 2012 (Public Law 112-141) consolidated the previous funding for Repetitive Flood Claims and Severe Repetitive Loss grant programs into FMA."

Funds are allocated to each state based on the total number of NFIP insurance policies and the total number of RL properties within the state. States may apply for funding in excess of their allocations; additional funds are awarded on a competitive basis pending availability of funds.

Pre-Disaster Mitigation (PDM) Program

As stated in the FEMA's *Hazard Mitigation Assistance Guidance (February 2015)*, "The PDM program is authorized by Section 203 of the Stafford Act, 42 U.S.C. 5133. The PDM program is designed to assist States, Territories, Indian Tribal governments, and local communities to implement a sustained pre-disaster natural hazard mitigation program to reduce overall risk to the population and structures from future hazard events, while also reducing reliance on Federal funding from future disasters."

Hazard Mitigation Grant Program (HMGP)

As stated in the FEMA's *Hazard Mitigation Assistance Guidance (February 2015)*, "HMGP is authorized by Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, as amended (the Stafford Act), Title 42, United States Code (U.S.C.) 5170c. The key purpose of HMGP is to ensure that the opportunity to take critical mitigation measures to reduce the risk of loss of life and property from future disasters is not lost during the reconstruction process following a disaster. HMGP is available, when authorized under a Presidential major disaster declaration, in the areas of the State requested by the Governor. The amount of HMGP funding available to the Applicant is based upon the estimated total Federal assistance to be provided by FEMA for disaster recovery under the Presidential major disaster declaration."

A number of the above HMA programs require a match component. For HMGP, the Commonwealth or the local government (the sub-applicant) has provided the match from general funds. For PDM and FMA, the local government (or sub-applicant) or the homeowner has provided the matching funds. Sometimes, funding is appropriated to PEMA by the Commonwealth for the purpose of providing the 25% match on mitigation projects that apply to a specific disaster. Other agencies also have funding streams that may support matches for the FEMA grant programs. Table 5.3.3-1 summarizes the mitigation activities for which FEMA HMA funds have been made available.

Table 5.3.3-1 FEMA grant program eligible activities (FEMA Hazard Mitigation Assistance Guidance, February 2015).			
Mitigation Activity	Figure 5.3.3-1 HMA Program		
	HMGP	*PDM	FMA
1.Mitigation Projects	√	√	√
Property Acquisition and Structure Demolition	√	√	√
Property Acquisition and Structure Relocation	√	√	√
Structure Elevation	√	√	√
Mitigation Reconstruction			√
Dry Floodproofing of Historic Residential Structures	√	√	√
Dry Floodproofing of Non-residential Structures	√	√	√
Minor Localized Flood Reduction Projects	√	√	√
Structural Retrofitting of Existing Buildings	√	√	
Non-structural Retrofitting of Existing Buildings and Facilities	√	√	√
Safe Room Construction	√	√	
Wind Retrofit for One- and Two-Family Residences	√	√	
Infrastructure Retrofit	√	√	√
Soil Stabilization	√	√	√
Wildfire Mitigation	√	√	
Post-Disaster Code Enforcement	√		
Generators	√	√	
5 Percent Initiative Projects	√		
Advance Assistance	√		
2.Hazard Mitigation Planning	√	√	√
3.Management Costs	√	√	√

Other FEMA Programs

National Flood Insurance Program (NFIP) – As discussed in other sections, the NFIP offers flood insurance to homeowners, renters, and business owners if their community participates in the NFIP. Flood insurance protects two types of insurable property – building and contents. The program is administered in Pennsylvania by the DCED. The NFIP includes Increased Cost of Compliance (ICC) coverage for new and renewed Standard Flood Insurance Policies. ICC is an effective way to mitigate RL and SRL properties and may be considered in combination with other funding streams.

Community Rating System (CRS) – The National Flood Insurance Program's (NFIP) Community Rating System (CRS) is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. As a result, flood insurance premium rates are discounted to reflect the reduced flood risk resulting from the community actions meeting the three goals of the CRS.

Public Assistance (PA) Program – According to the FEMA website, “Through the PA Program, FEMA provides assistance for the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain PNP organizations. Section 406 of the Stafford Act provides a funding source for cost-effective hazard mitigation measures that would reduce or eliminate the threat of future damage to a facility damaged during the disaster. The measures must apply only to the damaged elements of a facility rather than to other, undamaged parts of the facility or to the entire system. Section 406 mitigation measures are considered part of the total eligible cost of repair, restoration, reconstruction, or replacement of a facility. They are limited to measures of permanent work, and the Applicant may not apply mitigation funding to alternate projects or improved projects if a new replacement facility is involved. Upgrades required to meet applicable codes and standards are not ‘mitigation measures’ because these measures are part of eligible restoration work.”

FEMA Regional Catastrophic Preparedness Grant Program (RCPGP) – The RCPGP is intended to support coordination of regional all-hazard planning for catastrophic events, including the development of integrated planning communities, plans, protocols, and procedures to manage a catastrophic event in high-risk urban areas and their surrounding regions.

Emergency Management Performance Grants (EMPG) – According to the FEMA website, “Emergency Management Performance Grants (EMPG) provides funding to assist State and local governments with sustaining and enhancing all-hazards emergency management capabilities. Emergency management must be able to coordinate in the context of natural and human-made hazards, as well as technological events, that threaten the security of the homeland and the safety and well-being of citizens. An all-hazards approach to preparedness, including the development of a comprehensive program of planning, training, and exercises, sets the stage for an effective and consistent response to any threatened or actual disaster or emergency, regardless of the cause.” EMPG has a 50% federal and 50% state cost-share requirement.

Community Assistance Program – State Support Services Element (CAP-SSSE)
According to the FEMA website, “[the CAP-SSSE] program provides funding to States to provide technical assistance to communities in the National Flood Insurance Program (NFIP) and to evaluate community performance in implementing NFIP floodplain management activities. In this way, CAP-SSSE helps to:

- Ensure that the flood loss reduction goals of the NFIP are met,
- Build State and community floodplain management expertise and capability, and
- Leverage State knowledge and expertise in working with their communities.”

In Pennsylvania, FEMA Region III, PEMA, and DCED negotiate a CAP-SSSE Agreement that specifies activities and products to be completed by the Commonwealth in return for CAP-SSSE funds. In addition, since Federal Fiscal Year 2005, the Commonwealth is required to develop a

Five-Year Floodplain Management Plan describing the activities to be completed using CAP-SSSE funding as well as how the required performance metrics will be met. Performance standards that address quality of service are to be developed and measured. There is a 25% non-federal match for all states receiving CAP-SSSE funds. The CAP-SSSE funding will contribute to the new NFIP management positions planned for BORM.

Community Disaster Loan Program - The program provides direct loans to local governments to offset the loss of tax or other revenues as a result of a major disaster. The loans are to be directly used to maintain local governmental functions such as police and fire protection, or water and sewer services.

Individuals and Households Program (IHAP) – The Individuals and Households Program is a combined FEMA and state program. When a major disaster occurs, this program provides funds and services to people in the declared area whose property has been damaged or destroyed and whose losses are not covered by insurance. In every case, the disaster victim must register for assistance and establish eligibility.

Environmental Planning and Historic Preservation Program (EHP) – FEMA's EHP integrates the protection and enhancement of environmental, historic, and cultural resources into FEMA's mission, programs and activities; ensures that FEMA's activities and programs related to disaster response and recovery, hazard mitigation, and emergency preparedness comply with federal environmental and historic preservation laws such as the National Historic Preservation Act and executive orders; and provides environmental and historic preservation technical assistance to FEMA staff, local, State and Federal partners, and grantees and subgrantees.

Risk MAP (Mapping, Assessment, and Planning) – According to the FEMA website, "The vision for Risk MAP is to deliver quality data that increases public awareness and leads to action that reduces risk to life and property. Risk MAP builds on flood hazard data and maps produced during the Flood Map Modernization (Map Mod) program." Risk MAP combines flood hazard mapping, risk assessment tools and mitigation planning into one seamless program. The intent of this integrated program is to encourage beneficial partnerships and innovative uses of flood hazard and risk assessment data to maximize flood loss reduction. FEMA will collaborate with federal, state, and local stakeholders to achieve the following goals under Risk MAP:

- Flood Hazard Data. Address gaps in flood hazard data to form a solid foundation for risk assessment, floodplain management, and actuarial soundness of the National Flood Insurance Program (NFIP).
- Public Awareness/Outreach. Ensure that a measurable increase of the public's awareness and understanding of risk results in a measurable reduction of current and future vulnerability.
- Hazard Mitigation Planning. Lead and support States, local, and Tribal communities to effectively engage in risk-based mitigation planning resulting in sustainable actions that reduce or eliminate risks to life and property from natural hazards.

- Enhanced Digital Platform. Provide an enhanced digital platform that improves management of Risk MAP, stewards information produced by Risk MAP, and improves communication and sharing of risk data and related products to all levels of government and the public.
- Alignment and Synergies. Align Risk Analysis programs and develop synergies to enhance decision-making capabilities through effective risk communication and management.

National Dam Safety Program (NDSP) – The NDSP, led by FEMA, is a partnership of the states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. The NDSP, which was formally established by the Water Resources and Development Act of 1996, includes:

- Grant assistance to the states, which provides vital support for the improvement of the state dam safety programs that regulate most of the 79,500 dams in the United States.
- Dam Safety Research, which is a program of technical and archival research.
- Dam safety training for state dam safety staff and inspectors.

The Dam Safety and Security Act of 2002, signed into law on December 2, 2002, reauthorized the NDSP for four more years and added enhancements to the 1996 Act that are designed to safeguard dams against terrorist attacks.

U.S. Army Corps of Engineers Programs

Planning Assistance to States (PAS) Program – Section 22 of the 1974 Water Resources Development Act provides authority for the US Army Corps of Engineers Planning Assistance to the States (PAS) and Indian Nations. Under this program, the USACE assists the States, local governments, Native American Tribes and other non-federal entities in the preparation of comprehensive plans for the development and conservation of water and related land resources. Types of work that can be done include: Water Quality Studies, Wetland Evaluation Studies, Flood Plain Management Studies, Coastal Zone Management/Protection Studies, Harbor/Port Studies, or other water resource planning investigations. The needed planning assistance is determined by the individual non-federal sponsors.

Flood Plain Management Services Program (FPMS) – Section 206 of the 1960 Flood Control Act (PL 86-645), as amended, provides the authority for the USACE to provide assistance and guidance on all aspects of flood plain management planning. The program develops or interprets site-specific data on obstructions to flood flows, flood formation, and timing and the extent, duration, and frequency of flooding. Upon request, program services are provided to the state, regional, and local governments, Native American Tribes, and other non-federal public agencies without charge.

Continuing Authorities Program (CAP) – Congress has provided USACE with a number of standing authorities to study and build water resource projects for various purposes without additional project specific congressional authorization. The types of projects addressed by the

CAP include emergency streambank and shoreline erosion, flood control projects, snagging and clearing for flood control, and small beach erosion control projects.

Inspection of Completed Works (ICW) Program – Civil works structures whose failure or partial failure could jeopardize the operational integrity of the project, endanger the lives and safety of the public, or cause substantial property damage, are periodically inspected and evaluated to ensure their structural stability, safety, and operational adequacy. For those structures constructed by the USACE and turned over to others for operation and maintenance, the operating entity is responsible for periodic inspection and evaluation. The USACE may conduct the inspection on behalf of the project sponsor provided appropriate reimbursement to the USACE is made. However, the USACE may participate in the inspection with the operating entity at the government's expense.

Rehabilitation and Inspection Program (RIP) – The Rehabilitation and Inspection Program is a USACE program that provides for inspection of flood control projects, the rehabilitation of damaged flood control projects, and the rehabilitation of federally-authorized and constructed hurricane or shore protection projects.

National Levee Safety Program – The National Levee Safety Program assesses the integrity and viability of levees and recommends actions to assure that levee systems do no present unacceptable risk to the public, property, and the environment.

Beach Restoration and Shoreline Protection Program – This program authorizes USACE under Section 103 of the 1962 River and Harbor Act, as amended, to develop and construct small projects for the purpose of shore protection and beach restoration on Great Lakes and coastal areas. In Pennsylvania, this program is applicable in Erie County.

General Investigation (GI) – These are congressionally authorized studies under USACE's Civil Works program. Congress can authorize USACE to study, design, and construct major flood risk management projects. The feasibility study is cost-shared 50/50 and construction is cost shared 65/35 between the federal government and non-federal sponsor. These are generally large-scale projects that cost more than $10 million. Congress can also authorize USACE to conduct other water-related studies/projects such as watershed assessments, ecosystem restoration, and navigation improvements.

Other Federal Programs

Community Development Block Grant-Disaster Recovery (*CDBG-DR)* – The CDBG-DR program provides grants and technical assistance to federally-designated and non-designated municipalities for any type of community development. There is an Entitlement component that provides funding for designated communities via a set formula. The Competitive component provides funding of up to $500,000 to non-federally-designated communities. These grants may be used for infrastructure improvement, public services, or development and planning. 70% of the project must benefit low- and moderate-income persons. CDBG-DR money can be used as matching funds for the FEMA HMA grant programs.

Department of Homeland Security Grant Program (HSGP) – The Homeland Security Grant Program consists of three sub-programs: the State Homeland Security Program (SHSP), Urban Areas Security Initiative (UASI), and Operation Stonegarden (OPSG). The SHSP is the core assistance program in this suite; it provides funds to build capabilities at the state and local levels and to implement the goals and objectives included in state homeland security strategies and initiatives in their State Preparedness Reports. At least 25% of these funds are dedicated toward anti-terrorism activities. UASI focuses on enhancing regional preparedness in metropolitan areas, while OPSG is intended to enhance cooperation and coordination among law enforcement agencies in a joint mission to secure the US border.

Small Business Administration Disaster Loan Programs – The SBA Disaster Loan Program provides low-interest, long-term loans to businesses and most private nonprofit organizations to repair or replace damaged property owned by the business, including real property, machinery and equipment, fixtures, inventory, and supplies. Homeowners may also qualify for low-interest loans to help rebuild or repair their primary homes or repair or replace uninsured or underinsured flood damaged personal property. Renters may qualify for loans to repair or replace personal property such as clothing, furniture, cars and appliances. Economic Injury Disaster Loans provide working capital to small businesses, small agricultural cooperatives and most private nonprofit organizations to assist them through the recovery period.

Natural Resources Conservation Service (NRCS) provides financial and technical assistance that supports mitigation before and after a disaster. The programs are unique in that they will support improvements to both private and public lands. Prior to a disaster, the NRCS's easement programs promote Natural System Protection mitigation. The Wetlands Reserve Program is the easement program most closely linked to flood mitigation by providing a place for flood waters to appropriately flow. Though the remaining easement program also could provide a role for Natural System Protection mitigation depending on where they are implemented: Farm and Ranch Land Protection Program, Grasslands Reserve Program, and Healthy Forests Reserve Program.

In response to disasters, the NRCS provides the Emergency Watershed Protection Program (EWP) for Recovery and Floodplain Easement (FPE). The EWP-Recovery program supports improvement for watersheds including projects to address debris-clogged stream channels, unstable streambanks, jeopardized water control structures and public infrastructures, wind-borne debris removal, and damaged upland sites stripped of protective vegetation by fire or drought. The EWP-FPE program targets floodplain restoration by purchasing permanent easements on floodplain lands. The purpose of these easements is to restore, protect, manage, maintain, and enhance the functional values of floodplains and other lands, and for the conservation of natural values including fish and wildlife and their habitat, water quality improvement, flood water retention, groundwater recharge, open space, aesthetic values, and environmental education.

Other federal programs that provide hazard funding and technical assistance are listed below. The comprehensive list was obtained from the Final Silver Jackets Interagency Flood Mitigation Program Guide (October 2015).

- Department of Commerce (DOC)/Economic Development Authority (EDA) Infrastructure Construction Grant Program
- DOC/EDA Planning Grants
- DOC/EDA Revolving Loan Fund
- DOC/EDA Technical Assistance Grants
- Department of Housing and Urban Development (HUD) 5-H Homeownership Program HUD Home Program
- HUD/Federal Housing Administration (FHA) Title I Home Repair Loan Program
- HUD/FHA Section 203(h) Mortgage Insurance for Disaster Victims
- HUD/FHA Section 203(k) Rehabilitation Mortgage Insurance Program
- HUD Partnership for Advancing Technology in Housing
- Department of Interior (DOI)/United States Geological Survey (USGS) Natural Hazards Program
- DOI/USGS Water Programs
- DOI/USGS Floods, Droughts, and Current Conditions
- DOI/USGS Flood Monitoring in Pennsylvania
- DOI/USGS Water Data from the Nation's Water Resources
- Department of Transportation (DOT)/Federal Highway Administration Emergency Relief Program
- Internal Revenue Service Casualty Loss-Special Disaster Provisions
- National Oceanic and Atmosphere Administration (NOAA) StormReady Program
- NOAA Weather Radio All Hazards (NWR)
- NOAA Damage Assessment, Remediation and Restoration Program
- NOAA Center for Operational Oceanographic Products and Services (CO-OPS) National Water Level Observation Network
- NOAA Coastal Services Center Land Cover Mapping
- NOAA Integrated Ocean Observing System Program IOOS Regional Association
- NOAA CO-OPS Delaware Bay Hydrodynamic Model
- NOAA CO-OPS Delaware River and Bay PORTS
- NOAA Office of Response and Restoration Regional Resource Coordinator (RRC)
- NOAA Office of Ocean and Coastal Resource Management (OCRM) Pennsylvania Coastal Resources Management Program/Pennsylvania Department of Environmental Protection
- NOAA National Sea Grant College Program- Pennsylvania Sea Grant College Program
- NOAA Earth System Research Laboratory/Global Systems Division – Ground-Based GPS Meteorology
- NOAA Earth System Research Laboratory/Global Systems Division – Science On a Sphere – Whitaker Center
- NOAA Earth System Research Laboratory/Global Monitoring Division – Surface Radiation Measurement Network
- NOAA Great Lakes Environmental Research Laboratory – SLERL CoastWatch
- NOAA Air Resources Laboratory – Atmospheric Integrated Research Monitoring Network
- NOAA Air Resources Laboratory – Mercury Measurement Site

- NOAA Cooperative Institute for Limnology and Ecosystems Research (CILER), Penn State University
- NOAA Climate Reference Network – Avondale Station
- National Weather Service (NWS) multiple Forecast Centers and Forecast Offices
- NWS/Federal Aviation Administration (FAA)/Department of Defense (DOD) Automated Surface Observing Systems
- NWS Cooperative Observer Program (COOP)
- United States Department of Agriculture (USDA) Water and Waste Disposal Programs
- USDA/Farm Service Agency (FSA) Conservation Reserve Program
- USDA/FSA EM Program (Emergency Loans)
- USDA/FSA Emergency Conservation Program
- USDA/FSA Tree Assistance Program
- USDA/NRCS Emergency Watershed Protection Program
- USDA/NRCS Watershed Protection and Flood Prevention ProgramUSDA/NRCS Watershed Surveys and Planning Program
- USDA/NRCS Dam Rehabilitation Assistance
- USDA/Rural Business Service (RBS) Business and Industrial Loans
- USDA/Rural Housing Service (RHS) Community Facilities Loans and Grants
- USDA/RHS Rural Rental Loans
- USDA/RHS Section 502 Single-Family Housing Direct and Guaranteed Loans
- USDA/RHS Section 504 Repair Loans and Grants
- USDA Repair and Rehabilitation Loan
- USDA/RHS Self-Help Housing Loans
- USDA/Risk Management Agency (RMA) Federal Multi-Peril Crop Insurance
- USDA/RMA Noninsured Crop Disaster Assistance Program

5.3.3.2. State-Level Funding and Technical Assistance

The Commonwealth uses a variety of funding sources to meet the match requirements of the various HMA grant programs. In addition, the Commonwealth has a variety of technical assistance programs available to aid communities with hazard mitigation. Funding sources are listed by agency and program.

Department of Community and Economic Development (DCED)

DCED offers assistance through a number of programs. Applicants can apply via a Single Application for Assistance online. The Single Application is a streamlined application process for financial assistance for the following programs:

Municipal Assistance Program (MAP) – The program provides funding to assist local governments to plan for and efficiently implement a variety of services and improvements, and soundly manage development with an emphasis on intergovernmental approaches. Funding is available for three groups of activities: shared services, community planning, and floodplain management.

- Shared service activities: consolidating or regionalizing shared services among multiple counties and municipalities boundary change studies, shared personnel, and shared equipment. New or expanded intergovernmental initiatives that promote local governmental efficiencies and effectiveness.

- Community planning: comprehensive plans and parts thereof, land use ordinances, Transit Revitalization Investment District planning studies and entrepreneurial/innovative plans that support community and economic development improvements with an emphasis on multi-municipal plans.
- Floodplain management: reimbursement for costs of preparation, enactment, administration and enforcement of floodplain management regulations pursuant to the Flood Plain Management Act.

Grants of up to 50% eligible costs are available; the program is administered by the Governor's Center for Local Government Services within the DCED.

CDBG-DR – As discussed above, the CDBG-DR program provides grants for any type of community development. In Pennsylvania, state law governs how the Commonwealth distributes the annual HUD Non-Entitlement allocation. The law provides for two ways of distributing these funds: as Entitlement funds (applicable to non-urban counties, non-urban third class cities, urban boroughs and townships) and as Competitive funds (applicable to non-urban boroughs and townships and other restricted municipalities).

Business Financing – Several programs under this general program category could be used to help businesses finance a mitigation-related activity. All projects must demonstrate that a certain number of jobs will either be retained or created. These programs have not been itemized for this plan because of the wide variety of state programs in existence. Each application for these state funds must be customized and/or tailored to fit the economic development criteria. Therefore, it is recommended that each applicant meet with the central office or field economic development staff specialists of the department before completing online applications.

Local Municipal Resources and Development Program (LMRDP) – The program provides grants from a minimum of $5,000 up to $25,000 for infrastructure rehabilitation, acquisition and demolition of structures, and revitalization of community facilities.

Urban Development Program (UDP) - The program provides grants from a minimum of $5,000 up to $25,000 for construction or rehabilitation of infrastructure, acquisition and demolition of structures, rehabilitation of structures, planning of community assets, and public safety training (i.e. first responder training). However, this program is currently inactive.

H2O PA Program – This program provides single-year or multi-year grants to the Commonwealth, independent agencies, municipalities, or municipal authorities for the construction, improvement, repair, or rehabilitation of all or part of a flood control system. Funding is for a minimum of $500,000 or more and a maximum amount of $20 million for any project. Types of flood control projects may include channel improvements, compacted earth levees, concrete channels, concrete floodwalls, detention dams, non-structural measures, or any combination of these project types. Major repairs or rehabilitation of an existing flood protection project would also be eligible.

PENNVEST

PENNVEST provides low-interest loans to communities to fund sewer, storm water, and drinking water projects throughout the Commonwealth. PENNVEST is responsible for administering the Clean Water State Revolving Fund, the Drinking Water State Revolving Fund, and the American Recovery and Reinvestment Act of 2009 funds. Storm water improvement projects by PENNVEST represent significant funding for Pennsylvania. The total funding from 1933-2018 is $142,120,276. The following table provides details on the location, title, and funding for each storm water project.

Table 5.3.3-2 PENNVEST Storm water projects 1993-2018 (PENNVEST, 2018).

COUNTY	PROJECT NAME	APPROVAL DATE	AMOUNT
Bradford	Sayre Boro.-stormwater project in the borough	11/10/1993	$1,435,000
Philadelphia	PAID-stormwater drainage system for spectrum II arena	11/10/1993	$2,341,467
Allegheny	Scott Twp -lincoln ave storm line	3/23/1994	$364,300
Beaver	Monaca Boro -phase I storm water	3/23/1994	$501,218
Delaware	Brookhaven Boro-storm water inlets & piping	3/23/1994	$195,460
Delaware	Eddystone Boro-storm sewers	3/23/1994	$1,402,625
Jefferson	Reynoldsville Boro. -storm sewers on Mabel St.	3/23/1994	$230,000
Lancaster	E Hempfield twp- stormsewers in cherry hill, wheatland &running pump	3/23/1994	$1,229,000
Delaware	Prospect park boro-new storm water drainage system	11/30/1994	$128,374
Delaware	Ridley Park boro-stormwater dam project	11/30/1994	$650,000
Delaware	Ridley Park boro-stormwater improvement project	11/30/1994	$650,000
Delaware	Ridley twp-upgrade & extend stormwater drainage system	11/30/1994	$1,242,500
Lawrence	Shenango Twp. -storm sewers Brookshire Area	11/30/1994	$224,971
Luzerne	LAFLIN BORO 94-s; storm	11/30/1994	$153,790
Schuylkill	Pottsville City stormwater 94	11/30/1994	$331,775
Erie	Lake Cty. Boro. -stormwater drainage system Martin Ave.	3/22/1995	$85,000
Tioga	Mansfield Boro. MA -install stormsewer lines, manholds, etc.	3/22/1995	$461,100
Tioga	Wellsboro Boro -Stormsewer project along Charleston St. and East Ave.	3/22/1995	$291,178
Westmoreland	Hempfield Twp -zellers street storm sewers	3/22/1995	$908,969
Allegheny	Dravosburg Boro -storm water mine water	7/12/1995	$186,019
Blair	Newry boro-storm sewers & 4 catch basins	7/12/1995	$40,000
Bucks	Sellersville boro-storm drainage improvements	7/12/1995	$150,000
Dauphin	Hbg auth-improve stormwater inlets @ 5 locations	7/12/1995	$85,133
Mifflin	Burnham boro-stormwater system walnut st to hungry run	7/12/1995	$247,000
Northumberland	Mount Carmel MA -replace combined sewer box culvert	7/12/1995	$609,000

Table 5.3.3-2 PENNVEST Storm water projects 1993-2018 (PENNVEST, 2018).

COUNTY	PROJECT NAME	APPROVAL DATE	AMOUNT
Westmoreland	Hempfield Twp -high park storm sewers	7/12/1995	$269,101
Carbon	LANSFORD BORO 95 stormwater/sinkhole	11/29/1995	$604,290
Clearfield	Dubois City -storm sewer along New St.	3/20/1996	$126,010
Erie	Lawrence Park Twp.-replace stormsewer pipe	3/20/1996	$94,182
Erie	Millcreek Twp. -replace stoemsewer lines dredge Beaver Run	3/20/1996	$615,098
Erie	Wesleyville Boro.-replace storm sewer along Bird Drive	3/20/1996	$81,436
Washington	California Boro -sewer seperation project	7/17/1996	$703,620
Delaware	Lower Chichester twp-stormwater drainage improvements marshall terrace	11/13/1996	$695,000
Washington	Washington City -hall ave stromsewer	3/26/1997	$2,484,149
Berks	Colebrookdale twp-stormwater drainage improvements	7/16/1997	$157,187
Columbia	Mifflin Twp. -storm sewer to connect to PENNDOT system	7/16/1997	$407,419
Delaware	Ridley twp-stormwater drainage improvements in 12 areas	7/16/1997	$1,250,000
Somerset	Paint Boro -stormwater improvements	7/16/1997	$335,650
Luzerne	Wright Twp yorktown rd.	11/19/1997	$236,200
Delaware	Upper Chichester twp-storm sewer improvements in 9 locations	3/25/1998	$706,700
Luzerne	EDWARDSVILLE BORO 98-storm; Larkmont Manor	7/15/1998	$101,342
Luzerne	FREELAND BORO 98-storm separation	7/15/1998	$1,786,826
Westmoreland	Penn Twp -level green	7/15/1998	$597,570
Delaware	Upland boro-storm sewer improvements	11/18/1998	$236,950
Fayette	Connellsville City -stormwater extensions	11/18/1998	$125,197
McKean	Bradford City -stormwater pipe and storm inlets	11/18/1998	$2,575,017
Allegheny	Pleasant Hills Boro -east bruceton phase 1	3/24/1999	$561,195
Bucks	Middletown twp-stormwater drainage improvements	3/24/1999	$674,475
Lycoming	Picture Rocks Boro. -stormwater drainage system Taylor Hill	7/14/1999	$62,734
Delaware	Upper Chichester twp-storm sewers @ johnson, hillside & roger aves	3/22/2000	$559,000
Delaware	Lansdowne boro-storm sewer improvements	7/12/2000	$1,538,741
Mercer	Sharon City -storm sewer along Mesabi St.	7/12/2000	$272,518
Westmoreland	Penn Twp -berlin stream	7/12/2000	$238,000
Crawford	Titusville City -stormwater pipe and catch basins	10/4/2000	$3,522,045
Allegheny	Mt Oliver Boro -anthony street phase 1 storm	11/15/2000	$856,370
Allegheny	Pittsburgh WSA -overbrook blvd	11/15/2000	$991,115
Cambria	Westmont Boro -spear ave storm sewers	11/15/2000	$163,382
Clinton	Avis Boro.-storm sewer system	3/21/2001	$438,350

Table 5.3.3-2 PENNVEST Storm water projects 1993-2018 (PENNVEST, 2018).

COUNTY	PROJECT NAME	APPROVAL DATE	AMOUNT
Allegheny	Baldwin Boro -strom sewer phase 1	7/18/2001	$205,050
Allegheny	Mt. Oliver Boro -anthony street phase 2 storm	7/18/2001	$1,164,050
Clinton	Wayne Twp.- stormwater drainage system	7/18/2001	$360,519
Northumberland	Northumberland Boro. -new storm sewer collection system	11/14/2001	$1,113,715
Westmoreland	Penn Twp -berlin dam project	11/14/2001	$806,920
Cambria	Cambria Twp -mylo park storm water project	3/20/2002	$349,561
Erie	Lawrence Park Twp. - replace stormsewer pipe	3/20/2002	$271,000
Fayette	Uniontown City -stormwater separation project	3/20/2002	$1,664,000
Westmoreland	Penn Twp -cortina marie project	3/20/2002	$1,325,000
Allegheny	Edgewood Boro -race street storm	7/17/2002	$158,520
Luzerne	HAZLE TWP 02-storm	7/17/2002	$1,274,040
Washington	Charleroi Boro -stormwater system	7/17/2002	$7,900,000
Lawrence	South New Castle Boro. -stormwater pipe along Morris St.	11/20/2002	$97,091
Montgomery	Schwenksville Boro - Third Street Improvements	5/7/2003	$80,000
Luzerne	Freeland Boro -Northside Storm Water Project	3/24/2004	$1,149,848
Westmoreland	Unity Twp - Lawson Heights Storm Sewer Project	3/24/2004	$960,000
Berks	Colebrookdale Twp - Mill Street	7/7/2004	$630,000
Berks	Exeter Twp - East Neversink Storm Sewer	7/7/2004	$299,193
Bedford	Everett Boro - West Street Improvements	11/17/2004	$346,400
Washington	North Franklin Twp - Stormwater Construction on eight (8) streets	11/17/2004	$306,927
Union	Lewisburg Area Rec Auth - Saint Mary Street Park Improvements	3/23/2005	$298,909
Berks	Sinking Spring Boro - Mountain Home Road Stormwater Project	7/6/2005	$603,094
Dauphin	Steelton Boro - Pine & Jefferson Streets Stormwater Facilities	11/9/2005	$1,259,000
Luzerne	Bear Creek Vlg Boro - Beaupland Road Storm Sewers	5/24/2006	$199,000
Westmoreland	Derry Boro (Westmoreland Cty) Storm Sewer Improvements	5/24/2006	$1,900,938
Westmoreland	Unity Twp - Lawson Heights Storm Sewer Replacement - Phase 2	5/24/2006	$386,135
Luzerne	Greater Hazelton Jt SA - Terrace Stormwater Improvement Project	10/23/2007	$726,534
Luzerne	Freeland Boro - East-West Storm Water Project	4/14/2008	$651,100
Philadelphia	Philadelphia City - Green Infrastructure for Stormwater Management	4/20/2009	$30,000,000
Allegheny	Friends of the Pittsburgh Urban Forest - City of Pbgh Parking Lot Landscaping Initiative	7/21/2009	$274,393
Allegheny	Pittsburgh Botanic Garden - Botanic Garden Irrigation Ponds	7/21/2009	$1,368,894
Allegheny	Western Pennsylvania Conservancy--TreeVitalize	7/21/2009	$2,400,000

Table 5.3.3-2 PENNVEST Storm water projects 1993-2018 (PENNVEST, 2018).			
COUNTY	**PROJECT NAME**	**APPROVAL DATE**	**AMOUNT**
Armstrong	Armstrong Conserv District - Water Improvement	7/21/2009	$1,552,007
Bedford	Broad top Twp (Six Mile Run Area Vltr Fire Co) - Station 36 Innovative Stormwater Reuse	7/21/2009	$35,070
Bedford	Everett Boro (Everett Hardwood Bsnss Pk) - Boro Brownfield Stormwater Mgnt	7/21/2009	$137,802
Bradford	Standing Stone Twp - Slope Stabilization Mosier Road Slide 1 into Rummerfield Creek	7/21/2009	$128,653
Bradford	Standing Stone Twp - Slope Stabilization Mosier Road Slide 2 into Rummerfield Creek	7/21/2009	$101,462
Bucks	Tinicum Twp - Dirt Road/storm water management	7/21/2009	$600,000
Bucks	West Rockhill Twp - Jesmont Road	7/21/2009	$49,343
Cambria, Centre, Clearfield, Snyder, Union	Snyder CCD - Riparian Stream Buffer Tree Planting Project	7/21/2009	$119,833
Chester	Chester Cty Conserv District - Brandywine Christina Stormwater BMPs - Agriculture and Urban	7/21/2009	$1,832,839
Chester	Chester Cty Conserv District - Octoraro/Elks/Northeast AG BMPs	7/21/2009	$339,245
Chester	Tredyffrin Twp - Maude-Lisa-Vincent Drainage Improvement Project	7/21/2009	$523,974
Clearfield	Ferguson Twp - Dirt & Gravel Road Environmental Innovative	7/21/2009	$142,380
Crawford	Sadsbury - Clean Water - Foust Rd. Project	7/21/2009	$98,000
Cumberland	Upper Mifflin Twp - Bridgewater Rd and Parkhill Rd Improvements	7/21/2009	$205,291
Dauphin	Chesapeake Bay Foundation, Inc. - Riparian Forest Buffers & Ag BMPs to Improve Water Quality	7/21/2009	$14,966,444
Delaware	Villanova Univ - Down Spout Disconnection Program	7/21/2009	$55,912
Erie	Erie County Conserv District - rural road stormwater improvements	7/21/2009	$1,191,201
Fayette	PA Environmental Council – Ohio Pyle Green Infrastructure Projects	7/21/2009	$1,312,718
Lackawanna, Luzerne, Wyoming	PA Urban & Community Forestry Council - Green Stormwater Management	7/21/2009	$300,000
Lehigh	Lehigh Cty - County Environmental Center	7/21/2009	$40,000
Lehigh, Northampton	Lehigh Cty Conserv District - Lehigh/Northampton Stormwater BMP Demo Project	7/21/2009	$100,000
Luzerne	Lake Twp: Wesley Road and Bear Hollow Road Project	7/21/2009	$131,044
Montgomery	Towamencin Twp - Fischer's Park Pervious Pavement Project	7/21/2009	$281,964
Montgomery	Whitemarsh Twp - McCarthy Park Stormwater Basin Retrofits	7/21/2009	$618,485

Table 5.3.3-2 PENNVEST Storm water projects 1993-2018 (PENNVEST, 2018).			
COUNTY	PROJECT NAME	APPROVAL DATE	AMOUNT
Philadelphia	PA Cleanways - The Cobbs Creek, West Philadelphia- Storm Water Mitigation Project	7/21/2009	$136,429
Philadelphia	PA Horticultural Society - Green Infrastructure Tree Plantings	7/21/2009	$1,655,249
Pike	Shohola Twp - Rosa Road Stormwater and Landslide Corrections	7/21/2009	$494,417
Sullivan	Sullivan Cty Conserv District - Sullivan Dirt and Gravel Headwater Protection	7/21/2009	$820,482
Wyoming	Factoryville Boro - Factoryville and Clinton Township Municipal Park Green Parking Lot Project	7/21/2009	$85,600
York	North Hopewell Twp - Dirt & Gravel Road Water Quality Improvements	7/21/2009	$749,976
York	York Twp - Stump Park Green Infrastructure Improvements	7/21/2009	$460,673
Franklin	Waynesboro Boro -South Potomac Street Storm Water Drainage Network	7/20/2010	$5,737,812
Luzerne	Yatesville Boro - Storm Sewer Improvements	7/20/2010	$400,000
Northumberland	Mt Carmel MA - Butternut Box Culvert Replacement	7/20/2010	$1,350,458
Westmoreland	Unity Township Phase 3 Storm Water Project	4/19/2017	$1,741,047
Snyder	Middleburg Storm Water Improvements	7/19/2017	$978,500
Northampton	Bangor Borough Messinger Stormwater Culvert Replacement	10/18/2017	$1,986,826
Cumberland	Mount Holly Springs - Hill Street Drainage Improvement Project	10/18/2017	$1,640,650
Wayne	Hawley Borough Storm Water Repair	1/31/2018	$277,911
Total Funding:			$142,120,276

Department of Environmental Protection (DEP)

Stream Improvement Program – DEP administers this program, which offers assistance by designing and constructing small projects to reduce flooding, protect structures from streambank erosion, and to restore degraded stream channels.

Dam Safety Program – DEP, in collaboration with FEMA, federal agencies, and other stakeholders, oversees the regulation and safety of dams and reservoirs in the Commonwealth.

Flood Protection Program – According to the DEP website, “This program responds to requests from municipalities, state and federal legislators, county and state government officials, and private residents to investigate flood problems within the Commonwealth of Pennsylvania and determine the feasibility of providing a solution to these flood problems. The program considers long term structural solutions to a community's flood problem by evaluating the magnitude and frequency of flooding, performing a hydrologic and hydraulic analysis, evaluating flood protection alternatives, estimating construction costs, assessing environmental impacts, performing an economic analysis, determining local sponsor responsibilities, and designing and constructing the project.”

Nonpoint Source Implementation Program (Section 319) – This program provides funding to assist in implementing PA’s Nonpoint Source Management Program. This includes funding for abandoned mine drainage, agricultural and urban run-off, and natural channel design/stream bank stabilization projects, as well as for development of watershed-based restoration plans.

Act 13 Impact Fee (Oil and Gas Act 13 of 2012) – Impact fees support county conservation districts, the Pennsylvania Fish and Boat Commission, PUC, DEP, PEMA, the Pennsylvania Office of State Fire Commissioner, and PennDOT to address statewide issues and local municipalities to address water, wastewater, and road infrastructure maintenance and improvements; emergency preparedness; environmental programs; tax reductions; increased safe/affordable housing; employee training; or planning initiatives.

Department of Conservation and Natural Resources (DNCR)

Community Conservation Partnership Program – DCNR provides a wide range of technical assistance and grants for land acquisition, park rehabilitation and development, and small community development projects.

Pennsylvania Rivers Conservation Program – DCNR administers this program to provide technical and financial assistance to municipalities and river support groups to carry out planning, implementation, acquisition, and development activities to preserve and enhance river resources. Grants can be used for planning, implementation, development, and acquisition.

State Conservation Commission (SCC)

Dirt and Gravel Road Maintenance Program – The SCC receives an annual apportionment from the Commonwealth to administer this program, which provides funding for the maintenance and improvement of dirt and gravel roads. The SCC allocates monies to county conservation districts to assist with implementing the program at the local level. Grants are awarded to municipalities and state agencies that maintain dirt and gravel roads to carry out environmentally sound maintenance practices to correct pollution problems related to the roadway.

Local

Several of the programs under the HMA program as well as several of the other above state programs require a local match component. If funding is not obtained through other state or federal grant programs, often local municipalities use their own funds to provide the match. Mitigation resources from the local level are limited to funds generated from local taxes permitted by state enabling legislation and/or proceeds from the issuance or floating of local municipal bonds. Political and economic constraints have strongly discouraged local officials from seriously consider this financing alternative for mitigation activities in the past. It will also likely continue to be a deterrent in the future. Consequently, most, if not all, local entities rely on funding available from the Federal and/or state government. However, if local communities cannot provide direct funds for hazard mitigation, they often will provide staff time for projects or plan development.

Penn State Extension and County Conservation Districts are also valuable local resources. 66 of the 67 Pennsylvania counties have County Conservation Districts, which provide technical assistance to municipalities and residents and administer laws and regulations for PA DEP, PA Department of Agriculture, and the State Conservation Commission.

Private Sector and Non-Profit

Private sector and non-profit sector financing of mitigation activity typically occurs through land trusts, conservancy groups, and certain foundations whose focus is preserving natural areas such as floodplains, wetlands, farmland, viewsheds, and other valuable land areas. Important groups that provide technical assistance to counties and municipalities include:

- County Commissioners Association of Pennsylvania
- League of Cities and Municipalities
- Pennsylvania State Association of Township Supervisors (PSATS)
- Pennsylvania State Association of Boroughs (PSAB)
- Pennsylvania Association of Conservation Districts (PACD

There are numerous other land conservancies, watershed organizations, and foundations that provide technical assistance and assist municipalities with mitigation projects. Because these funding sources have a wide array of eligibility requirements and project specifications, they are not all enumerated individually in this plan.

There are several other state programs that provide funding and technical assistance; these additional programs are described in Table 5.5-1

In addition, there are potential sources of state funding including the Growing Greener program which in the past has provided millions of dollars in grants to fund various environmental projects to clean up rivers and streams; protect natural areas, open spaces and working farms; and shore up key programs to improve quality of life and revitalize communities across the Commonwealth. The Act 167 program funding, *when available*, has been used to reimburse counties up to 75% of the costs to prepare storm water management plans. Greenway Planning is an additional way to implement projects that improve natural resources and accommodate flooding.

5.3.4. Development and Construction Management Capability

In Pennsylvania, local municipalities regulate development and construction. They do this by adopting zoning ordinances, floodplain ordinances, and subdivision and land development ordinances and by granting building permits only after verifying that development proposals are consistent with these documents. Local municipalities have several effective tools at their disposal to address development and construction in hazard prone areas. These tools are discussed below.

Regarding regulation of development, in 1968, Pennsylvania passed the Pennsylvania Municipalities Planning Code Act, P.L. 805, No. 247 (Act 247) which granted authority to boroughs, townships, and counties to individually or jointly prepare zoning, subdivision, land development, floodplain management and other ordinances, and official zoning maps. Through local ordinances, municipalities can guide growth and minimize development in hazard prone areas. However, municipalities often grant variances, waivers, or special exceptions to regulations and ordinances on a case by case basis if requested by a permit or development applicant. The opportunity for improvement is to increase the number of municipalities that effectively implement the regulations and choose to adopt regulations that exceed minimum standards.

Zoning ordinances allow for local communities to regulate the use of land in order to protect the interest and safety of the general public. Zoning ordinances can be designed to address unique conditions or concerns within a given community. They may be used to create buffers between structures and high-risk areas, limit the type or density of development, and/or require land development to consider specific hazard vulnerabilities.

Subdivision and land development ordinances are intended to regulate the development of housing, commercial, industrial or other uses, including associated public infrastructure, as land is subdivided into buildable lots for sale or future development. Within these ordinances, guidelines on how land will be divided, the placement and size of roads and the location of infrastructure can reduce exposure of development to hazard events.

Act 247 also requires counties to create and adopt a comprehensive plan and encourages municipalities to adopt municipal or joint municipal comprehensive plans generally consistent with the county comprehensive plan. Comprehensive plans promote sound land use and regional cooperation among local governments to address planning issues. These plans serve as the official policy guide for influencing the location, type, and extent of future development by establishing the basis for decision-making and review processes on zoning matters, subdivision and land development, land uses, public facilities, and housing needs over time.

To protect people and structures from flood hazards, FEMA administers the NFIP that has an objective to guide development away from high-flood risk areas. Local municipalities participate through ordinance adoption and floodplain regulation and, as a condition of community participation in the NFIP structures built within the Special Flood Hazard Area must adhere to the floodplain management regulations. FEMA Region III provides an ordinance review checklist to local communities listing 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.

Through administration of floodplain ordinances, municipalities can ensure that all new construction or substantial improvements to existing structures located in the floodplain are flood-proofed, dry-proofed, or built above anticipated flood elevations. Floodplain ordinances may also prohibit development in certain areas altogether.

The responsibility for supporting municipalities with ordinance technical assistance and updates is transitioning from DCED to PEMA. The transition is being assisted by PEMA continuing with the same contractor Leslie Rhoads, CFM supporting municipalities with ordinance updates. DCED has model floodplain ordinances posted on their website related to the CFR, Title 44, Section 60.3 level of regulations that are typical in Pennsylvania. However, adoption of level D regulations is encouraged throughout Pennsylvania communities to provide communities with the highest level of regulation typical in Pennsylvania and to facilitate future ordinance updates if maps change. The models 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 also contain provisions that exceed minimum federal requirements.

Additionally, the DRBC's Flood Advisory Committee (FAC) issued Recommendations of the DRBC Flood Advisory Committee (FAC) for More Effective Floodplain Regulations in the Delaware River Basin. These recommendations apply to all communities within Pennsylvania, New Jersey, and New York that make up the Delaware River Basin. These recommendations were made by reviewing and evaluating existing floodplain regulations in the Delaware River Basin and proposing more effective floodplain management requirements. The floodplain regulation recommendations are available on DRBC's website at http://www.state.nj.us/drbc/programs/flood/floodplainregs.html for local municipalities to utilize when drafting or updating existing floodplain management ordinances. In general, the recommendations are more restrictive than the NFIP requirements and DCED's suggested ordinance. Examples of recommendations include but are not limited to the following:

- Defining the floodplain as the 1% annual chance flood PLUS an additional 25% in flow
- Defining floodway in the Delaware River Basin as a 0.2-foot rise standard
- Requiring critical facilities to be kept outside of the 0.2% annual chance (500 year) floodplain
- Prohibiting any and all new development in the floodway
- Adopting a minimum 100' vegetated buffer along all waterways in the Delaware River Basin
- Requiring new or substantially improved residential, institutional, and commercial structures to be constructed with a two-foot freeboard above the 1% annual chance base flood elevation

Act 166 mandates municipal participation in and compliance with the NFIP for communities with SFHAs. It also establishes higher regulatory standards for hazardous materials and high-risk land uses. As new FIRMs are published, the BORM and the State NFIP Coordinator housed at DCED will work 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.

The duties of Community Assistance Contacts (CAC) and Community Assistance Visits (CAV) are planned to transfer from DCED to PEMA. In the last five years, DCED has completed 1 CAV, 3 CACs, and provided general technical assistance 2,611 times. These statistics are planned to increase with the added capacity of NFIP management planned for BORM; CAVs are targeted at 5-10 annually and CACs and general technical assistance is also anticipated to increase. FEMA completed 56 CAVs, 9 CACs, and provided general technical assistance 4,560 times in Pennsylvania during the same period of time. Twenty additional CACs were completed by an agency other than DCED and FEMA. DCED's 2,611 general technical assistance incidents reached 1,989 communities and approximately 20 percent of that assistance pertained to floodplain management ordinance support. The following table provides detail on the location and number of CACs and CAVs for Pennsylvania during the 5-year period between SHMP updates.

Table 5.3-1 Total CACs and CAVs in Pennsylvania from January 1, 2013 to May 20, 2018 (CIS, 2018).

Community	CAC	CAV	Total
ABINGTON, TOWNSHIP OF	0	1	1
ALLENTOWN, CITY OF	0	1	1
AMBLER, BOROUGH OF	1	1	2
ATHENS, BOROUGH OF	0	1	1
BEAR CREEK, TOWNSHIP OF	2	0	2
BETHEL, TOWNSHIP OF	0	1	1
BETHLEHEM, CITY OF	0	1	1
BLOOMSBURG, TOWN OF	0	1	1
BRISTOL, TOWNSHIP OF	0	1	1
BROOKHAVEN, BOROUGH OF	0	1	1
BURNSIDE, BOROUGH OF	1	1	2
CANTON, BOROUGH OF	1	0	1
CARROLL VALLEY, BOROUGH OF	1	0	1
CHELTENHAM, TOWNSHIP OF	0	1	1
CONEWAGO, TOWNSHIP OF	1	0	1
CONSHOHOCKEN, BOROUGH OF	0	1	1
CRANBERRY, TOWNSHIP OF	0	1	1
DARBY, BOROUGH OF	0	1	1
DAUPHIN, BOROUGH OF	1	0	1
EAST HANOVER, TOWNSHIP OF	1	0	1
FAIRFIELD, TOWNSHIP OF	1	0	1
FALLS, TOWNSHIP OF	0	1	1
FISHING CREEK, TOWNSHIP OF	0	1	1
GREENSBURG, CITY OF	1	0	1
HALIFAX, BOROUGH OF	1	0	1
HAMILTON, TOWNSHIP OF	1	0	1
HIGHSPIRE, BOROUGH OF	1	0	1
HUMMELSTOWN, BOROUGH OF	1	0	1
JERSEY SHORE, BOROUGH OF	0	1	1
LEHIGHTON, BOROUGH OF	1	0	1
LONDONDERRY, TOWNSHIP OF	0	1	1
LOWER BURRELL, CITY OF	1	0	1
LOWER MAKEFIELD, TOWNSHIP OF	0	1	1
LOWER MERION, TOWNSHIP OF	0	1	1
LOWER MORELAND, TOWNSHIP OF	0	1	1
LOWER PROVIDENCE, TOWNSHIP OF	0	1	1
LOWER SOUTHAMPTON, TOWNSHIP OF	0	1	1
LOWER SWATARA, TOWNSHIP OF	1	0	1
LOWER WINDSOR, TOWNSHIP OF	0	1	1

Table 5.3-1 Total CACs and CAVs in Pennsylvania from January 1, 2013 to May 20, 2018 (CIS, 2018).

Community	CAC	CAV	Total
MEHOOPANY, TOWNSHIP OF	1	0	1
MESHOPPEN, BOROUGH OF	1	0	1
MIDDLETOWN, BOROUGH OF	0	1	1
MIDDLETOWN, TOWNSHIP OF	0	1	1
MILLVALE, BOROUGH OF	1	1	2
MOUNT JOY, TOWNSHIP OF	1	0	1
NEW CASTLE, CITY OF	0	1	1
NEW HOPE, BOROUGH OF	0	1	1
NEW KENSINGTON, CITY OF	1	0	1
OIL CITY, CITY OF	0	1	1
OLYPHANT, BOROUGH OF	0	1	1
PHILADELPHIA, CITY OF	0	1	1
PIATT, TOWNSHIP OF	0	1	1
PITTSBURGH, CITY OF	1	1	2
PLUMSTEAD, TOWNSHIP OF	0	1	1
PLYMOUTH, TOWNSHIP OF	0	1	1
PORTER, TOWNSHIP OF	0	1	1
RADNOR, TOWNSHIP OF	0	1	1
REED, TOWNSHIP OF	1	0	1
SALEM, TOWNSHIP OF	1	0	1
SILVER SPRING, TOWNSHIP OF	1	0	1
SNOW SHOE, BOROUGH OF	0	1	1
SOLEBURY, TOWNSHIP OF	0	1	1
SOUTH FAYETTE, TOWNSHIP OF	0	1	1
SOUTH GREENSBURG, BOROUGH OF	1	0	1
SOUTH WHITEHALL, TOWNSHIP OF	0	1	1
SOUTHWEST GREENSBURG, BOROUGH OF	1	0	1
ST. CLAIR, BOROUGH OF	1	0	1
TINICUM, TOWNSHIP OF	0	1	1
UPLAND, BOROUGH OF	0	1	1
UPPER BURRELL, TOWNSHIP OF	1	0	1
UPPER DARBY, TOWNSHIP OF	0	1	1
UPPER DUBLIN, TOWNSHIP OF	0	1	1
UPPER GWYNEDD, TOWNSHIP OF	0	1	1
UPPER MAKEFIELD, TOWNSHIP OF	0	1	1
UPPER MORELAND, TOWNSHIP OF	0	1	1
WARMINSTER, TOWNSHIP OF	0	1	1
WARRINGTON, TOWNSHIP OF	0	1	1
WARWICK, TOWNSHIP OF	0	1	1
WASHINGTON, TOWNSHIP OF	1	0	1
WEST NORRITON, TOWNSHIP OF	0	1	1
WHITEHALL, TOWNSHIP OF	0	1	1
WHITEMARSH, TOWNSHIP OF	0	1	1
WILLIAMSTOWN, BOROUGH OF	1	0	1
YARDLEY, BOROUGH OF	0	1	1
TOTAL	**33**	**56**	**89**

Municipalities can also participate in the NFIP's CRS program. Community participation in this program can provide premium reductions for properties located outside of Special Flood Hazard Areas of up to 10% and reductions for properties located in Special Flood Hazard Areas of up to 45%. These discounts can be obtained by undertaking public information, mapping and regulations, flood damage reduction, and flood preparedness activities.

The Commonwealth also has policies to regulate construction standards for new construction and substantially renovated buildings. Building codes regulate construction standards for new construction and substantially renovated buildings. Standards can be adopted that require resistant or resilient building design practices to address hazard impacts common to a given community.

In 2004, the Commonwealth of Pennsylvania implemented Act 45 of 1999, the UCC, a comprehensive building code that establishes minimum regulations for most new construction, including additions and renovations to existing structures. In 2017, new Acts 35 and 36 went into effect adopting the 2009 International Codes issued by the International Code Council (ICC) and certain provisions from the 2015 International Codes. Municipalities are required to adhere to the UCC and enforce building code regulations for all building permits. According to Pennsylvania DLI, more than 90% of Pennsylvania municipalities administer and enforce the UCC at a local level. DLI has no code enforcement authority in these jurisdictions. However, DLI is responsible for commercial code enforcement in any municipality that has elected to not administer the UCC locally. For residential code enforcement in jurisdictions that do not locally administer the UCC, a certified third-party agency must be hired by the property owner or the contractor (DLI, 2018).

5.4. Local Capability Assessment

5.4.1. Status of Local Hazard Mitigation Plans

All 67 of PA's counties have or are working on CFR 44 compliant Hazard Mitigation Plans (HMPs) using a Standard Operating Guide provided by PEMA. These plans are developed in conjunction with their municipalities and coordinated with other major stakeholders within the county, such as employers, educational and health institutions, adjacent counties, and state and federal agencies. The plans expire every five years and there an average of 13 county plans under revision at any one time. The planning process normally takes 18 – 24 months from grant submission to FEMA approval. Shortages of county planning personnel and the extensive coordination requirements lead to some plans expiring before the update process is complete. PEMA closely tracks plan expiration dates because municipalities without a current plan are ineligible for HMGP funds and other forms of disaster assistance. Townships and boroughs are required to participate in the county planning process and adopt the approved county plan into be eligible for HMGP funds and other aid.

Figure 5.4-1 shows the expiration years and status of each county's HMP according to FEMA's records as of May 22, 2018. Note that this information summarizes the FEMA Region III 322 plan status table combined with contracting and Adoption Pending Approval data tracked by PEMA. This data is constantly changing as communities adopt plans and plans gain FEMA approval, but it is generally representative of the state of county-level hazard mitigation planning. Figure 5.4-2 also shows the approval status of county HMPs in Pennsylvania.

Figure 5.4-1 Pennsylvania county HMP expiration dates (FEMA, 2018).

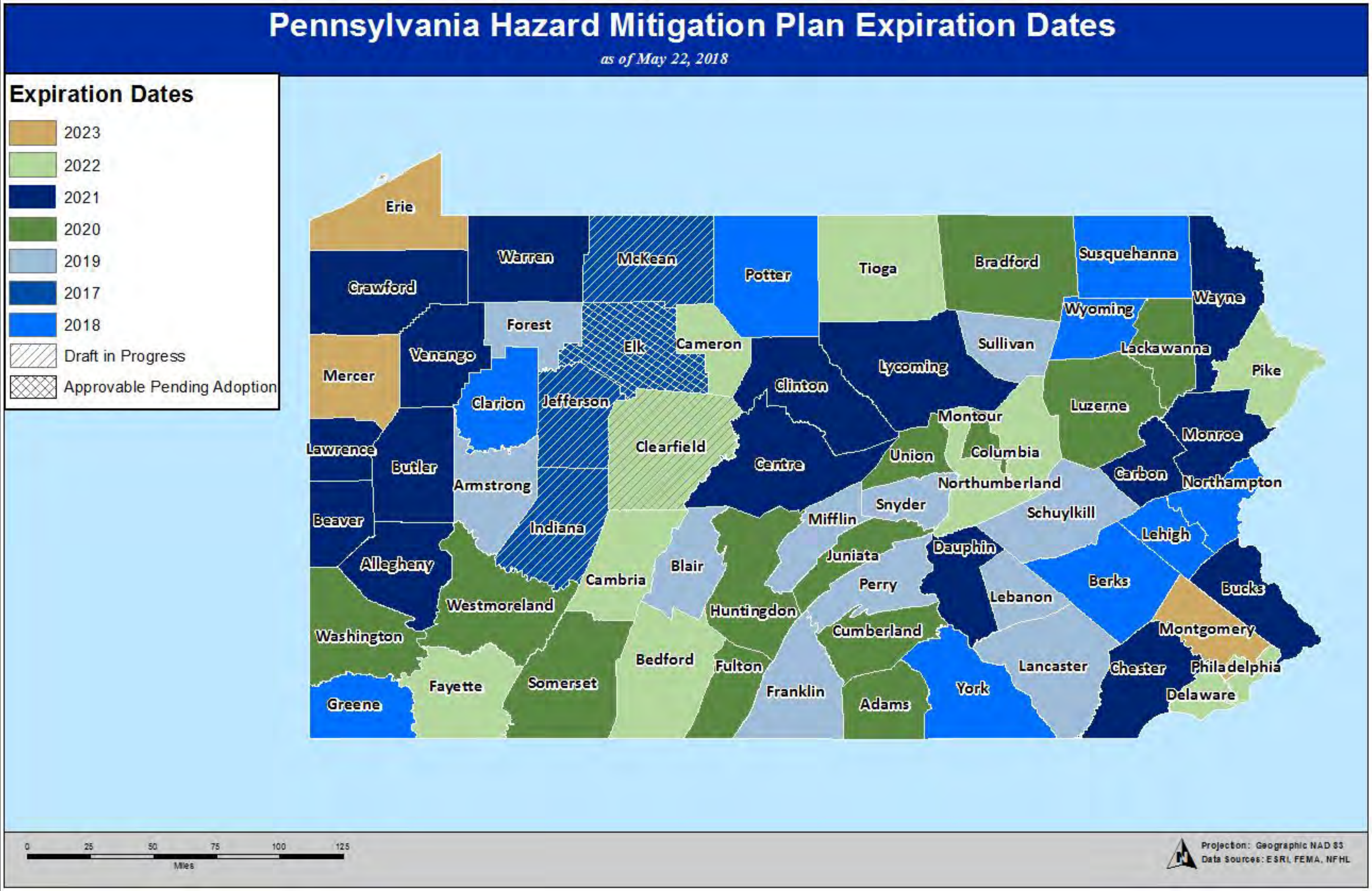
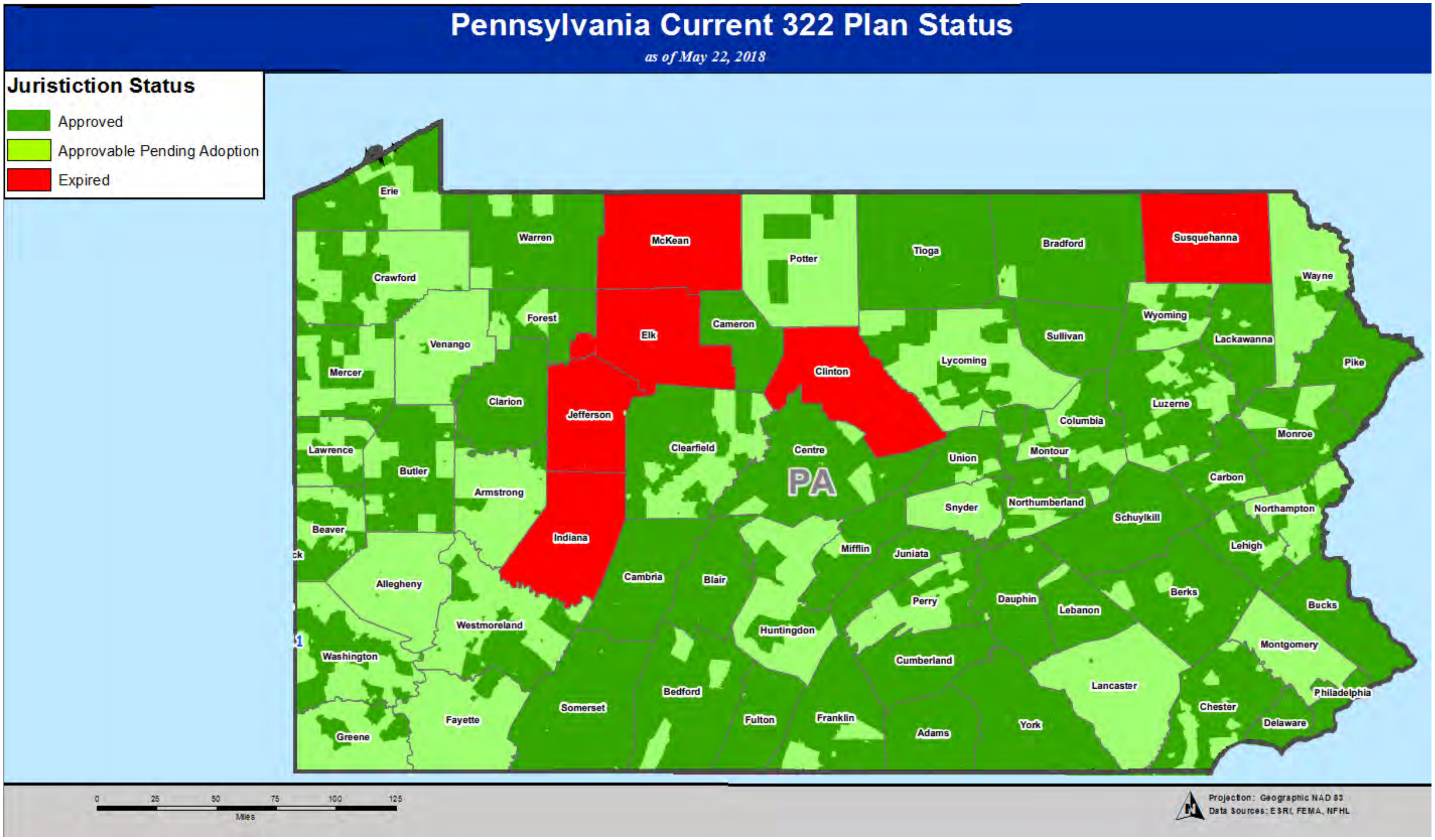


Figure 5.4-2 Status of county hazard mitigation plans in Pennsylvania (FEMA, 2018).



In addition to local HMPs, there are a number of university HMPs in Pennsylvania (Table 5.4.1-1). These plans were done for the member institutions of the Pennsylvania State System of Higher Education (PASSHE) through one contract funded with FEMA PDM grant funds.

Those colleges and universities that have not chosen to develop their own HMP are encouraged to participate in the hazard mitigation planning process of their respective counties. Both public and private universities have been participating in county HMPs. Staff from Millersville University participated in the 2018 SHMP. University participation in hazard mitigation planning efforts will continue to be important moving forward, especially as universities have a greater role in community emergency response. For instance, East Stroudsburg and West Chester Universities were shelters during Hurricane Sandy.

Table 5.4.1-1 University hazard mitigation plan status (FEMA, 2018).

UNIVERSITY	APPROVAL DATE
Bloomsburg	May 2016
California	March 2016
Cheyney	April 2016
Clarion	May 2016
East Stroudsburg	September 2015
Edinboro	February 2016
Indiana	March 2016
Kutztown	May 2016
Lock Haven	May 2016
Mansfield	May 2016
Millersville	May 2016
Shippensburg	May 2016
Slippery Rock	May 2016
West Chester	May 2016
Dixon University Center	May 2016

5.4.2. Summary & Evaluation of Local Mitigation Capability

Pennsylvania continues to strive to improve hazard mitigation capabilities and the ability to evaluate the effectiveness of local mitigation policies, programs, and capabilities. Local mitigation capabilities include not only the traditional execution of hazard mitigation projects, but also hazard mitigation planning (as discussed in Section 5.4.1), participation in the NFIP and CRS, Act 167 Plans, and county-level greenway and open space planning.

Historically, the evaluation of local mitigation capabilities has been challenging due to inconsistent planning methods and the lack of standard tracking and reporting processes. Local mitigation project information is often missing or incomplete and information regarding local policies and programs pertaining to mitigation has not always been well documented.

The most effective way to obtain these improvements has been realized through the development of the SOG. The SOG, described in much greater detail in Section 6.3.1.2, contains a Capability Assessment Survey along with a Model Plan Outline. These two tools, when used together, ensure that appropriate information pertaining to local capabilities is collected and reported completely and consistently.

The Capability Assessment Survey is to be completed by county and municipal officials and contains questions about specific information pertaining to planning, regulatory, administrative, technical, fiscal, and political capabilities. The Model Plan Outline prompts users to enter the information into the plan regarding the following areas of hazard mitigation capability:

- Emergency Management
- Participation in the NFIP
- Planning and Regulatory Capability
- Administrative and Technical Capability
- Fiscal Capability
- Political Capability
- Self-Assessment
- Existing Limitations

This information is then input into the local HMP, which not only improves Pennsylvania's ability to evaluate the effectiveness of local mitigation capabilities, it greatly increases local planning capabilities by simplifying, streamlining, and standardizing the hazard mitigation planning process.

There have been a number of successful mitigation projects in Pennsylvania. These include efforts to mitigate the extensive damages caused by flooding throughout the Commonwealth. Flooding is by far the most extensive hazards in Pennsylvania. PEMA is very active in mitigation efforts, especially those concerning flooding. A majority of these efforts have been through the acquisition and demolition of structures in floodplains. This effort is considered the most advantageous flood mitigation project as it completely removes the potential for flooding of homes or property. Additionally, there have been other significant mitigation efforts to reduce the vulnerability to flooding.

Currently, local capability information that is tracked on a federal or state level can be evaluated and reported most effectively. As stated in Section 4.1, flooding poses the highest risk to Pennsylvania communities and therefore flood-related capabilities are of the utmost importance. Participation in the NFIP provides one mechanism for assessing flood hazard mitigation capabilities.

All 67 Pennsylvania counties have most of their municipalities participating in the NFIP, with a total of 97% of all municipalities participating. Table 5.4.2-1 below provides a list of counties with the corresponding number of jurisdictions and the percentage participating in the NFIP. Of Pennsylvania's 67 counties, 25 have 100% jurisdictional participation in the NFIP. Only two counties have less than 90% participation in the NFIP; Clarion and Armstrong Counties with 88 and 87 percent participation, respectively. It is important to note that many communities in

Pennsylvania do not participate in the NFIP program because they have no designated Special Flood Hazard Areas (SFHAs) in their jurisdictions.

The NFIP is managed by local municipalities participating in the program through ordinance adoption and floodplain regulation, and often the county planning and/or zoning department provides an oversight and coordination role.

Table 5.4.2-1 Community participation in the NFIP (FEMA, 2018).

COUNTY	TOTAL NO. OF JURISDICTIONS	NO. OF JURISDICTIONS PARTICIPATING IN NFIP	PERCENT OF JURISDICTIONS PARTICIPATING IN NFIP	NO. OF NON-PARTICIPATING JURISDICTIONS	NO. OF SUSPENDED JURISDICTIONS
Adams	34	33	97%	1	0
Allegheny	130	129	99%	1	0
Armstrong	46	40	87%	5	1
Beaver	54	53	98%	0	1
Bedford	38	38	100%	0	0
Berks	75	73	97%	2	0
Blair	24	24	100%	0	0
Bradford	51	49	96%	1	1
Bucks	53	49	92%	4	0
Butler	57	52	91%	5	0
Cambria	63	58	92%	5	0
Cameron	7	7	100%	0	0
Carbon	23	23	100%	0	0
Centre	35	34	97%	0	1
Chester	74	72	97%	2	0
Clarion	34	30	88%	4	0
Clearfield	50	48	96%	2	0
Clinton	29	29	100%	0	0
Columbia	33	33	100%	0	0
Crawford	51	51	100%	0	0
Cumberland	32	32	100%	0	0
Dauphin	40	39	98%	1	0
Delaware	49	48	98%	0	1
Elk	12	12	100%	0	0
Erie	38	35	92%	1	2
Fayette	43	40	93%	3	0
Forest	9	9	100%	0	0
Franklin	22	21	95%	1	0
Fulton	13	12	92%	1	0
Greene	26	24	92%	1	1

Table 5.4.2-1 Community participation in the NFIP (FEMA, 2018).					
COUNTY	TOTAL NO. OF JURISDICTIONS	NO. OF JURISDICTIONS PARTICIPATING IN NFIP	PERCENT OF JURISDICTIONS PARTICIPATING IN NFIP	NO. OF NON-PARTICIPATING JURISDICTIONS	NO. OF SUSPENDED JURISDICTIONS
Huntingdon	48	43	90%	4	1
Indiana	38	36	95%	2	0
Jefferson	34	33	97%	1	0
Juniata	17	17	100%	0	0
Lackawanna	40	40	100%	0	0
Lancaster	60	58	97%	2	0
Lawrence	26	25	96%	1	0
Lebanon	26	25	96%	1	0
Lehigh	25	25	100%	0	0
Luzerne	76	75	99%	1	0
Lycoming	52	52	100%	0	0
Mckean	22	21	95%	1	0
Mercer	48	46	96%	2	0
Mifflin	16	15	94%	1	0
Monroe	20	20	100%	0	0
Montgomery	62	61	98%	1	0
Montour	11	11	100%	0	0
Northampton	37	37	100%	0	0
Northumberland	36	33	92%	2	1
Perry	30	29	97%	1	0
Philadelphia	1	1	100%	0	0
Pike	13	13	100%	0	0
Potter	31	31	100%	0	0
Schuylkill	67	67	100%	0	0
Snyder	21	21	100%	0	0
Somerset	49	45	92%	4	0
Sullivan	13	13	100%	0	0
Susquehanna	40	38	95%	0	2
Tioga	39	39	100%	0	0
Union	14	13	93%	1	0
Venango	31	29	94%	2	0
Warren	27	25	93%	2	0
Washington	65	59	91%	4	2
Wayne	28	27	96%	0	1
Westmoreland	64	59	92%	4	1

Table 5.4.2-1 Community participation in the NFIP (FEMA, 2018).					
COUNTY	**TOTAL NO. OF JURISDICTIONS**	**NO. OF JURISDICTIONS PARTICIPATING IN NFIP**	**PERCENT OF JURISDICTIONS PARTICIPATING IN NFIP**	**NO. OF NON-PARTICIPATING JURISDICTIONS**	**NO. OF SUSPENDED JURISDICTIONS**
Wyoming	23	23	100%	0	0
York	72	66	92%	6	0
TOTAL	**2,567**	**2,468**	**96%**	**83**	**16**

FEMA Region III has documented and tracked communities that adopt floodplain management ordinances that contain provisions which exceed the minimum requirements through the Mitigation Action Tracker (MAT) since 2013. The MAT lists 160 communities in nine counties that have adopted higher standards. The nine counties are Beaver, Berks, Bradford, Chester, Lancaster, Lycoming, Montgomery, Schuylkill, and York. It is important to note that the MAT has not captured all communities with higher standards; there are likely hundreds of other communities that have adopted higher standards as recommended in DCED's model floodplain management ordinance. Higher standards documented in the model ordinances that DCED provides to communities are described below. The majority of municipalities have incorporated a freeboard requirement and prohibit any new construction or development within the area measured 50 feet landward from the top-of-bank of any watercourse.

1. **Community Identified Flood Hazard Areas:** shall be those areas that the municipality identified local flood hazard or ponding areas, as delineated and adopted on a "Local Flood Hazard Map" using best available topographic data and locally derived information such as flood of record, historic high water marks, soils or approximate study methodologies.

2. **Conservation District Review**: A copy of all applications and plans for any proposed construction or development in any identified floodplain area to be considered for approval shall be submitted by the Floodplain Administrator to the County Conservation District for review and comment prior to the issuance of a Permit. The recommendations of the Conservation District shall be considered by the Floodplain Administrator for possible incorporation into the proposed plan.

3. **Fill Prohibited**: Within any Identified Floodplain Area the use of fill shall be prohibited.

4. **Freeboard:** Establishes a freeboard safety factor (usually 1.5 feet) in addition to the requirement to elevate and floodproof to the regulatory base flood elevation (BFE).

5. **Manufactured Homes Prohibited in the Floodway.**

6. **Manufactured Homes Prohibited in any SFHA.**

7. **Manufactured Homes Prohibited – 50 ft. Buffer:** Within any Identified Floodplain Areas, manufactured homes shall be prohibited within the area measured 50 feet landward from the top-of-bank of any watercourse.

8. **New Construction Prohibited in the Floodway.**

9. **New Construction – 50 ft. Buffer:** Within any SFHA, no new construction or development shall be located within the area measured 50 feet landward from the top-of-bank of any watercourse.

10. **No Enclosures:** Prohibits fully enclosed spaces (excluding basements) below the base flood elevation with any new and substantially improved structures.

11. **Recreational Vehicles Prohibited in the Floodway.**

12. **Recreational Vehicles Prohibited in any SFHA.**

13. **Repetitive Loss Review:** In the case of existing structures, prior to the issuance of any Development/Permit, the Floodplain Administrator shall review the history of repairs to the subject building, so that any repetitive loss issues can be addressed before the permit is issued.

14. **Less than 50%:** Any modification, alteration, reconstruction, or improvement of any kind to an existing structure, to an extent or amount of less than 50% of its market value, shall be elevated and/or floodproofed to the greatest extent possible.

15. **Special Permits Prohibited:** Activities within the SFHA requiring special permits are prohibited including the construction or expansion of hospitals, nursing homes, jails/prisons, or manufactured home parks/subdivisions.

16. **Substances Prohibited:** Any new or substantially improved structure which will be used for the production, or storage, or will require the maintenance of a supply of more than 550 gallons of any of the substances identified as dangerous to human life, are prohibited in the SFHA.

17. **Substances Prohibited – 50 ft. Buffer:** Any new or substantially improved structure which will be used for the production, or storage, or will require the maintenance of a supply of more than 550 gallons of any of the substances identified as dangerous to human life, are prohibited within the area measured 50 feet landward from the top-of-bank of any watercourse.

18. **Smaller Subdivisions:** Subdivision proposals and development proposals containing at least 50 lots or at least five acres, whichever is the lesser, within the SFHA where elevation data are not available, shall be supported by hydrologic and hydraulic engineering analyses that determine the BFE and floodway.

19. **Prohibitive:** Prohibits new development and substantial improvements except by variance.

Currently there are a total of 16 jurisdictions in the Commonwealth which have been suspended from the NFIP. These communities are listed in Table 5.4.2-2. Suspension results after a community has been found to no longer be in compliance with NFIP requirements. Suspended communities are subject to sanctions for non-participating communities and flood insurance is not available to residents. A probation period precedes suspension during which time the community is formally notified that its floodplain management program is non-compliant. Sanctions during the probationary period include increased flood insurance premiums for property owners. There are no communities on probation as of May 2018. All 16 community suspensions were due to a failure to adopt a compliant floodplain management ordinance.

Table 5.4.2-2 Communities Suspended from the NFIP.

COUNTY	COMMUNITY NAME	SUSPENSION DATE
Armstrong	BURRELL, TOWNSHIP OF	02/18/2016
Beaver	GEORGETOWN, BOROUGHS OF	08/17/2015
Bradford	ROME, TOWNSHIP OF	10/17/2014
Centre	SNOW SHOE, BOROUGH OF	05/07/2009
Delaware	RUTLEDGE, BOROUGH OF	11/25/2009
Erie	LAWRENCE PARK, TOWNSHIP OF	06/08/2017
Erie	WESLEYVILLE, BOROUGH OF	02/20/2014
Greene	CARMICHAELS, BOROUGH OF	10/19/2015
Huntingdon	MORRIS, TOWNSHIP OF	12/04/1985
Northumberland	WEST CAMERON, TOWNSHIP OF	07/17/2008
Susquehanna	JACKSON, TOWNSHIP OF	04/03/2013
Susquehanna	UNIONDALE, BOROUGH OF	07/05/1993
Washington	LONG BRANCH, BOROUGH OF	10/01/2015
Washington	NORTH BETHLEHEM, TOWNSHIP OF	10/01/2015
Wayne	PROMPTON, BOROUGH OF	05/17/2013
Westmoreland	YOUNGSTOWN, BOROUGH OF	08/05/1997

Community participation in the NFIP allows property owners to obtain flood insurance. Flood insurance provides a means for homeowners, renters, and business owners to financially protect themselves. This capability greatly improves resilience after a flood hazard event by allowing residents to repair and rebuild. Table 5.4.2-3 provides a list of counties with the number of flood insurance policies that exist in that county. Since the last HMP update, the number of flood insurance policies in Pennsylvania has decreased by a staggering 24%, from 74,665 to 56,822. Every county in the Commonwealth has fewer flood insurance policies since 2013 except for Armstrong and Erie Counties, which show 7% and 1% increases in number of policies, respectively. Lycoming County has the largest percent decrease at 52%, which could be partially explained by mitigation, with several homes being acquired or elevated and no longer needing flood insurance, or by the fact that the county experienced a decrease in Zone A area as part of the 2016 FIRM update. In general, a decrease in the number of flood insurance policies in Pennsylvania suggests decreased recovery capabilities and an increase in flood vulnerability.

Table 5.4.2-3 NFIP policies and total dollar amount of coverage per county and percent change in the number of policies since 2013 (FEMA, May 2018).

COUNTY	NUMBER OF NFIP POLICIES	TOTAL COVERAGE ($)	% CHANGE IN NUMBER OF NFIP POLICIES SINCE 2013
Adams	486	$102,016,500	-19%
Allegheny	3,613	$892,617,400	-11%
Armstrong	597	$78,421,700	7%
Beaver	403	$76,886,200	-21%
Bedford	438	$52,747,800	-35%
Berks	1,039	$253,707,500	-20%
Blair	909	$140,247,200	-29%
Bradford	639	$125,338,800	-25%
Bucks	3,896	$1,044,199,000	-20%
Butler	537	$101,398,200	-20%
Cambria	791	$135,580,600	-33%
Cameron	134	$13,920,300	-29%
Carbon	236	$39,171,600	-31%
Centre	366	$64,745,000	-28%
Chester	1,480	$379,422,600	-22%
Clarion	112	$21,537,400	-11%
Clearfield	408	$53,555,200	-16%
Clinton	522	$62,110,600	-44%
Columbia	869	$138,355,200	-34%
Crawford	538	$93,722,300	-23%
Cumberland	1,060	$212,439,900	-25%
Dauphin	2,394	$500,675,800	-32%
Delaware	1,907	$464,398,700	-22%
Elk	185	$28,021,100	-17%
Erie	527	$124,348,400	1%
Fayette	455	$78,016,100	-7%
Forest	36	$4,961,400	-18%
Franklin	330	$69,240,400	-21%
Fulton	36	$5,156,800	-10%
Greene	148	$23,374,500	-5%
Huntingdon	411	$48,759,000	-30%
Indiana	340	$49,645,000	-21%
Jefferson	293	$49,282,900	-11%
Juniata	174	$19,003,100	-36%
Lackawanna	983	$168,185,900	-24%
Lancaster	1,197	$260,310,900	-16%
Lawrence	252	$42,679,600	-14%
Lebanon	442	$95,251,500	-27%
Lehigh	710	$160,303,400	-19%
Luzerne	6,613	$1,703,275,900	-25%
Lycoming	1,252	$180,590,300	-52%

Table 5.4.2-3 NFIP policies and total dollar amount of coverage per county and percent change in the number of policies since 2013 (FEMA, May 2018).

COUNTY	NUMBER OF NFIP POLICIES	TOTAL COVERAGE ($)	% CHANGE IN NUMBER OF NFIP POLICIES SINCE 2013
McKean	265	$37,915,500	-22%
Mercer	145	$31,241,500	-1%
Mifflin	479	$50,929,400	-37%
Monroe	541	$141,298,800	-13%
Montgomery	3,710	$992,853,700	-24%
Montour	164	$32,704,900	-29%
Northampton	947	$209,752,000	-16%
Northumberland	863	$147,057,700	-42%
Perry	352	$48,591,500	-28%
Philadelphia	3,837	$936,177,800	-12%
Pike	303	$77,503,000	-22%
Potter	237	$26,016,400	-31%
Schuylkill	912	$115,722,500	-32%
Snyder	347	$51,698,000	-35%
Somerset	457	$67,433,700	-33%
Sullivan	75	$12,952,900	-38%
Susquehanna	341	$52,955,200	-28%
Tioga	287	$42,206,400	-21%
Union	492	$68,503,200	-43%
Venango	230	$37,366,900	-6%
Warren	270	$41,668,600	-13%
Washington	856	$154,242,700	-15%
Wayne	264	$62,146,700	-22%
Westmoreland	1,159	$215,145,300	-19%
Wyoming	342	$68,404,200	-29%
York	1,189	$248,877,000	-19%
Total	**56,882**	**$12,128,987,200**	**-24%**

Appendix K includes policies and coverage by municipality. There are 10 municipalities in Pennsylvania that have over 100 million dollars in coverage shown in the table below. These municipalities represent nearly 24% of the NFIP coverage in the Commonwealth.

Table 5.4.2-4 NFIP policies and total dollar amount of coverage for municipalities with greater than $100 million in coverage (FEMA, May 2018).

COUNTY	MUNICIPALITY	NUMBER OF NFIP POLICIES	TOTAL COVERAGE ($)
Allegheny	PITTSBURGH, CITY OF	436	$175,292,500
Bucks	BRISTOL, TOWNSHIP OF	572	$134,184,200
Dauphin	HARRISBURG, CITY OF	839	$205,227,800
Luzerne	FORTY FORT, BOROUGH OF	689	$186,962,800
Luzerne	HANOVER, TOWNSHIP OF	453	$104,790,600
Luzerne	KINGSTON, BOROUGH OF	1,979	$562,208,900

Table 5.4.2-4 NFIP policies and total dollar amount of coverage for municipalities with greater than $100 million in coverage (FEMA, May 2018).			
COUNTY	**MUNICIPALITY**	**NUMBER OF NFIP POLICIES**	**TOTAL COVERAGE ($)**
Luzerne	SWOYERSVILLE, BOROUGH OF	484	$117,482,000
Luzerne	WILKES-BARRE, CITY OF	1,319	$329,303,800
Montgomery	LOWER MERION, TOWNSHIP OF	477	$129,834,800
Philadelphia	PHILADELPHIA, CITY OF	3,837	$936,177,800
	Total	**7,135**	**$2,881,465,200**

The NFIP's CRS is a voluntary incentive program that recognizes and encourages community floodplain management activities that exceed the minimum NFIP requirements. Participation in this program results in discounted flood insurance premium rates that reflect the reduced flood risk resulting from the additional actions taken. Table 5.4.2-5 summarizes the number of credit points associated with each corresponding CRS class.

Table 5.4.2-5 CRS classes and associated credit points.			
CRS CLASS	**CREDIT POINTS**	**PREMIUM REDUCTION SFHA**	**PREMIUM REDUCTION NON-SFHA**
1	4500+	45%	10%
2	4,000-4,499	40%	10%
3	3,500-3,999	35%	10%
4	3,000-3,499	30%	10%
5	2,500-2,999	25%	10%
6	2,000-2,499	20%	10%
7	1,500-1,999	15%	5%
8	1,000-1,499	10%	5%
9	500-999	5%	5%
10	0-499	0	0

Currently, 23 of Pennsylvania's 2,576 municipalities are participating in CRS. Brookhaven and Danville Boroughs and Lower Makefield and Warwick Townships are relatively new to the program, joining since the last HMP update. It is important to note that while a small number of Pennsylvania municipalities participate in CRS, participation in the program nationwide is generally low. Nationwide there are only 1,407 communities participating in CRS with an average of 28 communities per state. Within FEMA Region III, there are a total of 85 communities participating in CRS, or an average of 17 communities per state. Table 5.4.2-6 below provides additional details about the community participation in the CRS program and average savings for property owners.

Table 5.4.2-6 Jurisdictional participation in FEMA's CRS program and average policy savings (FEMA, 2018).					
JURISDICTION	**COUNTY**	***CRS CLASS**	**NUMBER OF POLICIES**	**TOTAL SAVINGS ($)**	**AVERAGE SAVINGS PER POLICY ($)**
ETNA, BOROUGH OF	ALLEGHENY	7	182	14,648	80
SHALER, TOWNSHIP OF	ALLEGHENY	8	153	14,394	94
UPPER ST. CLAIR, TOWNSHIP OF	ALLEGHENY	7	74	4,660	63
BEDFORD, TOWNSHIP OF	BEDFORD	9	54	4,305	80
ALTOONA, CITY OF	BLAIR	8	144	8,303	58
LOWER MAKEFIELD, TOWNSHIP OF	BUCKS	7	334	20,954	63
WARWICK, TOWNSHIP OF	BUCKS	7	54	2,201	41
BLOOMSBURG, TOWN OF	COLUMBIA	8	302	23,667	78
HARRISBURG, CITY OF	DAUPHIN	7	839	119,640	143
BROOKHAVEN, BOROUGH OF	DELAWARE	9	24	2,256	94
HANOVER, TOWNSHIP OF	LUZERNE	9	1319	66,066	50
KINGSTON, BOROUGH OF	LUZERNE	9	453	19,464	43
WILKES-BARRE, CITY OF	LUZERNE	6	1979	58,607	30
JERSEY SHORE, BOROUGH OF	LYCOMING	8	197	11,356	58
GRANVILLE, TOWNSHIP OF	MIFFLIN	9	47	2,181	46
LEWISTOWN, BOROUGH OF	MIFFLIN	8	174	9,070	52
DANVILLE, BOROUGH OF	MONTOUR	8	130	8,649	67
HERNDON, BOROUGH OF	NORTHUMBERLAND	8	198	10,317	52
MILTON, BOROUGH OF	NORTHUMBERLAND	7	16	754	47
NORTHUMBERLAND, BOROUGH OF	NORTHUMBERLAND	8	198	18,793	95
SUNBURY, CITY OF	NORTHUMBERLAND	8	20	988	49
UPPER AUGUSTA, TOWNSHIP OF	NORTHUMBERLAND	8	48	3,136	65
NEWPORT, BOROUGH OF	PERRY	8	53	3,606	68
CHAPMAN, TOWNSHIP OF	SNYDER	9	4	285	71
MONROE, TOWNSHIP OF	SNYDER	9	52	2,753	53
PENN, TOWNSHIP OF	SNYDER	7	29	1,788	62
SELINSGROVE, BOROUGH OF	SNYDER	7	153	94,85	62
LEWISBURG, BOROUGH OF	UNION	8	170	13,120	77

Table 5.4.2-7 provides estimates for non-CRS participating communities with the highest savings potential on annual flood insurance premiums should they join the program with a rating of 9 which would provide for a 5 percent discount on all policies. Given the number of flood insurance policies in Philadelphia, the city has the highest total savings potential for property owners while the City of Johnstown in Cambridge County could have the highest average savings per policy at $111.

Table 5.4.2-7 Non-CRS communities with the highest potential savings (FEMA, 2018).				
COMMUNITY	**COUNTY**	**POLICIES**	**TOTAL POTENTIAL SAVINGS ($)**	**AVERAGE POTENTIAL SAVINGS PER POLICY ($)**
City of Philadelphia	Philadelphia	3,837	176,753	46
City of Pittsburgh	Allegheny	436	48,045	110
City of Johnstown	Cambria	396	44,026	111
Bristol Township	Bucks	572	32,709	57
Susquehanna Township	Dauphin	237	24,022	101
Yardley Borough	Bucks	217	23,345	108
New Hope Borough	Bucks	234	19,848	85
Upper Darby Township	Delaware	234	19,568	84
Abington Township	Montgomery	346	18,392	53
Forty Fort Borough	Luzerne	689	18,339	27

Aside from NFIP and CRS capabilities, counties have two strong planning capabilities that relate closely to hazard mitigation planning and projects. Since many floods in Pennsylvania are caused by or exacerbated by increased storm water flow during excessive rainfall events, Act 167 Storm Water Management Plans can be an effective tool in evaluating and mitigating storm water-related flooding. Act 167 requires counties to develop storm water management plans for its watersheds and requires municipalities to adopt the plans and adopt or amend storm water management ordinances necessary to meet the requirements of their Act 167 Plan. These plans typically focus on design and construction measures that are intended to reduce the impact of more frequently occurring minor urban flooding. Storm water management plans greatly enhance mitigation capabilities needed to address flood and transportation hazards.

A number of Pennsylvania communities have taken steps to reduce their wildfire vulnerability by joining the Firewise, a program of the National Fire Protection Association. Firewise encourages local solutions for safety by involving homeowners in taking individual responsibility for preparing their homes from the risk of wildfire. Firewise is typically done on the level of the homeowners' association, not at the municipal level. Pennsylvania has 3 Firewise communities, most of which are located in the Pocono Mountains area.

Table 5.4.2-8 Pennsylvania Firewise communities.				
FIREWISE COMMUNITY	**CITY**	**POPULATION**	**YEAR JOINED**	**INVESTMENT IN REDUCING WILDFIRE RISK**
Big Bass Lake	Thornhurst	2,240	2012	$46,695
Hemlock Farms Community Association	Hawley	8,000	2006	$704,471
Penn Forest Estates Neighborhood Group	Jim Thorpe	1,136	2003	$218,697

There are 92 StormReady sites in Pennsylvania. StormReady is a NWS program to help communities with the communication and safety skills needed to save lives and property--before and during the event.

Table 5.4.2-9 Pennsylvania StormReady communities (April 2018).

STORMREADY COUNTIES			
Adams	Crawford	Lebanon	Potter
Allegheny	Cumberland	Lehigh	Schuylkill
Armstrong	Dauphin	Luzerne	Snyder
Beaver	Elk	Lycoming	Somerset
Bedford	Erie	McKean	Sullivan
Blair	Fayette	Mercer	Susquehanna
Bradford	Franklin	Mifflin	Tioga
Butler	Fulton	Monroe	Union
Cambria	Greene	Montgomery	Venango
Cameron	Huntingdon	Montour	Warren
Centre	Indiana	New Brighton	Washington
Chester	Jefferson	Northampton	Wayne
Clarion	Juniata	Northumberland	Westmoreland
Clearfield	Lackawanna	Perry	Wyoming
Clinton	Lancaster	Pike	York
Columbia			

COMMUNITIES	UNIVERSITIES	COMMERCIAL	
• Canton • Charleroi • Chippewa • Cogan House • Hamilton • Heidelberg • Hempfield Township • Millcreek • Milton Hershey School • Monica • Paradise • Pittsburgh • New Brighton • Tunkhannock • West Lebanon • York	• California University of Pennsylvania • Carnegie Mellon University • Penn State University • University of Pittsburgh • University of Pittsburgh, Greensburg	• The Boeing Company • Dorney Park/Wildwater Kingdom • Excela Health Latrobe Hospital • Frick Hospital • Hershey Entertainment Complex	• Pennsylvania Turnpike Commission • RAND Corp. • Westmoreland and Jeannette Hospital • Westmoreland Hospital • York Hospital

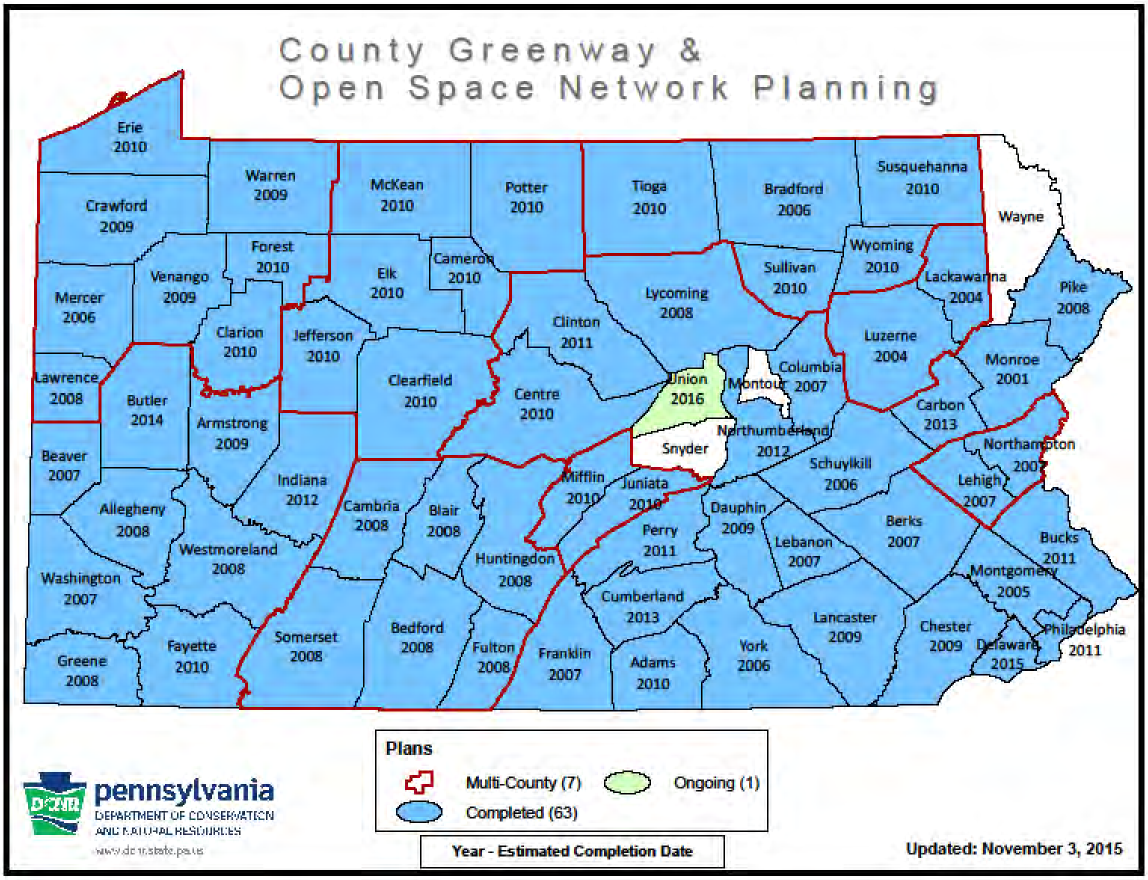
SUPPORTERS	
• Bridgestone Allentown • Bridgestone, Fredericksburg • Dickinson College • Longwood Gardens • Mountain Productions Inc • PA Emergency Management Agency • St. Christopher's Hospital for Children • Univ. of Pittsburgh, Bradford • Univ. of Pittsburgh, Johnstown • Univ. of Pittsburgh, Titusville Campus • Williamsport	Shopping Centers: • Grove City Premium Outlets • King of Prussia Mall • Lehigh Valley Mall • Montgomery Mall • Oxford Valley Mall • Philadelphia Mills • Philadelphia Premium Outlets • Ross Park Mall • South Hills Village • The Crossings Premium Outlets

Act 167 was enacted in 1978 to address storm water runoff resulting from land development which results in water pollution, soil erosion, and an increase in flooding frequency. Act 167 requires counties to prepare and adopt storm water management plans and municipalities to adopt and implement ordinances to regulate development in conjunction with these plans.

Act 167 and supporting regulations require the development of storm water management plans in an effort to promote health, safety, and welfare within the municipality and its watershed by minimizing the harms and maximizing the benefits of an effective storm water management plan. Counties must submit the plans to DEP for approval, and municipalities must enact ordinances or regulations consistent with the plans. After adoption and approval of a watershed storm water plan, the location, design and construction of storm water management systems, obstructions, flood control projects, subdivisions and major land developments, highways and transportation facilities, public utility services, and facilities owned or financed in whole or in part by funds from the commonwealth within the watershed must be conducted in a manner consistent with the watershed storm water plan (DEP Act 167, 2018)

Another key local planning mechanism that can assist with reducing vulnerability to hazards, especially natural hazards, is greenway and open space planning. Frequently, open space and greenway plans are used to preserve land in sensitive environmental areas, such as stream banks and steep slopes. While frequently focused on the recreational uses of open space and greenways, these plans also assist in hazard mitigation planning by directing development away from areas that are more hazard-prone. These plans may also work hand-in-hand with existing hazard mitigation and flood protection projects. For example, Monroe County's greenways plan helped spur the development of a trail loop along their levee system, thus ensuring that the levee system stays clear of obstructions and is properly maintained. Since properties that are acquired through HMA grants must be kept as open space in perpetuity. Figure 5.4.2-2 shows the status of greenway and open space planning in counties across Pennsylvania since the information was last updated in 2015.

Figure 5.4.2-2 County greenway and open space planning efforts (DCNR, 2015).



The following general improvements in local capability are apparent statewide:

- Improved administration resulting in better tracking, data collection and reporting, including tracking of mitigated RL and SRL properties.
- An increase in the awareness of the availability of non-disaster grants for hazard mitigation, which allows for a broader range of mitigation actions and larger project budgets.
- An increase in the use of the PEMA hazard mitigation website.
- Creation of a Projects data base.
- Plans are improving in quality and depth.

General weaknesses in local hazard mitigation capability include:

- While implementation is improving, there is still room for increased growth in implementation activities.
- Lack of local funds for cost sharing and awareness of soft match.
- Integration of hazard mitigation planning into other planning mechanisms is at cursory level in local plans.

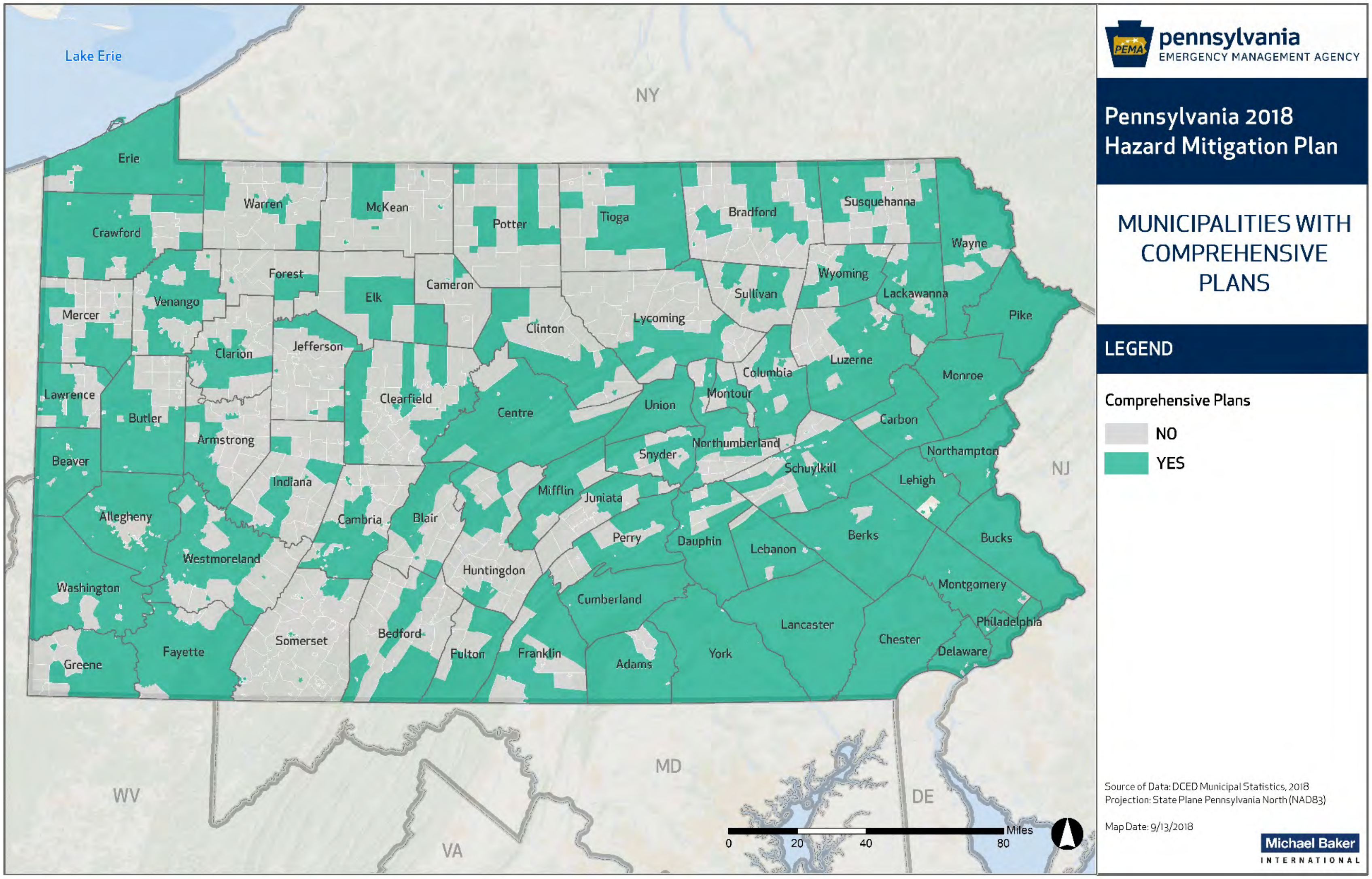
- Lack of awareness of the ability to contract SRL administration.
- Insufficient staffing.
- Lack of awareness of substantial damage in floodplain management ordinances and little or no enforcement.
- Only 15%of property owners that should have flood insurance obtain it.
- Institutional memory.

5.4.3. Local Mitigation Plan Integration

Counties have been working to integrate their hazard mitigation plans into other existing plans and documents to create more connections between land use, development, and hazard mitigation. Integration does not simply mean using other plans and documents in the development of the local mitigation plan; instead, it means that communities consistently consider hazard risk and mitigation legal and development management framework (see Section 5.3.4). According to FEMA's Integrating Hazard Mitigation into Local Planning, local integration is specific to each community. Since, in Pennsylvania, much of the land use, environmental, and development planning occurs at the local and county level; local mitigation plan integration is essential at the municipal and county level.

One of the most important local planning mechanisms is the comprehensive plan. A community's comprehensive plan establishes the framework for future growth and serves as the official policy guide for decisions about how development will be managed, where and how it will occur, and what capital improvements and public services will support it. Act 247 requires Pennsylvania counties to create and adopt a comprehensive plan and encourages municipalities to adopt municipal or joint municipal comprehensive plans generally consistent with the county comprehensive plan. As shown in Figure 5.4.3-1, Pennsylvania has a strong foundation of local comprehensive plans, with 1,742 of the state's 2,570 municipalities having adopted comprehensive plans (DCED, 2018). The Pennsylvania SOG includes a discussion of how each county can encourage the integration of hazard mitigation principles into local comprehensive plans and other local planning mechanisms.

Figure 5.4.3-1 Municipalities with comprehensive plans (PA DCED, 2018).



The Standard Operating Guide also addresses how the hazard mitigation plan will strengthen and support local planning mechanisms. Additionally, the Pennsylvania Model Plan Outline establishes integration between local planning mechanisms as a key part of local hazard mitigation plans.

5.5. State-Level Program and Plan Integration

While most planning and development in Pennsylvania occurs at the most local level, the ideas of plan integration are also important at the state level. Plan integration at the state level means that the policies, codes, plans, and programs directed from federal and Commonwealth agencies consider hazard mitigation and strive for synchronicity between and among planning efforts. This kind of plan integration will increase the success rate of hazard mitigation and can improve the overall resilience of the Commonwealth.

Plan integration at the state level includes two key components: the contributions of federal, regional, and state planning mechanisms and programs to the hazard mitigation plan, and the connections between the hazard mitigation plan and other key state-level planning processes.

5.5.1. Integration with Existing Mechanisms

At the state level, there are connections between Pennsylvania's efforts in hazard mitigation, sustainability, flood protection, and emergency management via numerous federal, state and local planning mechanisms. These mechanisms are consistent with and support the achievement of Pennsylvania hazard mitigation goals. A summary of these various mechanisms is provided in Table 5.5-1. This includes a brief assessment of how these tools are integrated into Commonwealth hazard mitigation efforts as well as FEMA mitigation programs.

The next step in plan integration is to review requirements across plans, de-conflict techniques, synchronize efforts, and finally fully integrate plans. This step is reflected in Action 4-3a: Identify statutory, regulatory or other barriers that currently exist with respect to mitigation efforts and build consensus and plan integration with partners and decision makers.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Act 537 Sewage Facilities - Planning Authorizations	DEP	24-Jan-66	Statewide	DEP provides technical assistance, financial assistance, and oversight to support municipalities in implementing the Act 537 Program to improve sewage disposal problems and prevent future problems. The leading mitigation activity associated with Act 537 is that it prevents the siting of sewage treatment facilities in sensitive areas like the floodplain, areas susceptible to landslides, and on certain kinds of soils. These planning restrictions help to reduce overall risk from a sewage break and require sewage systems to be planned, approved, and properly constructed.
CDBG Disaster Recovery Assistance	DCED	Continuous	Statewide	This program makes funding available to prevent further damage to an affected area after a disaster. The focus is on assisting communities in low-income areas. The goals of the program align with those in the SHMP, especially in regard to Pennsylvanians most at-risk. Although this program is focused on the recovery process, the leading mitigation technique for this funding program is through code enforcement and slum/blight prevention after a disaster occurs.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Commonwealth Critical Infrastructure Protection Program	Governor's Office of Homeland Security	2009	Statewide	The Critical Infrastructure Protection Program focuses on all critical infrastructure and key resources that are deemed critical to the Commonwealth. The purpose of this program is to ensure the overall preparedness of critical infrastructure/key resources by helping set security goals, identify assets, assess vulnerabilities, prioritize investments, and implement outreach programs. The information from this program is integrated into the SHMP as it is used to complete the vulnerability and loss estimates of state critical facilities. The Critical Infrastructure Program data is spatially mapped and compared to known hazards so that the SHMP identifies what Critical Infrastructure is in the floodplain or at-risk for other spatially-based hazards. This program to identify Critical Infrastructure falls clearly in two categories of mitigation techniques; it is a plans and regulations action to influence how buildings are developed and protected, and it is the first step to identifying structure and infrastructure projects that may be needed to protect the Commonwealth's Critical Infrastructure.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Comprehensive Land Use Plans	Counties, Municipalities, Regions	Varies	Varies	Governor's Executive Order 1999-1 provides the basis for integrating hazard mitigation into comprehensive and land use planning. Comprehensive land use plans define how and where a community, region, or area should be developed. Land use plans also often include an assessment and associated mapping of the respective area's vulnerability to location-specific hazards. PEMA's participation in this process assists in the integration of mitigation strategies into the goals and objectives of the land use planning process. Comprehensive plans may include many mitigation techniques, including potentially the integration of mitigation actions directly from a local hazard mitigation plan. Other leading mitigation techniques in a comprehensive plan may include steering new development away from hazard-prone areas such as floodplains and steep slopes, identifying hazard areas as opportunities for acquisition or preservation for recreation or open space purposes, and encouraging natural system preservation (such as wetlands) so that a buffer is provided between hazard areas and developed areas to help mitigate the effects of some hazards.
Comprehensive Plan for the Water Resources of the Susquehanna River Basin	Susquehanna River Basin Commission (SRBC)	June 2013	Susquehanna River Basin (Eastern and Central Pennsylvania)	This plan provides a framework for the SRBC to manage and develop the basin's water resources and serves as a guide for all SRBC programs and activities. This plan is also intended as a resource for the SRBC's member jurisdictions, water resource managers, private sector interests, and others in the basin. Flooding is a key focus of the plan, and flood damage reduction is a key program area of the SRBC. The SRBC is a member of the State Planning Team. The leading mitigation technique in this plan is Plans and Regulations and includes goals pertaining to drought impact mitigation, Flood Forecast and Warning System (SFFWS) implementation, floodplain management promotion, flood preparedness education and outreach, and interagency coordination for flood forecasting and drought emergency.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Delaware River Basin Baseline Monitoring and Characterization	DRBC	May 2010	Delaware River Basin (Eastern PA)	DRBC is collecting pre-gas drilling baseline conditions in the upper section of the Delaware River Basin. They are collecting biological samples, reanalyzing frozen samples, and deploying continuous conductivity meters in order to minimize impacts from future natural gas development and provide baseline data to contrast changing conditions if/when impacts occur. The leading mitigation technique in this plan is *Plans and Regulations* aimed at establishing existing conditions to guide regulation and permitting for natural gas development. The commissioners postponed adopting new regulations in 2011.
Delaware River Basin Interstate Flood Mitigation Task Force	DRBC	July 2007	Delaware River Basin (Eastern PA)	The Task Force establishes areas of priority funding for acquisition, elevation, flood-proofing; develops interoperable reservoir operating plan; develops and implements comprehensive floodplain regulations across the entire Delaware River Basin; and enables storm water utilities. DRBC sits on State Planning Team, and DRBC members hosted an outreach presentation for the plan and provided feedback on plan goals, objectives, and actions. The leading mitigation techniques are plans and regulations and structure and infrastructure *projects* pertaining to flooding. Specifically, the plan focusses on floodplain mapping and regulations, storm water management, and acquisition/elevation.
Disaster-Resistant Universities	FEMA	August 2003	Statewide higher education entities	The Disaster-Resistant Universities initiative is a joint effort between higher education institutions and FEMA to define and address issues that will improve the ability of campuses to withstand disaster threats. 15 state schools in PA have created mitigation plans through this initiative. The State System of Higher Education administers this program. The leading mitigation techniques from Disaster Resistant University plans are often structural mitigation actions to retrofit existing structures to make them less hazard-prone; protecting existing equipment from hazards; engaging in public education and awareness of students, faculty, and staff to the risk of hazards; and the installation of warning systems and backup generators.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Federal Energy Regulatory Commission (FERC) Dam Plans	FERC	Various	Statewide	Each dam regulated by FERC has its own safety plan; these dam plans cover all types of dams with all levels of dam safety risk. Since dam failure has been identified as a hazard of significant concern, these plans are crucial in mitigating the risk associated with dam failure. The leading mitigation technique in a FERC Dam Safety Plans is the development and implementation of a dam safety monitoring program for the dam to outline procedures for surveillance, monitoring, testing, inspection, warning and safety devices, and reporting.
Firewise	DCNR BOF	Ongoing	Statewide	Firewise is a multi-organizational initiative designed to include not only fire safety professionals, but also homeowners, community leaders, developers, and others in localized efforts to lessen the risk of interface wildfires. The ultimate goal of Firewise is to reduce susceptibility of homes, communities, and structures to wildfire through cooperative education and mitigation techniques. The DCNR BOF contributed to the risk assessment for wildfire hazards in the 2010 SSAHMP update. DCNR BOF established Firewise Medal Communities to reward communities for their efforts to prepare for and reduce the risk of wildfire emergencies. Gold, Silver, and Bronze Medals are given to communities based on their level of preparedness for activities such as approved emergency action plans or seasonal wildland fire safety awareness programs. The leading mitigation techniques for this program are teaching homeowners how to prepare their homes for wildfires and preventative yard and home maintenance for minimizing the risks of wildfire. Other top techniques include holding safety committee meetings along with fire and safety educational training programs to better educate residents and first responders.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Flood Protection Program	DEP	Ongoing	Statewide	This program plans long-term structural solutions, including levees, through evaluation, hydrologic, and hydraulic analysis, environmental impacts analysis, and cost benefit analysis. Feasible projects move into an implementation phase including design and construction by DEP. The leading mitigation technique for this program is the design and construction of cost-effective flood protection projects like storm water detention facilities, concrete channels, concrete floodwalls, levees, channel improvements, or other structural flood control solutions. Other leading mitigation techniques include analysis of flooding patterns and outreach to local municipalities to sponsor and maintain properly placed and constructed flood protection projects.
Floodplain Land Use Assistance Program	DCED	Ongoing	Statewide	This program ensures municipal compliance with minimum NFIP and PA Act 166 floodplain development regulations. Staff from PEMA and DCED collaborate on NFIP management. The leading mitigation technique implemented through this program is plans and regulations as it focuses on local floodplain management. Education and Awareness about the NFIP and floodplain management regulation are also a part of this program.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Floodplain Management Services Program, Section 22 Program, Civil Works Program	USACE	Ongoing	Statewide	These programs provide technical services for mitigation projects. Additionally, the Civil Works Program provides the study, design, and construction of the flood mitigation program as well as tackling water resource development, flood risk management, and emergency response. USACE staff sits on the State Planning Team and participates in the prioritization of projects that may be eligible for assistance under these programs. The leading mitigation techniques employed by USACE in this program are responsive development and management of water resources infrastructure and protection, restoration and management of the environment in an environmentally, economical, and technically sound manner. Mitigation actions are typically developed through a planning process which formulates, evaluates, and compares alternative plans before selecting the most effective plan. As it relates to flood risk management, and where applicable to a specific program, both structural and non-structural mitigation techniques will be considered.
Hazard Mitigation Assistance Program	FEMA	Ongoing	Statewide	This HMP is designed to meet requirements needed for Pennsylvania to be eligible for funding under the various federal mitigation grant programs. Representatives from FEMA Region III sit on the SPT. PEMA uses FEMA RL and SRL data to identify projects for funding under the HMA guidance. PEMA manages these HMA programs, which provide a significant portion of the mitigation funding resources to implement mitigation activities. Funding from the PDM and HMGP programs are used as funds to assist in developing state and local hazard mitigation plans. The HMA program provides for the use of grant funds for pre- and post-disaster mitigation activities to reduce the risk to individuals and property from hazards. PEMA manages the HMA programs, which provide a significant portion of the mitigation funding resources to implement mitigation activities. Funding from the PDM and HMGP programs are used as funds to assist in developing state and local hazard mitigation plans.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Heat Wave Plan	PEMA	2008	Statewide	The Heat Wave Plan is intended to assist municipalities in the prevention of deaths and serious health conditions caused by extreme heat events. It establishes mitigation criteria and networks of support for those most vulnerable to heat events. Information from this plan informed vulnerability information for the Extreme Temperatures hazard profile. The leading mitigation techniques outlined in plan are developing distribution points for fans or air conditioners, by setting up cooling stations, and by developing volunteer programs to check-in with at-risk individuals during extreme heat events.
Keystone Principles and Criteria for Growth, Investment, and Resource Conservation	Interagency Effort	Ongoing	Statewide	While not legally binding, the Principles and Criteria are designed to encourage multifaceted project development that will integrate programs and funding sources across agencies. The leading mitigation technique associated with this statewide guidance is plans and regulations as it establishes core criteria that prevent major growth and investment projects in high-hazard areas.
Land Use Planning and Technical Assistance Program (LUPTAP)	DCED	Ongoing	Statewide	LUPTAP provides grants for comprehensive plans and for the preparation of local zoning or subdivision. The leading mitigation technique associated with this program is plans and regulations as it provides funding to amend or develop comprehensive plan to include an assessment of hazard vulnerability and take appropriate mitigation measures.
Levees and the National Flood Insurance Program: Improving Policies and Practices	National Research Council of the National Academy of Sciences	March 2013	Statewide	This report examines how the NFIP address levees and risk for properties located behind levees. The report finds that the Levee Analysis and Mapping Procedures (LAMP) are, “founded on sound algorithms with sound science and engineering behind them and follows established approaches to hydrology and hydraulics.” Recognition that LAMP will provide more accurate risk information is the first of several mitigation techniques recommended by the study. Mapping, communicating, regulating, and insuring the newly-defined risk are mitigation strategies that will support the mitigation of the impacts of levee failures. The release of the study

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
				is complemented by a FEMA lead pilot project to implement the LAMP approach in about 10% of the current on-hold studies.
Local Hazard Mitigation Planning	County Officers	Various	Statewide	Local entities are encouraged to review the SHMP; a state mitigation planner reviews all local plans for consistency with state plan and federal planning requirements. Local plan data reviewed and integrated into the state plan. Local hazard mitigation plans have many mitigation techniques; however, the top ranked actions in the majority of local plans in Pennsylvania have to do with education and awareness programs and plans and regulations. Additionally, most local mitigation actions in Pennsylvania pertain to flooding.
National Flood Insurance Program/Proof of Loss/Claims Filed	FEMA	2012	Statewide	Proof of loss claims must be filed within a specified time of the flood incident; if claims are denied, lawsuits may be filed only if proof of loss was filed. The NNFIP/Proof of Loss/Claims Filed process ensures a timely processing of flood insurance claims so that damaged property can be replaced or repaired.
NFIP and State Floodplain Management Program	DCED	Ongoing	Statewide	Pennsylvania relies on the NFIP as the comprehensive flood protection/mitigation source available to assist with reconstruction, elevation, or buyout of flood-prone properties. 2,460 Pennsylvania municipalities participate in the NFIP. NFIP principles are integrated closely with the Commonwealth's mitigation goals, objectives, and actions. The program coordinator from DCED sits on the SPT. The leading mitigation technique associated with the State Floodplain Management Program is plans and regulations to reduce vulnerability to flooding through the regulation of new and improved construction.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Nuclear/Radiological Plan	DEP, PEMA	2008	Statewide	The Commonwealth Nuclear/Radiological Plan addresses the many components of mitigation planning for nuclear facilities. The data in this plan was integrated starting with the 2010 SSAHMP update. The leading mitigation technique outlined in the plan is to require strict accounting for all licensed radioactive sources and provide a robust response when necessary.
Pennsylvania Chapter 106 – Floodplain Management	PA DEP & FEMA	September 1996	Statewide	Outlines the permit process and regulations for development within the floodplain in support of the NFIP, protection of people and property within floodplains, and with the goal for future reduction of losses by restoration of the natural floodplain. The leading mitigation technique outlined in the plan is to analyze impacts of proposed municipal and other public utility floodplain developments to ensure protection of properties and consistency with local flood plain management requirements. It includes the establishment of permitting requirements for floodplain obstructions, design criteria for construction or modification of obstructions, construction requirements, and operations and maintenance criteria.
Pennsylvania Climate Change Act (Act 70)	PA DEP	2008	Statewide	The Pennsylvania Climate Change Act provides for a report on potential climate change impacts and economic opportunities for this Commonwealth, for duties of the Department of Environmental Protection, for an inventory of greenhouse gases, for establishment of the Climate Change Advisory Committee (CCAC), for a voluntary registry of greenhouse gas (GHG) emissions, and for a climate change action plan.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Pennsylvania Climate Change Action Plan	PA DEP	2015	Statewide	The Climate Change Action Plan is an initial step in establishing a basis for moving forward on the implementation of climate change actions in Pennsylvania. Evaluation of key factors such as cost effectiveness, economic impacts, and harmonization with other Pennsylvania programs and policies will be critical to the next stage of climate change policy implementation. The leading mitigation technique discussed in the Climate Change Action Plan is a 20-year reduction of greenhouse gas emissions that will reduce Pennsylvania's contributions to global warming and its effects, including those that exacerbate many natural hazards. Other leading mitigation strategies include requirements for greening state facilities, transportation systems, and residential/commercial structures and encouraging less reliance on fossil fuels, all of which contribute to a reduction in hazard risk. The plan also advocates for advanced public outreach related to climate change. The original Climate Change Action Plan that was issued by DEP in December 2009.
Coastal Zone Enhancement Grants Program Assessment and Strategy	PA DEP	September 2016	Pennsylvania portions of Delaware Estuary and Lake Erie	Self-assessment of nine NOAA priority areas followed by a five-year strategy to enhance the Pennsylvania coastal program in one or more of the priority areas. The approved strategy for October 1, 2016 – September 30, 2021 includes “Building Capacity to Facilitate Climate Adaptation Planning and Community Resiliency.”

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Pennsylvania Dam Safety Program	DEP	Ongoing	Statewide	The Dam Safety Program has statutory authority for permitting and monitoring dams and levees under the jurisdiction of the DEP in Pennsylvania. Note that USACE and Federal Energy Regulatory Commission dams are not included under this program. Members of the Bureau of Waterways Engineering, the office in charge of the Program, are active participants in the SPT. The leading mitigation technique outlined in the plan is to inspect and monitor properly placed and constructed dams and to require Emergency Action Plans from all owners of High Hazard Dams as well as requiring immediate drawdown and/or breaching of dams which develop structural problems.
Pennsylvania Drought Management Plan	PEMA & PA DEP	March 2012	Statewide	The Drought Management Plan outlines the public water supplier's sources of water and identifies watch, warning, and emergency conditions within the water supply system based on the water levels in those sources. Response actions appropriate to the individual water supply system are identified for each of the drought stages, including contingency plans and water rationing. Leading mitigation techniques discussed in this plan include drought contingency plans, non-essential water use restriction policies, drought declaration guidelines, water rationing, and inter-agency planning coordination.
Pennsylvania Energy Harvest Program	Pennsylvania Office of Energy and Technology	2003	Statewide	Grant program for green roof and other energy saving projects. Delivered $500,000 to green roof projects statewide in 2007. The leading mitigation technique associated with this program is structure and infrastructure projects directly and indirectly associated with utility interruption and environmental hazards. The majority of funded projects involve wind and solar energy, which can mitigate interruptions to power and indirectly reduce environmental hazards associated with natural resource extraction.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Pennsylvania Greenways Initiative	DCNR	2001-2012 (Varies by county)	Statewide	Meant to preserve the highest priority undeveloped floodplain areas via fee simple acquisition and/or easement and retain as public open space for passive recreational uses. Less critical floodplain areas may be preserved or protected via local ordinance. The leading mitigation technique for the Pennsylvania Greenways Initiative is to preserve the highest priority undeveloped floodplain areas via fee simple acquisition and/or easement and retain as public open space for passive recreational uses. Less critical floodplain areas may be preserved or protected via local ordinance.
Pennsylvania Invasive Species Management Plan	Governor's Council on Invasive Species; PA DCNR	2011	Statewide	This plan establishes strategic goals in combating invasive species threats and will establish a robust statewide risk assessment of invasive species hazards. Data from the plan was used in the 2013 SSAHMP update. The leading mitigation techniques outlined in plan include encouraging residents to select native plants for landscaping, managing existing on-site invasive species to prevent their spread, and conducting annual inspections for invasive species outbreaks.
Pennsylvania Mobility Plan & the Pennsylvania Transportation Security Plan	PennDOT	September 2006	Statewide	The PA Mobility Plan outlines a vision for direction and investment into transportation across the state from 2006 to 2030. Includes goals for safety that aim to mitigate transportation accidents. The PA Transportation Security Plan outlines goals to mitigate both transportation accidents and terrorist threats or attacks. The salient mitigation techniques from the documents include implementing Pennsylvania's Comprehensive Strategic Highway Safety Improvement Plan to reduce fatalities and crashes, improving the security of high-risk transportation facilities, and developing comprehensive and coordinated plans and procedures for emergency response and recovery.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.				
PLANNING MECHANISM NAME	**LEAD AGENCY/ AGENCIES**	**DATE OF APPROVAL**	**SCOPE**	**SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION**
Pennsylvania Pandemic Influenza Outbreak Plan	Department of Health (DOH)	2010	Statewide	This plan establishes response protocol for a pandemic event. Information in the plan was used in the 2018 SHMP; DOH staff provided feedback and review for the pandemic hazard profile and actively participated in the SPT. Mitigation activities for influenza focus on minimizing exposure and treating patients. The following DOH activities are identified in the plan to overcome challenges associated with influenza: • Assessing and reviewing capacity plans and working with acute and long-term health care facilities to prepare for an increase in the patient capacity resulting from influenza-stricken individuals. • Providing technical assistance on maintaining current plans for care of mass casualties. • Providing guidance and review emergency preparedness response plans to integrate and maintain critical business functions in the event of a pandemic. • Reviewing pandemic plans by hospitals and nursing care facilities to ensure that they meet the needs of a pandemic. • Developing emergency response plans with adjoining states for collaboration of public services, health care personnel, and security services.
Pennsylvania Radon Mitigation Standards	DEP	November 1997	Statewide	Provides standards to be referred to by certified mitigation contractors for installation of radon mitigation systems. Guidelines to ensure effective and uniform protection against radon for homeowners utilizing the systems. The leading mitigation technique outlined in the plan is to test for radon in residential, commercial and industrial buildings, delineate on public maps the areas with increased radon levels, and assist in the installation of radon reduction systems within structures that have increased levels of radon.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Pennsylvania State Plan on Aging	PA Department of Aging	2012	Statewide	The State Plan on Aging's goals, objectives, and strategies advance a vision characterized by three strategic directions: to help ensure that Pennsylvanians will age and live well and that communities will be places to help them age and live well; to ensure access to care at the right time, in the right setting, and at the right intensity; and to bring the best of Pennsylvania to Pennsylvanians. The most successful mitigation techniques outlined in the plan include the Healthy Steps for Older Adults falls prevention program and requiring each Area Agency on Aging to have a local plan for emergency response on file with the Department of Aging.
Pennsylvania's Management of State Homeland Security Program	Governor's Office of Homeland Security	September 2012	Statewide	The report addresses the Commonwealth of Pennsylvania's management of State Homeland Security Program and Urban Areas Security Initiative grants. The Homeland Security Program supports strategies to address, "planning, organization, equipment, training, and exercise needs to prevent, protect against, mitigate, respond to, and recover from acts of terrorism and other catastrophic events." Awards are based on Investment Justifications aligned with the State THIRA. The funding streams associated with this program focuses on preventing, preparing, responding, and recovering from disasters as to mitigate the impacts of terrorism or catastrophic events. Techniques funded that support mitigation include Commonwealth and regional fusion centers to share intelligence, Business Coalitions to support 'Whole Community' preparedness, outreach information the public, planning and training for first and second responders, and supporting the State VOAD.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Pennsylvania's Statewide Historic Preservation Plan 2012-2017	Pennsylvania Historical & Museum Commission, Bureau of Historic Preservation	2012	Historic properties statewide	The plan lays out strategies for government, nonprofits, and individuals to address historic properties in Pennsylvania. Several actions in the plan will better prepare local municipalities to identify and survey important local resources, improve data sharing amongst communities and agencies, to integrate preservation priorities into hazard mitigation, emergency management and other planning mechanisms. The leading mitigation technique in the plan is the collaboration between PA Historic Preservation with PEMA and FEMA to identify at-risk communities for natural disasters in order to create emergency management plans for their historic resources. The plan has not yet been updated beyond 2017.
Philadelphia Heat Island Initiative	City of Philadelphia, EPA, The Energy Coordinating Agency (ECA) of Philadelphia, and Public Health Department	Varies	Citywide	The City of Philadelphia started the Cool Roof Ordinance in May of 2010 mandating the use of white or highly reflective roof material or white roof coverings for all new construction, excluding projects involving vegetation, solar thermal, or photovoltaic equipment. The City was first to implement the Heat/Health Watch Warning System involving news reports to cover the dangers, appointed block captains to check on elderly neighbors, and the Department of Health to conduct home visits. The ECA has been implementing weatherization on city buildings by applying cool roof coatings to reduce building temperatures. The leading mitigation techniques for Philadelphia are to increase the use of white material for roof coverings and to increase vegetation to help reduce overall temperatures.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Silver Jackets	USACE	July 2011	Statewide	Silver Jackets is a pilot program that began in 2006. Pennsylvania has an interagency team that works to reduce flood losses in the Commonwealth by mitigating SRL/RL properties and providing outreach and education programs. USACE provides expertise and resources to develop comprehensive local flood mitigation strategies. Various members of the SPT participate in this program. The most salient mitigation technique is the effective and continuous collaboration between state and federal agencies. This is critical to successfully reducing the risk of flooding and other natural disasters in the United States and enhancing response and recovery efforts when such events do occur. No single agency has all the answers, but often multiple programs can be leveraged to provide a cohesive solution.
SRBC Water Resources Program	SRBC	Adopted June 20, 2013	Susquehanna River Basin (Eastern and Central Pennsylvania)	SRBC annually adopts the water resources program, which consists of planned projects SRBC and partnering agencies aim to accomplish to meet water resources needs within the basin. Consistent with the “Actions Needed” list from the comprehensive plan and covers six priority management areas including water supply, water quality, flooding, ecosystems, the Chesapeake Bay, coordination, cooperation, and public information. The leading mitigation technique associated with this program is plans and regulations that pertain to drought and flooding. Projects including drought coordination planning, low flow prevention policies, erosion control stream restoration, aquatic invasive species monitoring, storm water management, flood forecast and warning system planning, and flood damage reduction alternative develop are all included in the program.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
State Emergency Operations Plan	PEMA	February 2015	Statewide	An updated State Emergency Operations Plan ensures that disaster response can prevent or reduce damage and injuries from expected hazards or disasters. It is considered a major capability for implementing hazard mitigation activities. This plan has concurrence with the Emergency Plans of 20 state agencies, most of which sit on the SPT. For more information, please see Section 5.2. The EOP's most salient mitigation technique is the premise that the goal of an EOP is to prevent, prepare, respond, and recover from disasters in such a way as to mitigate the impacts of a disaster on residents, property, and natural responses. It is a tool for accomplishing all the goals, and especially the first goal, of the SHMP. By having a plan to respond, the Commonwealth is able to save lives and protect property and the natural environment. The EOP also promotes and has actions related to public outreach and mitigation programs including the NFIP.
Pennsylvania Statewide Comprehensive Outdoor Recreation Plan (2014-2019)	DCNR	December 2014	Statewide	The plan presents 28 programmatic and five funding recommendations to enhance the delivery of outdoor recreation facilities and services, organized under four major goals: strengthen connections between outdoor recreation, healthy lifestyles, and economic benefits in communities; reconnect people to the outdoors and develop a stewardship ethic through outdoor recreation; develop a statewide land and water trail network to facilitate recreation, transportation, and healthy lifestyles; and enhance outdoor recreation through better state agency cooperation. The most salient mitigation techniques identified in the plan are the Land and Water Conservation Fund and the education and awareness programs aimed at better informing residents of their role in environmental conservation.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
State Water Plan	DEP	March 2009	Statewide	Act 220 of 2002 requires that the DEP produce and regularly update a State Water Plan every five years. The current plan is a functional planning tool that delineates 104 watersheds in Pennsylvania's six major river basins and assures adequate quantity and quality of water. The plan monitors drought and connects storm water management to floodplain management and flood protection to mitigate local flooding. State Water Plan data was used in the 2013 SSAHMP update. The leading mitigation techniques used in the State Water Plan include reducing conflicts between water users and natural resource protection and forecasting water use and supply to protect Pennsylvania in times of flooding and drought. The plan advocates for flood protection, sustainable water use, and water supply protection by disseminating water resources information, adopting an integrated approach to water management, and adopting technological advances that can conserve and enhance water resources. The plan also advocates for advanced public outreach related to water resources.
Stream gauging in Pennsylvania	USGS Pennsylvania Water Science Center (PaWSC)	1894 (beginning of stream gauging program in U.S.)	Statewide	The PaWSC operates 279 continuous-record stream gages offering real-time stage and discharge information for streams in the Commonwealth. The gages are operated and maintained with cooperation from about 53 federal, state, and local partners. The most salient mitigation technique for this program is the function of stream gages as a warning system by alerting residents when stream flows are above normal.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

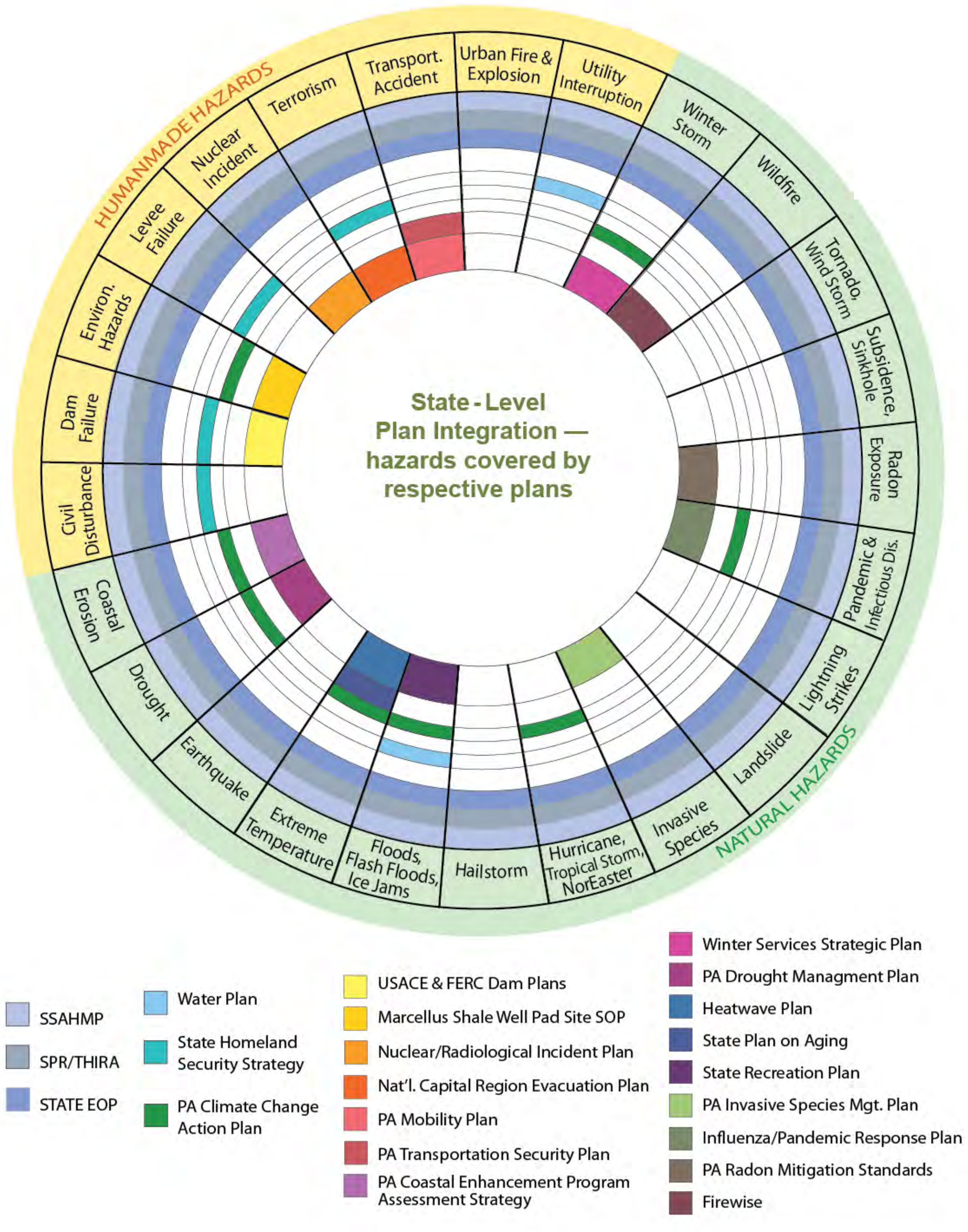
PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
Threat and Hazard Identification and Risk Assessment	FEMA	2017	Statewide	The THIRA is an all-hazards capability-based assessment tool suited for use by all jurisdictions. The THIRA allows a jurisdiction to understand its threats and hazards and how their impacts may vary according to time of occurrence, seasons, locations, and community factors. This knowledge allows a jurisdiction to establish informed and defensible capability targets and commit appropriate resources drawn from the whole community to closing the gap between a target and a current capability or for sustaining existing capabilities. The THIRA uses hazard information from the SHMP. It adds in a threat component and chooses natural, technological, and adversarial hazards that will stress the “overall system” the most. For example, there are over 20+ hazards profiled in the SHMP, however only 10 may be able to stress the system the most. The link between the THIRA and mitigation is that actions taken to reduce gaps and build, maintain, and sustain a capability will mitigate the impacts of disaster.
Uniform Construction Code	Local governments or PA Department of Labor and Industry (if local governments opt out)	2015	Statewide	The Pennsylvania Construction Code Act (Act 45 of 1999) established the basic requirements for the UCC. The leading mitigation technique in this plan is Plans and Regulations as codes ensure uniform, modern construction standards which reduce vulnerability to various natural and human-made hazard events including flooding, wind, tornado, earthquake, fire, utility interruption, and others.
USACE Dam Safety Program	USACE	Various	Statewide	26 dams in Pennsylvania fall under the jurisdiction of the USACE; these dams each have safety plans. Since dam failure has been identified as a hazard of significant concern, these plans are crucial in mitigating the risk associated with dam failure. The leading mitigation techniques are continuous and periodic project inspections and evaluations to make risk-informed decisions, communication of risk-related issues, and collaboration with federal, state and local partners to share information and develop solutions.

Table 5.5-1 Summary of other local, state and federal planning mechanisms.

PLANNING MECHANISM NAME	LEAD AGENCY/ AGENCIES	DATE OF APPROVAL	SCOPE	SUMMARY OF MECHANISM APPLICATION TO HAZARD MITIGATION
USACE Levee Safety Program	USACE	2007 (National Levee Database)	National	Congress authorized the USACE to develop the National Levee Database (NLD) in 2007 to organize levee inspection information, flood plain management, risk assessments, and flood risk communication. The most salient mitigation techniques are inspection and assessment of existing levees and using the data to prioritize action, communication of risk-related issues, and collaboration with federal, state and local partners to share information and develop solutions. The NLD is undergoing redevelopment as of 2018 and there are plans in place to make it a levee data repository for USACE and FEMA data.
Winter Services Strategic Plan (WSSP)	PennDOT	2012	Statewide	This is PennDOT’s plan to guide response and customer service for winter storms. While PennDOT cannot prevent winter storms, they are able to mitigate the impact of the storm and transportation accidents. Key mitigation techniques included in the plan are web-conferencing with other state agencies to review real-time weather forecasts, current conditions, and the status of statewide forces, pro-active speed-reduction restrictions, and a pilot program on 15 snow routes across the state using transportation-focused management software.

5.5.2. SHMP Integration into Other Planning and Program Initiatives

Figure 5.5.2-1 State-level plan integration – hazards covered by respective plans.



As described in 5.5.1 and demonstrated in Figure 5.5.2-1, hazards are addressed by a range of state-level plans, and some hazards are addressed across a range of plans. In some instances, hazards remain unaddressed by the plans listed. In some cases, this may be because the hazard risk is low in Pennsylvania, such as earthquake, but in others, such as tornado/wind storm, a lack of relevant plans may suggest areas that need to be addressed more comprehensively.

In addition to hazard and mitigation plans, various reports, task forces, programs, and other planning resources assist in integrating mitigation considerations into statewide and regional planning processes. For example, the Keystone Principles and Criteria for Growth, Investment and Resource Conservation aim to encourage integration across agencies to prevent major growth and investment projects in high-hazard areas. A report by the National Research Council of the National Academy of Sciences provides explanation of the Levee Analysis and Mapping Procedures (Levees and the National Flood Insurance Program: Improving Policies and Practices.) Planning programs such as the Land Use Planning and Technical Assistance program of DCED and FEMA’s HMA Program provide funding to support improved local and state hazard mitigation plans and actions. FEMA’s NFIP/Proof of Loss – Claims Filed process ensures timely processing of flood insurance claims so damaged property can be replaced or repaired. Pennsylvania’s Chapter 106 – Floodplain management defines the requirements and permitting processes for floodplain development.

Coordination efforts are high priority, as demonstrated through numerous efforts, including the SRBC Water Resources Program and Silver Jackets program. The SRBC Water Resources Program works to coordinate resources related to flooding, drought, water quality, and ecosystem health as well as other concerns, such as invasive species, erosion control, and stream restoration. Statewide, the Silver Jackets initiative in PA, coordinated through the USACE, is working to create interagency coordination between state and federal partners with responsibility for flood loss and mitigation. The Statewide Historic Preservation Plan aims to integrate preservation priorities into the hazard mitigation process statewide and to build emergency management plans for historic properties and resources. The UCC ensures construction standards which reduce vulnerability to various hazards, including flooding, utility interruption and others.

Further, regional and local efforts, such as the Philadelphia Heat Island Initiative, are working to integrate mitigation objectives into construction projects, by including Cool Roof regulations to temper extreme heat risk in the City of Philadelphia. Technical assistance from various programs informs education and public awareness. Continued stream gauging in Pennsylvania, in cooperation with the USGS, provides a robust monitoring and warning system for flooding statewide.

These mitigation mechanisms can be categorized by four approaches: local planning and regulations; structure and infrastructure projects; natural systems protection; and education and awareness programming. A summary of these additional mitigation mechanisms, organized by category, is included as Table 5.5.2-1.

Table 5.5.2-1 Mitigation planning mechanisms.

Mitigation Planning Mechanisms	
Local Planning and Regulations	**Structure and Infrastructure Projects**
• CDBG Disaster Recovery Assistance (DCED) • Commonwealth Critical Infrastructure Program (GOHS) • Comprehensive Land Use Plans • Comprehensive Plan for the Water Resources of the Susquehanna River Basin (SRBC) • Delaware River Basin Baseline Monitoring and Characterization (DRBC) • Delaware River Basin Interstate Flood Mitigation Task Force • Floodplain land Use Assistance Program (DCED) • Hazard Mitigation Assistance Program (FEMA) • Heat Wave Plan (PEMA) • National Flood Insurance Program/Proof of Loss/Claims Filed • PA Mobility Plan and the PA Transportation Security Plan • State Floodplain Management Program • Uniform Construction Code	• Act 537 Sewage Facilities - Planning Authorizations (DEP) • Commonwealth Critical Infrastructure Program (GOHS) • Delaware River Basin Interstate Flood Mitigation Task Force • Disaster Resistant Universities • Federal Energy Regulatory Comission (FERC) dam plans • Flood Protection Program (DEP) • Floodplain Mgmt Services Program, Sec. 22 Program, Civil Works (USACE) • Levee Study Program (USACE)
Natural Systems Protection	**Education and Awareness Programs**
• Floodplain Mgmt Services Program, Sec. 22 Program, Civil Works (USACE) • Pennsylvania Greenways Initiative (DCNR)	• Disaster-Resistant Universities (FEMA) • Firewise (DCNR)

6 Mitigation Strategy

6. Mitigation Strategy

6.1. Update Process Summary

The Commonwealth's Mitigation Strategy serves as the blueprint for reducing or avoiding long-term vulnerabilities to hazards identified in the Risk Assessment (Chapter 4). The Strategy identifies the Commonwealth's prioritized goals, objectives, and actions for reducing loss of life and property. 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 than goals; the described steps are usually measurable and can have a defined completion date. Mitigation actions are more specific than objectives and identify responsible parties, timeframes, and potential funding sources. The actions achieve the goals and objectives.

The 2013 Commonwealth of Pennsylvania SSAHMP adopted five overarching goals. These goals were carried over from the 2010 SSAHMP and include:

- Goal 1 - Protect lives, property, environmental quality, and resources of the Commonwealth, including RL and SRL properties.
- Goal 2 - Enhance consistent coordination, collaboration, and communication among stakeholders.
- Goal 3 - Provide a framework for active hazard mitigation planning and implementation.
- Goal 4 - Build legislative support and secure funding for mitigation efforts.
- Goal 5 - Increase awareness, understanding, and preparedness across all sectors.

The five goals were supported by 27 objectives and 121 actions, each of which was assigned to at least one Commonwealth agency.

The creation of the mitigation strategy for the 2018 Plan Update was a continual process beginning in 2014 with the SPT's annual review of the Mitigation Strategy of the 2013 HMP Update. The SPT conducted annual reviews in 2015 and 2016 as well. During each year's annual review, goals, objectives, and actions were reviewed with progress made towards achieving each action noted. Four new actions were added during the 2015 annual review. In June 2017, PEMA reviewed collective comments from each annual review noting changes in goals, objectives, and actions. It then sought individual input from SPT members. SPT members were asked to comment on recommended changes to the wording of each action, the addition/subtraction of agencies/organizations involved in addressing the action, available funding sources, input on the target completion date, and disposition of each action (complete, continue, remove, ongoing, etc.). Information collected from PEMA and SPT members was compiled and on October 11, 2017 a Mitigation Solutions Meeting was held to review the Goals and Objectives, provide an update on action review, and begin to develop actions for new hazards added during the planning process.

To ensure the 2018 Mitigation Strategy appropriately targets the Commonwealth's top hazards and priorities, the 2013 mitigation actions were categorized by characteristics such as mitigation technique, hazard type, top hazards according to number of mitigation actions developed versus those hazards ranked by risk, and agency responsibility. By examining the mitigation actions within these different categorizations, the SPT was able to better understand how closely the 2013 Mitigation Strategy reflected the Commonwealth's known risks and priorities and where adjustments might be necessary for the 2018 Mitigation Strategy.

As shown in Figure 6.1-1, over 50 percent of the 2013 mitigation actions fall within the Education and Awareness Programs mitigation technique, followed by Local Plans and Regulations (39%), Structure and Infrastructure Projects (8%), and Natural Systems Protection (2%).

Figure 6.1-1 2013 Mitigation Actions Categorized by Mitigation Technique

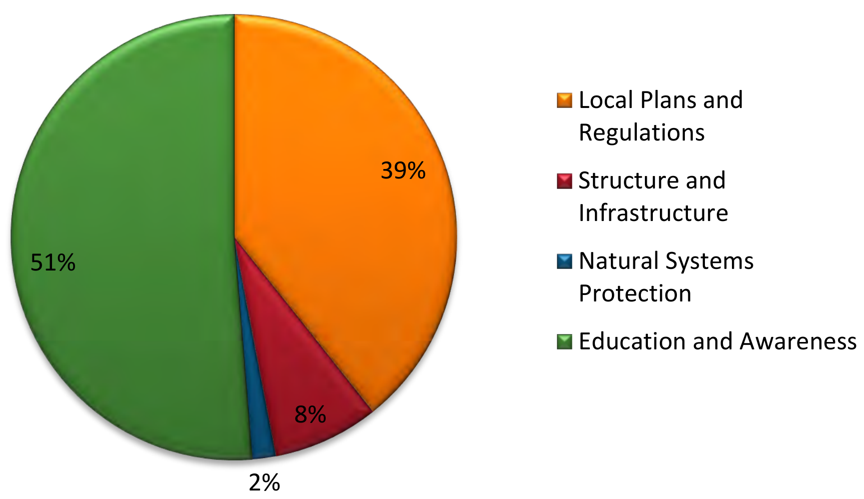
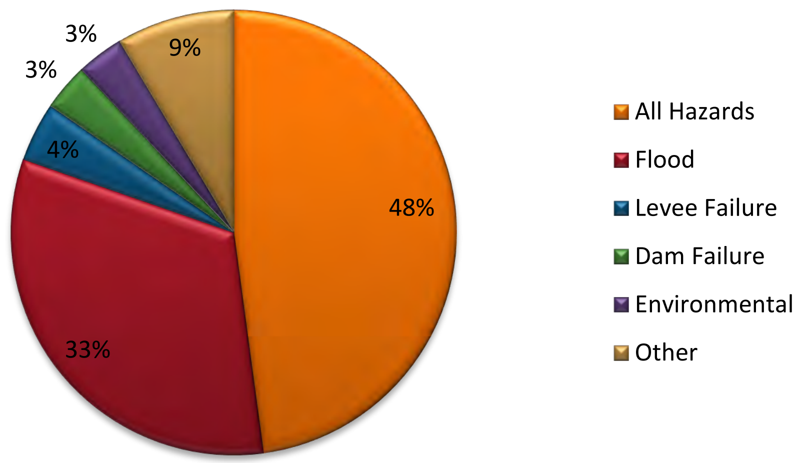


Figure 6.1-2 indicates that 48% of the mitigation actions in the 2013 SSAHMP address All Hazards and 33% address Flood, the Commonwealth's highest risk hazard. Actions addressing Levee Failure, Dam Failure, and Environmental Hazards comprise 4%, 3%, and 3% of mitigation actions, respectively. The remaining 9% of actions address specific hazards including: Earthquake; Mass Food, Animal Feed Contamination; Subsidence, Sinkhole; Terrorism; Utility Interruption; Wildfire; and Natural Hazards.

Figure 6.1-2 2013 Percent of Actions by Hazard for Hazards with the Most Actions



When comparing the high hazards related to the number of actions in the SHMP to the top hazards identified by the 2013 Risk Assessment there is a slight divergence between the two lists. While Flood is on both lists, the remaining top hazards are different when comparing overall risk for certain hazards in the Commonwealth to the number of mitigation actions assigned to hazards in the plan. Refer to Table 6.1-1.

Table 6.1-1 2013 Mitigation vs. Risk Evaluation

HIGH HAZARDS RANKED BY NUMBER OF ACTIONS	HIGH HAZARDS RANKED BY RISK
1. Flood	1. Flood
2. Levee Failure	2. Winter Storm
3. Dam Failure	3. Utility Interruption
4. Environmental Hazards	4. Hurricane

Table 6.1-2 shows the breakdown of mitigation actions categorized by responsible entity and illustrates which groups the Commonwealth relies on most heavily for implementation of the SHMP. PEMA is by far the most frequent agency assigned a lead or supporting role for the mitigation actions (33% of all assignments). DCED and Local/County governments were each assigned to over 10% of the actions, while FEMA and DEP were assigned to over 5%. While the 2013 distribution of assigned actions includes a diverse list of responsible entities, a large number of actions fall to relatively few agencies. While PEMA, FEMA, DEP, and DCED are key agencies for addressing hazard mitigation in Pennsylvania, the capacity of the agencies to effectively address mitigation actions on a continual basis should be evaluated. In other words, the relatively large number of actions assigned to each appears to make it difficult to keep up with addressing mitigation actions as part of day-to-day agency activities.

Table 6.1-2 2013 Actions Categorized by Responsible Entity			
AGENCY OR ORGANIZATION	NUMBER OF ASSIGNED ACTIONS	AGENCY OR ORGANIZATION	NUMBER OF ASSIGNED ACTIONS
PEMA	93	Office State Fire Com.	3
DCED	40	Chamber of Commerce & RTF B & LIC	3
Local/County	36	DHS	2
FEMA	23	Governor's Office Communications & Press	2
DEP	21	NCRS	2
USACE/Silver Jackets	17	PAFPM	2
DCNR	5	PDA	2
DGS	5	PDE	2
KEMA	5	PHMC	2
OA	5	River Basin Commissions	2
PA State Police	4	USDA	2
GOHS	3		

In reviewing the goals and objectives for the 2018 Plan Update, the SPT revisited the goals and objectives developed for the 2013 Plan at the October 2017 Mitigation Solutions Meeting. The purpose was to review, discuss, and determine if the goals and objectives still met the Commonwealth's priorities for hazard mitigation. The SPT agreed that the existing 2013 goals remained valid for the 2018 Plan Update with two goals requiring slight modification in wording.

In May 2018 the SPT reviewed the draft state mitigation strategy for the 2018 Plan. The SPT agreed to provide additional feedback via email:

- Risk Factor Rankings – The SPT reviewed the updated risk factor rankings for each of the hazards profiled in the 2018 Plan Update and provided comments.
- 2018 Mitigation Action Strategy - The SPT reviewed the revised mitigation objectives and actions for the 2018 SHMP update.
- Multi-Objective Mitigation Action Prioritization – The SPT reviewed and commented on the evaluation and prioritization of each action as discussed in Section 6.2.3.

By providing feedback on these items, the SPT ensured the 2018 Plan Update reflects the Commonwealth's risk for a variety of hazards and features a mitigation strategy that is appropriately prioritized.

The following two charts show 2018 action analysis similar to what was completed in 2013. The first chart shows a slight increase in the percentage of 'Plans and Regulations' actions and a decrease in actions for 'Education and Awareness Programs'. Though both categories remain the focus for most actions. The education category likely decreased due to combining and streamlining similar actions. 'Structure and Infrastructure Projects' increased as a percentage of actions from 8% to 11% due to new actions for cyber-terrorism. Natural Systems Protection increased slightly. The second table shows a similar distribution of actions in 2013 and 2018 for All Hazards, Flooding, Levee and Dam Failure, and Environmental hazards. Hazards that have

2% of the actions were added to the table to provide more information on how the mitigation strategy focused on hazards.

Figure 6.1-3 2018 Mitigation Actions Categorized by Mitigation Technique

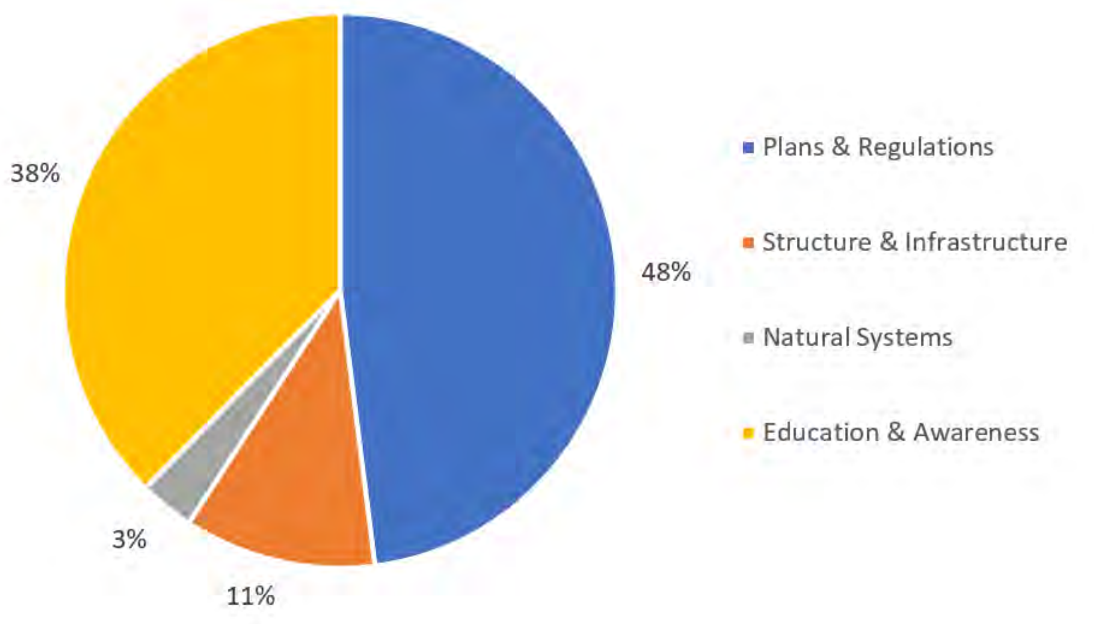
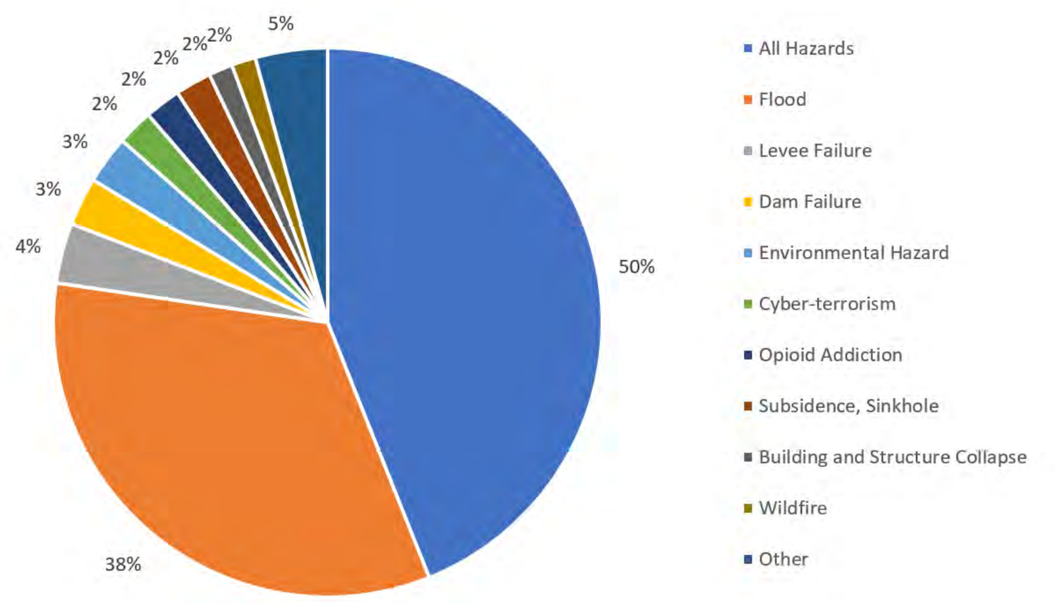


Figure 6.1-4 2018 Percent of Actions by Hazard for Hazards with the Most Actions



The challenge identified in 2013 remains: the relatively large number of actions assigned in 2018 to a few agencies appears to make it difficult to keep up with addressing mitigation actions as part of day-to-day agency activities. Though this has been discussed in SPT meetings and determined to be suitable for the mitigation strategy. The mitigation strategy is a combination of achievable and aspirational actions with related achievable and aspirational measures of success. The SPT believes it is suitable to have stretch actions or actions that may not proceed in a recession or funding cut. The SPT found this is a strong strategy to improve the safety and resiliency of the Commonwealth. Extra effort was made by the SPT in 2018 to remove repetitive actions, actions that no longer had champions, and actions that had become established capabilities. This streamlining and refocusing on agency driven action preferences should improve implementation while still providing a strategy that is a stretch to accomplish.

6.2. State Mitigation Strategy

6.2.1. Mitigation Goals and Objectives

The Mitigation Strategy is designed to guide the selection of activities to mitigate and reduce potential losses. It includes long-term goals and objectives, but also establishes short-term activities. Through the implementation of the Mitigation Strategy, BORM strives to establish a successful statewide mitigation program.

The keystones of this Mitigation Strategy are the Commonwealth of Pennsylvania’s mitigation goals and their associated objectives. These five goals establish a focused vision for the process and implementation of hazard mitigation for the Commonwealth in the coming years. This vision is supplemented by a number of objectives that bring Pennsylvania’s ideals of hazard mitigation into sharper focus, in many cases establishing targets and quantifying benchmarks that will indicate progress towards accomplishing the goals.

The SPT evaluated the 2013 mitigation goals and objectives during the 2017 Mitigation Solutions Meeting. Table 6.2.1-1 shows the 2013 mitigation goals and objectives with the corresponding SPT evaluation. The Identification and Analysis of Mitigation Techniques is discussed in Section 6.2.2. The mitigation actions are described in full detail in Section 6.2.4.

Table 6.2.1-1 Goals and Objectives for 2013 SSAHMP	SPT Evaluation
Goal 1: Protect lives, property, environmental quality, and resources of the Commonwealth, including RL and SRL properties.	Modify. Replace RL and SRL with high risk.
Objective 1-1: By 2016, reduce flood-related losses (with an emphasis on reducing repetitive loss and severe repetitive loss properties by 5%) through promotion of the Commonwealth’s flood protection program through county, state, and federal partners.	Modify. Add ‘NFIP identified’ before repetitive loss and ‘local’ before county.
Objective 1-2: Increase by 5% the number of projects implemented by the Commonwealth that will mitigate the most vulnerable structures against hazards by 2016.	Continue
Objective 1-3: Identify and work toward implementation of 5 feasible and cost-effective projects related to the mitigation of critical buildings, state facilities, and infrastructure.	Continue
Objective 1-4: Identify projects related to advanced warning within the Commonwealth by 2016.	Continue

Table 6.2.1-1 Goals and Objectives for 2013 SSAHMP	SPT Evaluation
Objective 1-5: By 2020, minimize risk to communities posed by levee structures by increasing compliance of all levees with National Levee Safety Program standard, focusing on planning and certification.	Modify. Reference FEMA and USACE. Reword to reflect voluntary participation.
Objective 1-6: By 2016, provide outreach and training opportunities for local building code enforcers by 500 individuals within the Commonwealth.	Modify. Remove 'by 500 individuals within'; Replace with 'throughout'.
Objective 1-7: Increase coordination, prioritization, and funding availability to address community needs for dam hazards with special emphasis on inundation zone evaluation by 2016.	Modify. Remove emphasis on inundation zone evaluation as work is complete.
Objective 1-8: Encourage aggressive enforcement of floodplain and storm water management ordinances and other all-hazards regulations within the Commonwealth to reduce losses in high risk areas.	Continue
Objective 1-9: Promote increased implementation of urban-wild land interface (wildfire) mitigation projects by local communities by 2016.	Continue
Objective 1-10: Enhance Commonwealth efforts to address mine/quarry related hazards by increasing inter-agency cooperation.	Continue
Objective 1-11: Enable the Department of Environmental Protection to fully characterize hazard issues from Marcellus Shale natural gas extraction operations and explore mitigation options by 2016.	Modify. Replace Marcellus Shale with 'shale gas formation extraction and distribution'.
Objective 1-12: Manage all Repetitive Loss and Severe Repetitive Loss databases, providing updates to FEMA at least annually in order to more efficiently identify properties to be mitigated.	Modify; merge Objectives 1-12 and 1-13 to reflect current RL and SRL reporting.
Objective 1-13: Compare properties within the Commonwealth that are known to have been mitigated with the FEMA-provided data sets for SRL and RL properties on an annual basis, and complete FEMA Form AW-501 to support update of the FEMA SRL and RL property databases.	Modify; merge Objectives 1-12 and 1-13 to reflect current RL and SRL reporting.
Objective 1-14: Promote Natural Systems Protection mitigation in the Commonwealth between 2013 and 2016.	Continue
Goal 2: Enhance consistent coordination, collaboration, and communications among stakeholders.	Continue
Objective 2-1: Promote development of COOP and COG plans for critical infrastructure within the Commonwealth, focusing on water treatment, water supply, and critical goods and services suppliers.	Continue
Objective 2-2: Promote integration of mitigation goals, objectives, and actions where appropriate in other federal, state and local planning initiatives by 2016.	Continue
Objective 2-3: Support Pennsylvania Emergency Management Agency in developing mitigation data strategies for decision-makers by 2015.	Modify. Reword to focus on data collection, update, and dissemination.
Objective 2-4: Identify local Hazard Mitigation Officers and increase participation by local community representatives in the Commonwealth's Mitigation Planning Team by 50% between 2013 and 2016.	Continue

Table 6.2.1-1 Goals and Objectives for 2013 SSAHMP	SPT Evaluation
Objective 2-5: Continue to support coordination between mitigation, planning, preparedness, and response personnel throughout the Commonwealth to ensure effectiveness in all-hazard mitigation planning.	Continue
Goal 3: Provide a framework for active hazard mitigation planning and implementation.	Continue
Objective 3-1: Identify opportunities for regional organizations, businesses, and universities to be engaged in hazard mitigation planning.	Modify. Replace 'universities' with 'academia'.
Objective 3-2: Enable the Pennsylvania Emergency Management Agency to encourage each participating jurisdiction to secure funding and initiate one mitigation action by 2016.	Continue
Goal 4: Build legislative support and secure funding for mitigation efforts.	Modify. Add 'and other organizational' before support and replace 'secure' with 'leverage'.
Objective 4-1: Provide opportunities for education of all State, county and local government officials and legislators about hazard risk and mitigation by Pennsylvania Emergency Management Agency and County Emergency Management Agencies by 2016.	Continue
Objective 4-2: By 2016, expand working relationships with at least two volunteer and professional organizations to improve mitigation efforts within the Commonwealth.	Continue
Objective 4-3: Identify statutory, regulatory or other barriers to completing mitigation efforts within the Commonwealth, and leverage support against these barriers to implement mitigation actions by 2016.	Continue
Objective 4-4: Encourage inclusion of at least 5 relevant mitigation projects in the Commonwealth's Capital Improvement Program by the next plan revision.	Modify. Reword to reflect all applicable state funding sources.
Goal 5: Increase awareness, understanding, and preparedness across all sectors.	Continue
Objective 5-1: Support all-hazards mitigation and preparedness programs to educate private and public stakeholders, academia, government employees and elected officials on the hazards pertinent to the Commonwealth.	Continue
Objective 5-2: Prioritize outreach efforts that will result in a 10% increase in RL and SRL related grant applications between 2013 and 2016.	Continue

All five goals will carry over into the 2018 SHMP update with minor changes made to the wording of goals 1 and 4. Several objectives were reworded to reflect current disposition of actions, and minor changes were made to objectives including updated target completion dates and quantitative measures. Objectives 1-12 and 1-13 were merged to reflect current reporting requirements for RL and SRL properties. Three new objectives were added. Objective 1-14 was added to address cyber-terrorism, Objective 1-15 was added to address NFIP changes in more detail, and Objective 2-6 was added to support resiliency and recovery planning. The 2018 goals and objectives are listed in Section 6.2.4, Mitigation Action Plan along with corresponding mitigation actions.

6.2.2. Identification & Analysis of Mitigation Techniques

The goals and objectives of each plan update establish a strategic course for hazard mitigation in the Commonwealth for the next five years. However, in order to make a tangible change in losses experienced and reduce risk, the goals and objectives must be supported by mitigation actions.

In the 2013 Plan Update, the mitigation actions were classified by four mitigation technique categories outlined in FEMA's Local Mitigation Planning Handbook (March 2013). The four categories include:

- **Plans and Regulations:** These actions include government authorities, policies, or codes that influence the way land and buildings are developed and built.
- **Structure and Infrastructure Projects:** These actions involve modifying existing structures and infrastructure to protect them from a hazard or remove them from a hazard area. This could apply to public or private structures as well as critical facilities and infrastructure. This type of action also involves projects to construct manmade structures to reduce the impact of hazards.
- **Natural Systems Protection:** These are actions that minimize damage and losses to natural systems and preserve or restore the functions of natural systems.
- **Education and Awareness Programs:** These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. Although this type of mitigation reduces risk less directly than structural projects or regulation, it is an important foundation. A greater understanding and awareness of hazards and risk among local officials, stakeholders, and the public is more likely to lead to direct actions.

Pennsylvania's 2018 Mitigation Strategy uses these four categories of techniques to address each of the hazards that affect the Commonwealth. Hazards listed by risk and the techniques that will be deployed to address each are shown in Table 6.2.2-1. The specific actions associated with these techniques are included in Section 6.2.4. In an effort to enhance consistency across hazard mitigation plans, PEMA requires local communities to classify mitigation actions using these four mitigation technique categories per the SOG. More information on local plan actions can be found in Section 6.3.2.

Table 6.2.2-1 Mitigation Technique used for each hazard in Pennsylvania.

HAZARD (ORDERED FROM HIGHEST RISK TO LOWEST RISK FACTOR) NATURAL (N) OR MAN-MADE (M)	MITIGATION TECHNIQUE			
	PLANS AND REGULATIONS	STRUCTURE AND INFRASTRUCTURE PROJECTS	NATURAL SYSTEMS PROTECTION	EDUCATION AND AWARENESS PROGRAMS
Flood, Flash Flood, Ice Jam (N)	✓	✓	✓	✓
Winter Storm (N)		✓		✓
Utility Interruption (M)	✓	✓		✓
Hurricane, Tropical Storm, Nor'easter (N)	✓	✓		✓
Cyber-terrorism (M)	✓			✓
EH - Hazardous Materials Release (M)	✓			✓

Table 6.2.2-1 Mitigation Technique used for each hazard in Pennsylvania.

HAZARD (ORDERED FROM HIGHEST RISK TO LOWEST RISK FACTOR) NATURAL (N) OR MAN-MADE (M)	MITIGATION TECHNIQUE			
	PLANS AND REGULATIONS	STRUCTURE AND INFRASTRUCTURE PROJECTS	NATURAL SYSTEMS PROTECTION	EDUCATION AND AWARENESS PROGRAMS
Dam Failure (M)	✓	✓		✓
Nuclear Incident (M)	✓			✓
Transportation Accident (M)	✓			✓
Wildfire (N)	✓	✓	✓	✓
Extreme Temperature (N)			✓	✓
Coastal Erosion (N)	✓	✓		✓
EH - Coal Mining (M)				✓
EH - Gas and Liquid Pipelines (M)	✓			✓
EH - Unconventional Oil and Gas Wells (M)	✓	✓		✓
EH - Conventional Oil and Gas Wells (M)	✓	✓		✓
Landslide (N)	✓	✓	✓	✓
Lightning Strike (N)		✓		✓
Opioid Addiction Response (M)	✓			✓
Tornado, Wind Storm (N)	✓	✓		✓
Invasive Species (N)	✓		✓	✓
Radon Exposure (N)	✓			✓
Civil Disturbance (M)		✓		✓
Drought (N)	✓	✓	✓	✓
Pandemic (N)				✓
Terrorism (M)		✓		✓
Building and Structure Collapse (M)	✓	✓		✓
Earthquake (N)	✓	✓		✓
Hailstorm (N)		✓		✓
Urban Fire and Explosion (M)	✓	✓		✓
Levee Failure (M)	✓	✓		✓
Mass Food/Animal Feed Contamination (M)	✓			✓
Subsidence, Sinkhole (N)	✓		✓	✓

6.2.3. Assessment of Mitigation Actions

Identifying mitigation actions to focus on during the next five years was critical to ensure the SPT has clear direction once the plan is finalized. To do this, the Multi-Objective Mitigation Action Prioritization criteria outlined in the SOG and reviewed and approved by the SPT during preparation of the 2018 SHMP was applied to each of the 125 mitigation actions.

Scores were assigned to each criterion using the weighted, multi-objective mitigation action prioritization criteria outlined in Table 6.2.3-1.

Table 6.2.3-1 Multi-Objective Mitigation Action Prioritization Criteria		
MITIGATION ACTION RANKING CRITERIA	**CRITERIA DESCRIPTION**	**WEIGHT VALUE**
Effectiveness	The extent to which an action reduces the vulnerability of people and property.	20%
Efficiency	The extent to which time, effort, and cost is well used as a means of reducing vulnerability.	30%
Multi-Hazard Mitigation	The action reduces vulnerability for more than one hazard.	20%
Addresses High Risk Hazard	The action reduces vulnerability for people and property from a hazard(s) identified as high risk.	15%
Addresses Critical Communications/Critical Facilities	The action pertains to the maintenance of critical functions and structures such as transportation, supply chain management, data circuits, etc.	15%

Scores of 0, 1, 2, or 3 were assigned for each multi-objective mitigation action prioritization criterion where 0 does not meet the criteria and 3 overwhelmingly meets the criteria. Actions were then prioritized using the cumulative score assigned to each. Each mitigation action was given a priority ranking (Low, Medium, and High) based on the following scale:

- High Priority: 2.5 – 3
- Medium Priority: 1.9 – 2.4
- Low Priority: 0 – 1.8

The SPT reviewed the results of the evaluation and prioritization process at the May 2018 Draft Plan Review Meeting. Comments were incorporated into the evaluation, and the actions and associated numerical rankings are included in Appendix I.

6.2.4. Mitigation Action Plan

An evaluation of 2013 Mitigation Actions is provided in Table 6.2.4-1. As noted in Section 6.1 mitigation action evaluation comments from annual reviews conducted in 2014, 2015, 2016, and 2017 were combined. BORM provided initial input and then each lead and support agency agencies were e-mailed actions pertaining to their organization for review and comment. Eighteen agencies/organizations responded by providing additional and more detailed updates expanding on information provided in large group meetings.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Goal 1 - Protect lives, property, environmental quality, and resources of the Commonwealth, including RL and SRL properties.						
Objective 1-1: By 2016, reduce flood-related losses (with an emphasis on reducing repetitive loss and severe repetitive loss properties by 5%) through promotion of the Commonwealth's flood protection program through county, state, and federal partners.						
Action 1-1a. Support new state-funded flood protection and prevention projects.	Flood	Pennsylvania Emergency Management Agency (PEMA); Department of Environmental Protection (DEP); Department of General Services (DGS)	Federal Emergency Management Agency (FEMA) Hazard Mitigation Assistance Programs; US Army Corp of Engineers (USACE); US Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS); DGS; DEP; PennDOT	July 2016	Secure funding for at least four new state-funded flood protection/prevention projects, one of which should focus on flood fighting supplies and training.	Complete and continue. Move action to Goal 4, Objective 4.4 to consolidate state funding actions. An estimated $17.8 million in state funding was released during the planning period for eight projects. Two PDM and six FMA projects were approved as well. DEP and PEMA hosted 8 USACE non-structural and flood proofing workshops in Pennsylvania during the planning period. Specific details pertaining to the projects and workshops are included in Section 4.3.5. Under Funding Source: Modify DGS to PA State Capital Budget Project Authorization (Capital Budget).

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-1b. Support the maintenance of existing flood protection projects and construction.	Flood	DEP; Department of Community and Economic Development (DCED); DGS; USACE; USDA; NRCS; Local Communities	H20 PA Grant Program; Flood Mitigation Grant Program (DCED) Capital Budget, Clean Water Fund, USACE, USDA NRCS, DGS	July 2016; Ongoing	Ensure existing flood protection projects are being operated and maintained to ensure a state of readiness. Provide annual workshops for Project Sponsors to discuss maintenance tips and latest technology.	Complete and continue. DEP Project Inspection monitors 110 projects for over 90 municipal sponsors in conjunction with the USACE. Through the inspection process, DEP identifies potential work and provides sponsors with information on how they can apply for DCED Flood Mitigation Grants. DEP hosts an annual Flood Protection Workshop. Under Funding Source, replace the reference to H2O PA which is currently inactive with Act 13, and include DEP Growing Greener Watershed Protection Grants and PENNVEST.
Action 1-1c. Provide non-federal match to project sponsors for FEMA Hazard Mitigation Assistance, NRCS, USACE and other federal funding sources.	Flood	Governor's Office	Agency Operating Budget, Capital Budget, DEP	July 2016	Allocate FY 2014 funds for the non-federal match for the projects listed in Action 1-1a.	Complete and continue. Move action to Goal 4, Objective 4.4 to consolidate state funding actions. Update measure of success replacing 'Allocate FY 2014 funds' with 'Allocate state funding'.
Action 1-1d. Participate in discussions about potential solutions/policy changes regarding farm land flooding due to stream impediments.	Flood	DCED; PEMA; USDA; PDA	Staff time; Legislative liaisons; Legislative Officials	December 2016	Determine feasibility of developing supporting legislation.	In progress. Continue. DCED received funding for outreach and communication from FEMA's Cooperating Technical Partners Program (CTP). Add CTP under Funding Source. Penn State Extension suggested prioritizing crop and livestock support infrastructure during hazard incidents. Farm risks should be flagged as a priority. Change Measure of Success to reflect Penn State Extension suggestions.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-1e. Support criteria to prioritize communities with severe repetitive and repetitive loss properties for available mitigation grant funding.	Flood	Counties; PEMA; DCED	Staff time	December 2016	Document project ranking and prioritization criteria including RL and SRL prioritization criteria and by December 2013.	Complete and move to capability. PEMA's project ranking and prioritization criteria incorporate SRL and RL mitigation.
Action 1-1f. Target SRL and RL properties for mitigation including demolition, acquisition and elevation, through HMA funding through prioritization during annual HMA project review and prioritization process.	Flood	PEMA; Counties; DCED	FEMA Hazard Mitigation Assistance Programs; Staff time	December 2014	Mitigate five or more SRL properties per year. Use the list of ‘shovel ready’ projects from recent DRs to facilitate mitigation project application process for future funding opportunities.	Complete and continue. A total of 416 SRL properties were mitigated between 2014 and 2018, with an average of 104 properties mitigated per year. Details pertaining to several of these projects are highlighted in Section 4.3.5.
Action 1-1g. Incorporate prioritizing of SRL and RL property mitigation into the PEMA-HM strategy and the Administrative Plan post-flood-related disaster.	Flood	PEMA; FEMA; DCED	Staff time	1 year after a flood-related disaster	Support the development of five or more SRL properties mitigation applications per flood-related-disaster.	Complete and move to capability. RL and SRL projects are prioritized in the grant review process by PEMA. Accomplished in FEMA-4099-DR (PA Hurricane Sandy) and FEMA-4149-DR (PA – Severe Storms, Tornadoes, and Flooding, 10/1/13).

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 1-1h. Include the targeting of SRL and RL structures for mitigation in the mitigation strategies section of multi-jurisdictional or county §322 plan with SRL or RL properties.	Flood	PEMA; DCED	Staff time	June 30, 2014	Ensure that each multi-jurisdictional or county planning committee is aware and is implementing this requirement for all RL/SRL properties by March 31, 2014.	Complete and move to capability. RL and SRL properties are identified in County or multi-jurisdictional plans. This requirement is facilitated by the FEMA Plan Review Tool and Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide. The State Hazard Mitigation Planner also assists by sharing exports of RL and SRL properties from BureauNet with counties following the required privacy requirements.
Objective 1-2: Increase by 5% the number of projects implemented by the Commonwealth that will mitigate the most vulnerable structures against hazards by 2016.						
Action 1-2a. Re-evaluate state GIS database to ensure datasets include hazard mitigation, planning and critical asset identification to enable the prioritization of mitigation projects.	All Hazards	PEMA; Counties	Staff time	Annually	Identify all the exact databases, and owners of those databases, to be evaluated by February of each year. Use the results of the survey by PENNHAZUS/ FEMA Region III to determine improvements to risk assessment based on County GIS capability.	In progress. Move action to Goal 2, Objective 2.3 to consolidate data related actions. Datasets will be available on the Pennsylvania Spatial Data Access (PASDA) database by October 2018.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-2b. Maximize use of FEMA HMA grant and other programs to support all-hazard mitigation as well as acquisition/ demolition, elevation and relocation of flood-prone residences along with flood-proofing of non-residential structures.	Flood, All Natural Hazards	PEMA; Local jurisdictions	FEMA Hazard Mitigation Assistance Programs; USACE	December 2016	Identify at least 100 structures to be acquired/ demolished/ elevated/ relocated with FEMA HMA grant support by January 2015.	Complete and continue. A total of 131 projects are funded for mitigation since 2013.
Action 1-2c. Identify Section 406 projects and increase 404 funding.	All Hazards	PEMA	Staff time	December 16; Ongoing		Ongoing. This action was added during the 2015 HMP review. Reword to reflect specific sources: FEMA Section 404 -b. Hazard Mitigation Grant Program and FEMA Section 406 - Public Assistance Program. Include Measure of Success.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 1-3: Identify and work toward implementation of five feasible and cost-effective projects related to the mitigation of critical buildings, state facilities, and infrastructure.						
Action 1-3a. Define “critical facilities” in terms of mitigation.	All Hazards	PEMA, OHS	Staff time	January 2016	Update Standard Operating Guidance with statewide critical facilities definition information.	Complete and continue. Update 2013 SOG to include statewide definition of critical facilities including Tiers and definitions. Per the Governor's Office of Homeland Security (GOHS), change 'critical infrastructure' to 'critical infrastructure/key resources (CI/KR)' per Section 1016(e) of Public Law 107-56 (42 U.S.C 5195c(e.)).
Action 1-3b. Review state practices for floodplain management and consider appropriate opportunities to address multiple hazards and to encourage mitigation of state-owned or regulated facilities through a similar mechanism.	All Hazards	DGS; PA Governor's Office of Administration (OA)	Staff time	December 2016	Build on DGS policy to not build in floodplain, by promoting opportunities to address two more hazards in a state-wide policy by 2016.	Complete, remove action. Policies and regulations are written and are included in the HMP as a capability.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-3c. Encourage mitigation of private sector infrastructure through technical assistance, education, demonstrations, etc.	All Hazards	PEMA; DLI; DCED; OHS; DHS; PSP; State Police; COC's	Staff time; Agency Operating Budget; State Police	January 2016	Coordinate with five local COC's to bridge information.	Complete; modify; continue. The Pennsylvania State Police (PSP) Critical Infrastructure/Key Resource (CI/KR) Unit educates and informs by training/presenting and preparing/ disseminating Information Bulletins and Alerts on known risks and potential threats to CI/KR in the Commonwealth. GOHS provides outreach to Level 1 and Level 2 facilities. Consider modifying the Action Description to: Establish and sustain a business, industry and infrastructure subcommittee to advance the identification of CI/KR and interdependencies of CI/KR providing essential services.
Action 1-3d. Leverage support of the nine Regional Task forces to support critical infrastructure mitigation.	All Hazards	PEMA; Regional Tasks Forces	DHS Hardening/Protection related Funding as available	January 2016	Complete 1 project through each task force before the 2016 plan update.	Complete and continue. Counties apply for Homeland Security Grant Program (HSGP) funding. Include HSGP under Funding Source.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action1-3e. Continue to use and improve GIS capability to prioritize hazard/critical infrastructure for mitigation.	All Hazards	PEMA; GOHS/PSP; DGS (CC note: GOHS/PSP are in charge of the critical infrastructure list. DGS is in charge of any state facilities that are also CI. May want to add as other agencies	Staff time	December 2016	Assign mitigation priorities to critical infrastructure by December 2016.	Complete and continue. Move action to Goal 2, Objective 2.3 to consolidate data related actions. DGS has all owned and leased buildings in OA Employee/Building GIS. GOHS, PSP, and each agency are in charge of identifying CI/KR.
Action 1-3f. Continue to support LiDAR data development initiative.	Flood	PEMA; Department of Conservation and Natural Resources (DCNR)	Emergency Management Performance Grants (EMPG); National Preparedness Funds	December 2016	Determine if any of the counties that underwent LiDAR data development will go through the Risk MAP process and if other counties should be prioritized for LiDAR development moving forward.	Complete and modify. Move action to Goal 2, Objective 2.3 to consolidate data related actions. Several locations in Pennsylvania have participated in or are working with FEMA on Risk Mapping, Assessment, and Planning (Risk MAP) projects. All or parts of 38 counties are in the Risk Map Post-Preliminary Process and all or parts of seven counties are in the Risk MAP Discovery Process. Improve coordination between FEMA and ACOE on Pennsylvania communities participating in Risk MAP. Reference the acquisition of orthophotography as identified in the Commonwealth's Geospatial Strategic Plan.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-3g. Identify insurable state-owned flood-prone buildings and appropriate mitigation methods if located in the special flood hazard area (SFHA).	Flood	DGS; DCED	FEMA Hazard Mitigation Assistance Programs; USACE	December 2016	Continue to coordinate with DGS to see progress of DGS database for use in SSAHMP work.	Ongoing and continue. DGS is continuing to work with OA to develop and refine GIS mapping of Commonwealth Owned and Leased buildings and providing flood layers. Revise Target Completion Date to: December 2018.
Action 1-3h. Evaluate state-owned structures for mitigation options for non-flood related high-priority hazards.	All Hazards	PEMA; Identified state agencies	Homeland Security Grant Programs 20% Portion	December 2016	Identify all state-owned structures vulnerable to high priority hazards by December 2016.	Ongoing and continue. Update Measure of Success to include a workshop with state agencies to identify state-owned structures vulnerable to high priority hazards. Structures identified during the planning period included: 911 towers and generators in Lehigh and Northampton counties; State System (Disaster Resistant University) DRU facilities.
Action 1-3i. Provide emergency electrical backup generation to key state, county, and municipal critical facilities.	All Hazards	PEMA, FEMA	FEMA Hazard Mitigation Assistance Programs; HMGP 5% initiative	July 2016; Ongoing	Identify and prioritize key facilities including critical gas stations by December 2013. Submit five relevant projects by 2014.	Complete and continue. PEMA developed a two-page survey to evaluate generator needs with 20 counties responding. FEMA supports pad and patch panel installation with a generator contract to provide the actual unit. This requires less maintenance.
Action 1-3j. Add internet interruption to the list of reportable incidences in PEIRS and Knowledge Center.	Utility interruption	PEMA, counties	Staff time	Fall 2014	Data tracking in place for utility interruption incidences that can be used for HM planning.	No progress. Modify action to include the system that replaced PEIRS.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 1-4: Identify projects related to advanced warning within the Commonwealth by 2016.						
Action 1-4a. Support the sustainment and enhancement of Commonwealth fusion centers.	Terrorism, Civil Disturbance	PEMA; Pennsylvania State Police; OHS	Department of Homeland Security (DHS) Grant Funding	December 2016	Identify the resources that would need to be acquired to sustain fusion centers by January 2014.	Complete and continue. The PSP Pennsylvania Criminal Intelligence Center (PaCIC) won three national awards: National Network of Fusion Centers 2015 Fusion Center of the Year Award, and two state employees received the Michael Schooler Critical Infrastructure Protection Award and the Excellence in the Field of Fusion Center Outreach Award. PSP won the Association of Law Enforcement Intelligence Units award: 2016 LEIU General Chairman's Award.
Action 1-4b. Promote reverse notification systems in high-hazard areas.	All Hazards	Counties	DHS Grant Funding; Act 78 Funding	June 2016	Identify and catalog success stories of jurisdictions utilizing reverse notification system by June 2014.	In progress and continue.
Action 1-4c. Increase participation in PA Alert.	All Hazards	OA	DHS Grant Funding	June 2016	Increase participation by 50% between 2013 and 2016.	In progress and continue.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 1-4d. Establish Water Monitoring Council Action to improve stream gauge coordination in Commonwealth.	Flooding	USGS; River Basin Commissions; PEMA; DEP; NWS; USACE; Water Authorities; Municipalities; FEMA	USGS; USACE; PA DEP; Water Authorities; Municipalities (2014 - SRBC, DRBC, USACE Question)	July 2016	Council established and met by 2016.	Continue. Discussions have occurred among various commissions, agencies and users about the need for and benefits of a water monitoring council but no formal work group has been established. Modify Target Completion Date to five years. Update Measure of Success to: A consistently meeting workgroup and an updated dashboard of monitoring/weather data where users have access to or have a web link to all available data.
Action 1-4e. Complete flood inundation mapping, like completed for Harrisburg, for additional high risk and high population centers.	Flooding	SJ Initiative including USGS; USACE; NWS; PEMA; River Basin Commissions; FEMA	USGS; USACE	July 2016	Complete one flood inundation mapping project and related outreach per year based on funding availability.	In progress and continue. Flood inundation mapping underway for 100 miles of the Susquehanna River was completed in 2017.
Action 1-4f. Develop Risk profile, capability analysis and mitigation actions for new hazards of cyber attack and animal disease.	Cyber-terrorism, Mass Food/Animal Feed Contamination	PEMA	Staff Time	October 2016	Complete FEMA standard additions to Risk, Capabilities and Mitigation Strategy portions of the plan.	Complete. Remove action. New hazards added during the 2015 and 2016 annual reviews. Hazards have been incorporated into the 2018 SHMP.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 1-5: By 2020, minimize risk to communities posed by levee structures by increasing compliance of all levees with National Levee Safety Program standard, focusing on planning and certification.						
Action 1-5a. Re-examine impacts of federal levee guidance and identify necessary actions.	Flood; Levee Failure	DEP; DCNR; USACE; FEMA	Staff time	Continuous	Continue to work with the USACE to implement the National Levee Safety Program and refine an inventory of all levees in the Commonwealth.	In progress and continue. DEP has an inventory of the 46 levees currently inspected under USACE's Inspection of Completed Works Program. Per DEP, remove DCNR from Lead/Support agencies. Add Act 13 Flood Mitigation Grants to Funding Source. Update Measure of Success: Support USACOE in efforts to conduct inspections and risk assessments of non-Program levees. The action complements FEMA's Levee Analysis and Mapping Procedures projects. New maps will be developed.
Action 1-5b. Support non-state and non-federal levee owners, identified in the National Levee Inventory, with information on compliance with the National Levee Safety Program and appropriate funding streams.	Flood; Levee Failure	USACE; FEMA	Staff time	December 2016	By 2013, USACE has performed outreach activities with 50% of levee owners.	In progress and continue. DEP staff conducts outreach and refers sponsors to DCED for Act 13 Flood Mitigation Grants, assists communities with developing Emergency Action Plans, and enrolling/restoring projects in the USACE PL84/99 Rehabilitation Program.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-5c. Develop emergency action plan guidelines for flood protection projects to assist project sponsors with developing project specific EAPs including inundation maps.	Flood; Levee Failure	DEP; USACE; PEMA; levee owners; County EMAs	Staff time	December 2014	Scheduled for completion in December 2014.	Complete and continue. The DEP Guidance Document for developing Emergency Action Plans for levees and floodwalls was finalized in July 2013 and is available at http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-108064/3110-BK-DEP4414%20EAP%20Guidelines%20for%20FPPs.pdf. Modify Target Completion Date: Update 2013 DEP guidance by December 2019. Modify Measure of Success to: When guidance is published.
Action 1-5d. Identify and work with local sponsors of state levee systems, given an unacceptable or minimally acceptable rating, to bring them back up to acceptable rating.	Flood; Levee Failure	DEP; DCED; USACE	Staff time, capital budget, H20 PA Grant Program, local government; DCED Act 13 Flood Mitigation Grant Program (2014 - DEP & USACE)	July 2016, Ongoing	Explore funding opportunities to provide support for levee project improvements.	Complete and ongoing. Funding sources identified include: Flood Mitigation Grant program, state Capital Budget, H2O PA Grants, Growing Greener Grants, Act 13 Flood Mitigation, Act 13 Watershed Restoration. A total of 17 projects were completed during the planning period. Per DEP, consider eliminating the action, which is levee specific. Action 1.1-b addresses all projects, including levees.
Action 1-5e. Encourage local, state, and federal levee system sponsors to develop Emergency Action Plans.	Flood; Levee Failure	USACE; DEP; Counties; Local Municipalities	Staff time	December 2013	Obtain Emergency Action Plans for 50% of state levee systems by December 2015.	Complete and continue. Change Target Date to: Ongoing. Currently 12 of 63 (19%) sponsors have submitted revised EAPs since 2013 guidance update. Modify Measure of Success: Obtain Emergency Action Plans for 29% of state levee systems by December 2020.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Objective 1-6: By 2016, provide outreach and training opportunities for local building code enforcers by 500 individuals within the Commonwealth.						
Action 1-6a. Develop and deliver a workshop on building code implementation.	All Hazards	DCED; FEMA Region III	HMGP 5% Initiative	December 2015	Provide six workshops statewide by December 2016.	Complete; continue. Modify action to reflect all different types of training for construction code officials. The PA Municipal League developed the PA Construction Codes Academy (PCCA) to provide statewide training and certification requirements for construction code officials. The Governor's Center for Local Government Services within DCED contracts with the PA Municipal League to provide the training. Training includes a five-day classroom course held throughout the year, live and archived webinars, and self-guided online training. Between 2013 and 2017, 268 classroom courses were held in addition to archived webinars, online training sessions, and sponsored trainings. In total, 8,117 people received training during this time period.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-6b. Provide briefings to code association and county officials on damage assessment expectations following a disaster.	All Hazards	PEMA; DCED; FEMA Region III	EMPG; HMGP	Ongoing	Determine code officials "plug-in" and existing training opportunities.	Ongoing. PEMA coordinates briefings post disaster. FEMA Region III provided a Surveyor Session in Western Pennsylvania in 2015. Counties are invited when PEMA conducts Disaster Assistance meetings. PA State Association of Boroughs and PA Municipal League conduct training. Consider developing the following courses: BMP course on damage assessment and methodologies, disaster webinar for County tax assessors and board of appeals employees and municipal officials. Make sure construction code officials receive training credits.
Action 1-6c. Invite the following groups to outreach meetings related to building resiliency and mitigation of structures: PA Association of Building Code Officials, PA Association of Code Officials and Council of Government organizations (COG).	All Hazards	PEMA; DCED	Organizational funding	December 31, 2016	Bridge the Silver Jackets with Codes Academy.	Ongoing. The PA Municipal League developed the PA Construction Codes Academy (PCCA) to provide statewide training and certification requirements for construction code officials. The Governor's Center for Local Government Services within DCED contracts with the PA Municipal League to provide the training. Training includes a five-day classroom course held throughout the year, live and archived webinars, and self-guided online training. Refer to Action 1-6a for results. Change Target Completion Date to Ongoing. Under Lead/Support Agencies add PA Municipal League.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 1-7: Increase coordination, prioritization, and funding availability to address community needs for dam hazards with special emphasis on inundation zone evaluation by 2016.						
Action 1-7a. Build on Silver Jackets initiative and on DEP's initiative to require dam owners to complete a dam break analysis and map inundation areas for dams of high hazard potential.	Flood, Dam Failure	DEP; PEMA; Counties	Staff time; National Dam Safety Program grant; USACE Silver Jackets, Dam Owner	December 2015	Host meeting by May 2014. Ensure that 95% of high hazard dams have completed a dam break analysis in order to develop a digital inundation map by December 2015.	Ongoing; continue. Flood inundation mapping in the Harrisburg area was completed in 2015 by PA Silver Jackets. Per DEP, consider removing reference to Silver Jackets Initiative Change Target Completion Date to: Ongoing. Modify Measure of Success: Increase percentage each year.
Action 1-7b. Identify and implement mitigation actions based on Silver Jacket meeting results.	Flood, Dam Failure	PEMA; DEP; USACE	Staff Time	December 2016	Conduct capability assessment of departments and agencies that can assist with mitigation implementation by December 2016.	Complete and continue. PA Silver Jackets continually updates Best Pennsylvania Flood Protection, Preparedness documents for Public and Municipal Officials (http://silverjackets.nfrmp.us/State-Teams/Pennsylvania). Modify Measure of Success to: Completion of Screening Level Risk Assessments by USACOE.
Action 1-7c. Evaluate and enforce appropriate remediation of dams.	Flood, Dam Failure	DEP (2014 - American River Association teardowns included (ARA non-regulatory)	Staff time; PENNVEST loan and grant program; H20 PA Grant Program; Growing Greener; capital budget; dam owner	December 2016; Ongoing	Identify applicable dams and enforce and assist with remediation.	Complete and continue. As part of the Dam Safety Program DEP enforces and assists with remediation projects. Yearly breakdown: 13 in 2013, 13 in 2014, 16 in 2015, 8 in 2016, and 5 in 2017. Change Target Completion Date to: Ongoing. Modify Measure of Success: Report DEP annual records of dams' removals.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-7d. Ensure that all high hazard dams to have an Emergency Action Plan as required.	Flood, Dam Failure	DEP, PEMA	Staff Time; Dam owner	December 2016	Obtain PEMA and DEP approved Emergency Action Plans for 95% of high hazard dams by December 2015.	Ongoing; continue. Change Target Completion Date to: Ongoing. Modify Measure of Success to achieve 95% EAP approval by December 2018.
Objective 1-8: Encourage aggressive enforcement of floodplain and storm water management ordinances and other all-hazards regulations within the Commonwealth to reduce losses in high risk areas.						
Action 1-8a. Continue to track floodplain management ordinance information including adopted building code(s), other relevant ordinance(s), code(s), regulation(s), etc., and the incorporation of any more restrictive requirements.	Flood, All Hazards	DCED; PEMA; FEMA Region III	Community Assistance Program – State Support Services Element (CAP-SSSE)	Continuous	Maintain or increase NFIP participation after FIRM update ordinance reviews. Promote early review and submission of ordinances to DCED.	In progress and continue. PEMA and DCED issued a Joint Letter to Municipalities with Suspended or Non-Participating NFIP designation in FEMA's BureauNet & CIS Systems. This resulted in several communities re-engaging by contacting DCED and FEMA Region III Floodplain Management offices. Add FEMA Cooperating Technical Partners Program (CTP) Grant to Funding Source. This grant is administered by DCED.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 1-8b. Conduct effective outreach with municipalities to explain value of floodplain ordinances and adopting more restrictive requirements.	Flood, All Hazards	DCED; PEMA; FEMA Region III	Community Assistance Program – State Support Services Element (CAP-SSSE)	Continuous	Reach 200 municipalities annually with ordinance related materials.	Complete and ongoing. The PA Municipal League was contracted by the Governor's Center for Local Government Services within DCED to deliver Floodplain Management Outreach Services to municipalities. Services provided include floodplain management training for municipal officials and updating municipal zoning ordinances. Certified Floodplain Managers and code officials earn certification maintenance credits and obtain a better understanding of the NFIP. Approximately 718 floodplain ordinances were adopted between 2013 and 2017. Add PA Municipal League training under Funding Source.
Action 1-8c. Explore the possibility of providing legal support for floodplain management ordinance enforcement to municipalities.	Flooding, All Hazards	DCED; FEMA Region III; State legal counsel	Staff time	July 2014	Coordinate with DCED and meet with state legal counsel.	In progress. Add municipal solicitor to Lead/Support Agency and Measure of Success. DCED municipal program funding is used for ordinance adoption (50%), administration, and enforcement including litigation.
Objective 1-9: Promote increased implementation of urban-wild land interface (wildfire) mitigation projects by local communities by 2016.						
Action 1-9a. Conduct formal statewide community risk assessment using Risk Assessment Mitigation Strategies database.	Wildfire	DCNR Bureau of Forestry; Office of State Fire Commissioner	Staff time	June 2014	Risk assessment disseminated to all communities by June 2014.	Continue. In progress.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 1-9b. Work with FIREWISE communities to complete grant applications for outreach and fuels reduction projects.	Wildfire	DCNR Bureau of Forestry; Office of State Fire Commissioner	Staff time	December 2016	Identify any support available to DCNR through the HMP process.	Continue. In progress.
Objective 1-10: Enhance Commonwealth efforts to address mine/quarry related hazards by increasing inter-agency cooperation.						
Action 1-10a. Support effort to complete subsidence mapping in the Commonwealth.	Subsidence Sinkhole	DEP – Mine Safety; Counties impacted by surface mine related hazards	State Funding	December 2014	Disseminate mapping and insurance information to jurisdictions once complete.	In progress. Modify Lead/Support Agency from DEP - Mine Safety to DEP - Mining and DCNR. The changes reflect that subsidence is caused by more than abandoned mines. It can be the result of water impact due to karst geology and properties in an active quarry's 'zone of influence'. DCNR maintains a sinkhole map/data layer and should be an active partner in the action. Quarry subsidence incidents are handled by DEP District Mining Offices. Priority should be on educating land owners on DEP programs, plans, and procedures. Change Target Completion Date to: Ongoing as funding and time permit. Modify Measure of Success to focus less on mapping every property and more about notifying counties, municipalities, and state agencies about what is currently finished; what is available to citizens in mining and non- mining areas; and how to utilize mine subsidence insurance, if available.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-10b. Fully characterize coal ash basin inundation zones, rank hazards, and develop mitigation actions.	Environmental Hazards	DEP/Bureau of Mining and Reclamation/Bureau of Waterways Engineering; PEMA	State Funding; U.S. Environmental Protection Agency	September 2016	Continue to implement Chapter 8 and work towards zero flowback.	Complete. Remove action. According to DEP's Bureau of Waterways Engineering and Wetlands this effort is complete and should be removed. CCR regulations required this action to be complete and all Pennsylvania sites have been evaluated and are on a schedule for inspection.
Objective 1-11: Enable the Department of Environmental Protection to fully characterize hazard issues from Marcellus Shale natural gas extraction operations and explore mitigation options by 2016.						
Action 1-11a. Identify impacts and consequences of Marcellus Shale natural gas extraction operations.	Environmental Hazards	DEP; Counties impacted by Marcellus Shale	Act 13 impact fee	March 2014	Complete TENORM study by 2016.	Complete. Remove action. DEP completed the TENORM study and concluded there is little potential for harm to workers or the public from radiation exposure due to oil and gas. The study is found at the following link. development. http://www.dep.pa.gov/Business/Energy/OilandGasPrograms/OilandGasMgmt/Oil-and-Gas-Related-Topics/Pages/Radiation-Protection.aspx.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-11b. Identify mitigation options for identified impacts and consequences.	Environmental Hazards	DEP; PEMA; Counties impacted by Marcellus Shale; PUC; PennDOT	Act 13 impact fee	December 2014	A preliminary list of actions will be identified by June 2014. Through Act 9, PEMA developed an Unconventional Well Site Emergency Response Plan template which was distributed to Counties. Over $200M was raised from Act 13 impact fees and distributed to local and state programs.	Complete and ongoing. Modify Action Description to reflect shale gas formation extraction and distribution. The Emergency Response Plans (ERP's) template has been made available to the response community. The identification of mitigation actions for impacts is ongoing as wells are permitted/drilled. Add Oil and Gas Industry to Funding Source as well drillers/operators are required to develop/provide an EPR for their sites. Change Target Completion Date to: Ongoing. ERPs are submitted and stored by DEP and are available online via DEP's Oil and Gas Mapping tool available: http://www.depgis.state.pa.us/PaOilAndGasMapping/OilGasWellsStrayGasMap.html.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 1-11c. Provide training that will enable counties to mitigate the negative impacts of Marcellus Shale extraction.	Environmental Hazards	DEP; Office of State Fire Commissioner and Academy; Partnerships with private sector; Counties impacted by Marcellus Shale; Universities	Act 13 impact fee	July 2015	Develop training by January 2015. Promote US Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety (US DOT PHMSA OPS) training webinars as appropriate.	Complete and continue. The Pennsylvania Public Utility Commission (PUC) provides oversight of Act 13 expenditures via annual reports submitted by recipients. Training plans and curriculum have been developed and are being offered. The Office of State Fire Commissioner has conducted 100 classes for well drilling professionals and emergency responders. A total of 2,292 students have been trained. At the time the state HMP update was prepared, gas industry activity has slowed down in Pennsylvania; therefore, urgency has diminished. Modify action to ensure communities are aware of and taking advantage of the funding and training opportunities (tools/plans/classes) available. Modify action to include support for a Hazmat and Pipeline Training facility in Pennsylvania in connection with a college or university. A PHMSA/Pennsylvania facility would allow for regional federal training on both hazmat for trains and pipelines as well as pipeline safety certification.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 1-12: Manage all Repetitive Loss and Severe Repetitive Loss databases, providing updates to FEMA at least annually in order to more efficiently identify properties to be mitigated.						
Action 1-12a. Maintain access to the National Flood Insurance Program (NFIP) BureauNet database of repetitive loss properties.	Flood	DCED; FEMA; PEMA	Staff time	Continuous (meet annual requirements)	Ensure identified PEMA and DCED program managers receive by BureauNet access by October 2010.	Remove action. DCED and PEMA staff have access to BureauNet and to FEMA Community Information System for NFIP data. Per FEMA, the action is more an administrative initiative rather than an action and should be considered for removal.
Action 1-12b. Improve the accuracy of geo-locational data on RL and SRL properties by researching matches for properties with incomplete and/or out-of-date addresses based on rural road designations that have changed.	Flood	DCED; PEMA; Counties; FEMA Region III	Staff time and travel	Continuous	Continue to verify and update as additional properties are added.	Ongoing and move to capability. The BureauNet data has been consistently and regularly updated since 2010. Not only has the rural route and geocoding information improved dramatically, the mitigation status and additional fields found for RL and SRL properties have improved.
Action 1-12c. Align RL and SRL property data with validated FEMA NFIP RL and SRL property data annually.	Flood	DCED; PEMA; County EMAs and Planning Departments	Staff time	December 2012	Continue to routinely extract validated property information as needed from BureauNet.	Ongoing and move to capability. The BureauNet data has been consistently and regularly updated since 2010. Not only has the rural route and geocoding information improved dramatically the mitigation status and additional fields found for RL and SRL properties have improved.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-12d. Use the Greatest Savings to the Fund (GSTF) data and methodology to promote the cost-effectiveness of SRL property mitigation for HMA grant applications.	Flood	PEMA; DCED	Staff time	June 2011	Use Greatest Savings to the Fund data in HMA grant applications, when applicable.	Changed. The GSTF analysis changed with the 2013 updates to the HMA program. This particular data set is not produced and shared by FEMA at this time. Pennsylvania has elected to continue the spirit of this initiative through the priority communities selected for outreach and mitigation in the annual Risk Reduction Consultation collaboration between State and Federal partners. This initiative identifies priority communities and in general focused on historic river towns with high flood risk. See new Action 5-2a focused on outreach to high priority communities.
Action 1-12e. Report the successes of flood-related projects in the annual update of the SSAHMP and provide a summary in the triennial plan update. Draft annual report by October 15th and finalize for submittal to FEMA no later than October 31st of the report year.	Flood	PEMA; DCED	Staff time	Continuous (annual requirement)	Submit annual reports on time; solicit support for RL/SRL funding to compile data.	Complete and continue. Annual reports outlining mitigation successes are prepared and submitted to the Governor's Office. A summary from each annual update is included in the Mitigation Successes section of the 2018 update. Add CDBG-DR to Funding Source.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-12f. Examine the FEMA-PEMA SRL and RL data sets to seek properties that could potentially be mitigated through the FEMA RFC, SRL or other HMA funding programs or any other funding sources on an annual basis.	Flood	PEMA; Counties; DCED	Staff time	December 2014	Improve prioritization criteria for project selection in both pre- and post-disaster modes.	Ongoing and move to capability. The SRL and RL data is regularly reviewed and used to prioritize mitigation action in Pennsylvania.
Objective 1-13: Compare properties within the Commonwealth that are known to have been mitigated with the FEMA-provided data sets for SRL and RL properties on an annual basis, and complete FEMA Form AW-501 to support update of the FEMA SRL and RL property databases.						
Action 1-13a. Update annually the list of completed SRL and RL mitigated properties and use GIS or other methods to merge FEMA's SRL and RL database with Pennsylvania's mitigated properties database. Update the merged database when each HMA grant closes or whenever local data becomes available.	Flood	PEMA; Counties; DCED	FEMA Hazard Mitigation Assistance Programs (management costs)	Continuous	Include information in annual report (Action 1-12e);100% compliance needed.	Modify. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Revise action to incorporate actions 1-13b, 1-13c, 1-13d, and 1-13e. Though this is generally viewed as a capability for Pennsylvania, it should be kept as an action due to the importance of annual review and reporting on this topic.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-13b. Complete FEMA Form AW-501 for each mitigated property and provide to FEMA through FEMA database or submittal to Region III upon project close-out.	Flood	Municipalities; PEMA	Staff Time and HMA Funding	Continuous (tri-annual requirement)	Tri-annual report accurately submitted on time.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.
Action 1-13c. Use GIS to merge the Increased Cost of Compliance SRL and RL database with Pennsylvania's mitigated properties database annually.	Flood	PEMA; DCED	Staff Time	Continuous (annual requirement)	Annual report accurately submitted on time.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-13d. Ensure that the latitude and longitude of each property is confirmed during project close-out as well as during sponsoring community's three-year mitigation compliance inspection for completed properties. Update mitigated properties Excel workbooks to assure accurate status of mitigated RL and SRL properties.	Flood	Municipalities; PEMA; DCED	FEMA Hazard Mitigation Assistance Programs (management costs)	Continuous	Accurately submitted tri-annual reports and project close-outs.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 1-13e. Contact counties with SRL properties to confirm the number and type of mitigated properties and source of funding, if known. This approach can be used to establish an ongoing process of verifying addresses by gathering latitude and longitude data and will ensure currency of the FEMA RL and SRL datasets.	Flood	PEMA in coordination with Counties and Counties in coordination with municipalities; DCED	Staff time	Continuous	Reach out to 2 counties per year starting with locations with highest number of RL and SRL properties.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 1-14: Promote Natural System Protection mitigation in the Commonwealth between 2013 and 2016.						
Action 1-14a. Identify cooperative funding opportunities with DEP for natural system protection projects	Flooding	PEMA; DEP; NRCS	FEMA Hazard Mitigation Assistance Programs; Growing Greener	July 2016	Obtain hazard mitigation funds for a stream corridor restoration or wetland restoration project associated with flooding by July 2016.	Complete and continue. DEP's Stream Improvement Program provides funding to restore stream channels damaged in floods and to stabilize streambanks affected by erosion. The program funds between 15 to 20 projects annually. This program was used as match for NRCS Emergency Watershed Protection funding on projects following flooding in October 2016 and is anticipated to be used similarly for projects impacted by flooding in July 2017. Add DEP Stream Improvement Program, NRCS Emergency Watershed Protection Program, and DCED Act 13 Flood Mitigation Grants to Funding Source. Due to the property specific nature of individual projects, DEP notes that a contiguous corridor of stream restoration is not always feasible. Reword action to remove DEP, keeping agency partners flexible.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Goal 2 - Enhance consistent coordination, collaboration, and communications among stakeholders.						
Objective 2-1: Promote development of COOP and COG plans for critical infrastructure within the Commonwealth, focusing on water treatment, water supply, and critical goods and services suppliers.						
Action 2-1a. Identify and prioritize critical government facilities and infrastructure that require back-up systems.	All Hazards	OA with support from all State Agencies; Counties; USACE	State agency funding; DHS grants	December 2016	Collect lat/long data for identified critical facilities. Request USACE Power team review of generator sizing.	Complete and ongoing. Latitude/longitude data for identified critical facilities has been collected. Through the Emergency Power Facility Assessment Tool (EPFAT,) generator requirements can be identified. FEMA Region III and PEMA sponsored a generator course at Ft. Indiantown Gap in 2015. Change Target Completion Date to Ongoing.
Action 2-1b. Conduct outreach to privately-owned businesses and infrastructure that provide critical services in post-disaster situations to encourage them to develop COOP or Business Recovery Plans.	All Hazards	PEMA; OHS; DHS; DCED; DHS Protective Services	Staff time	January 2016	Complete two outreach workshops by January 1, 2016. Gather information on complementary workshops from DHS/GOHS for next SSAHMP update.	Complete and continue. SCTF conducts an annual workshop at HACC. Under Lead/Support Agency modify DHS Protective Services to DHS Protective Security Advisors and Task Forces e.g. Regional Coalition for Business, Business Industry and Infrastructure (BI&I), CI/KR sub-committee). Add Department of Homeland Security (DHS) Grant Funding under Funding Source. GOHS noted that post disaster is the time that owners and operators of CI/KR can make strategic purchases to advance physical and cyber-security and resilience.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Objective 2-2: Promote integration of mitigation goals, objectives, and actions where appropriate in other federal, state and local planning initiatives by 2016.						
Action 2-2a. Integrate local (county level) risk assessment data into the State Plan updates and vice versa to ensure consistency between state and local plans with respect to the best available data.	All Hazards	PEMA; Municipalities; Counties	Staff time; Plans funded by Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Program (HMGP) funding	Continuous	Coordinate with PEMA OPS to integrate HM planning data and local plans into a single PA planning portal. Continue to update the SOG and provide annual training.	Continue and ongoing. Local plans are integrated into Pennsylvania's planning portal at: http://www.pennsylvaniahmp.com/home. The SOG will be updated in 2018.
Action 2-2b. Silver Jackets work to identify current policies, plans, regulations, and laws that should include mitigation.	All Hazards	PEMA; Other State Agencies; Silver Jackets; PAFPM	Staff time	January 2015	As part of the update to the SJ mitigation guide, include lessons learned and planning guidance for local officials.	Complete and continue. PA Silver Jackets Interagency Flood Mitigation Program Guide was updated in 2015. Update Measure of Success to include that Pennsylvania's planning portal will provide a link to the program guide.
Action 2-2c. Identify highest priority action items for counties that do not currently have a highest priority mitigation action identified in Section 6.3.2.	All Hazards	PEMA; Municipalities; Counties	Staff time	Ongoing	Update local standard operating procedures to reflect new mitigation action prioritization method so that highest ranking actions can be identified in the 2016 SSAHMP update.	Complete and continue. Local standard operating procedures have been updated per the SOG.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 2-3: Support Pennsylvania Emergency Management Agency in developing mitigation data strategies for decision-makers by 2015.						
Action 2-3a. Develop a comprehensive list of types of data that decision-makers might need by December 2015.	All Hazards	PEMA	Staff time	December 2015	Share the list of identified data with stakeholders.	Complete and ongoing. Add the following under Lead/Support Agency: OA, FEMA, PASSHE, counties (GIS).
Action 2-3b. Build a network of data stewards.	All Hazards	PEMA; Other State Agencies; Municipalities; FEMA Region III	Staff time	July 2015	Survey counties for available data and consolidate with agency GIS.	Ongoing. Consolidate with Action 2-3b and reference GeoBoard.
Action 2-3c. Develop data-sharing protocols.	PEMA; OA; OIC	PEMA; OA IT; FEMA Region III	Staff time	January 2015	Create and distribute a protocol that encourages local jurisdictions to coordinate with state when updating plans and best available data by January 1, 2015.	Complete and ongoing. Consolidate with Action 2-3a and reference GeoBoard.
Action 2-3d. Develop Pennsylvania-specific earthquake soil site classification data for use in Hazus earthquake modeling.	Earthquake	DCNR; PEMA	PDM; Staff time	March 2016	Completed, Hazus-ready GIS geodatabase with site classifications assigned statewide	Remove action. Low-risk hazard. State funding is not available to address.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 2-3e. Improve electronic data sharing between municipalities, BHP and PEMA to ensure statewide data remains current on historic properties and may be used for risk analysis.	All Hazards	Bureau for Historic Preservation (BHP) of PHMC; PEMA; FEMA	National Parks Service	June, 2016	Determine the status of historic resource surveys by municipality and identify under-surveyed areas. Encourage communities with local survey information to share their survey data with BHP and provide communities that have not completed survey with existing BHP survey tools to inventory locally important cultural and historic resources. Include historic properties risk analysis for high hazards in next SSAHMP update.	Ongoing. The Bureau for Historic Preservation (BHP) changed its name to the State Historic Preservation Office (PA SHPO) in 2015. Modify references accordingly. Cultural resource data are shared with hazard mitigation planners in every county. Municipalities with little or no data on historic properties are identified and targeted for survey projects. PA SHPO, PEMA, and counties promote partnership and funding opportunities for collecting and updating data, including the PHMC Keystone Historic Preservation Grant Program and the federal Certified Local Government Program. Four counties (Monroe, Bucks, Pike, Montour) participated in PHMC pilot program. PHMC met with PEMA to update PEMA HMP SOG used by counties and universities for HMP and DRU required revisions. Add counties to Action Description. Change target completion date to ongoing. Modify Funding Source to include Preservation and Disaster Planning.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Objective 2-4: Identify local Hazard Mitigation Officers and increase participation by local community representatives in the Commonwealth's Mitigation Planning Team by 50% between 2013 and 2016.						
Action 2-4a. Maintain planning, emergency management, and GIS/data management contacts lists and expand contacts to include conservation districts.	All Hazards	PEMA and Area Offices; DEP; Counties	Staff time	Continuous	Expand contact lists to include conservation districts.	In progress. Remove DEP from Lead/Support Agency and add the Office of Administration (OA). The State Geospatial Coordinating Board (GeoBoard) was established through Act 178 of 2014 within OA. The Board advises the Governor and public on geospatial issues, uniform data standards, and coordination across different sectors. Modify Measure of Success to reflect continual update and expansion of hazard mitigation contacts.
Action 2-4b. Create State/Federal charter and bring county leads and planning champions together for regular meetings, knowledge exchanges, and trainings.	All Hazards	PEMA; DCED' KEMA; FEMA Region III	Staff time; Agency operating budget; FEMA-sponsored training	December 1, 2015	Provide three integrated planning workshops/ seminars throughout the state (building on Bucks County pilot) by 2016.	Complete. Workshops were completed as part of the planning process for each of the 20 county hazard mitigation plans updated during the planning period. Planning partners are invited to participate in annual plan updates. Training events such as the Governor's Emergency Preparedness Summit are held annually. Reword action to remove state/federal charter and continue to encourage participation of local, county, regional, and state planning partners in hazard mitigation planning.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 2-4c. Involve appropriate county mitigation plan team members in hazard mitigation implementation activities.	All Hazards	PEMA; Counties	Staff time	Continuous	Offer training or meeting opportunities for county mitigation planning team members at PEMA Annual Conference.	Complete and continue. Six FEMA Mitigation for Emergency Managers (G-393) courses were taught in 2016 - 17 and one FEMA Mitigation Planning for Local and Tribal Communities (G-318) course has been held per year. Under funding sources add: EMPG, HMGP, PDM, FMA Management costs.
Action 2-4d. Identify and pursue projects that tie-in goals and initiatives of multiple State Planning Team member agencies.	All Hazards	PEMA; State Planning Team members	FEMA Hazard Mitigation Assistance Programs; USACE	May 2016	Complete high priority mitigation actions by May 2016	Continue. Progress made on high priority mitigation actions. Find sustained opportunity to meet and problem solve, like annual ARAP meeting. Assemble agenda by ESF to review problems by topic.
Action 2-4e. Develop County Hazard Mitigation Suggested Curriculum.	All Hazards	PEMA; Counties	EMPG	January 1, 2016	Encourage at least one member of the local hazard mitigation team with a Certified Floodplain Manager (CFM) certification.	Complete and continue. PEMA and DCED promote Certified Floodplain Manager training. SHMO distributes Hazus, Floodplain and Building Science course dates for EMI through counties. DCED's NFIP Coordinator lists CFM training on PAFPM's website.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 2-5: Continue to support coordination between mitigation, planning, preparedness, and response personnel throughout the Commonwealth to ensure effectiveness in all-hazard mitigation planning.						
Action 2-5a. Improve cooperation/ coordination of agencies with real time data (gauge station data, program availability, etc.).	All Hazards	Local, county, and state public safety agencies with planning support agencies	Various	Continuous	Combine data moving forward into the next generation EOC.	In progress. PEMA knowledge center hazard mitigation buildout complete in 2017. HMGP DR-4099 virtual warning project in Huntingdon, Dauphin, and Lancaster counties completed in 2016. Stream gauges used real time during flood events with Swatara Township, Dauphin County flooding noted as an example. Critical Infrastructure Reporting completed. DHS Special Event reporting was conducted in 2015 for the Papal visit to Philadelphia. Board developed for Ice Storms in 2015. The FDA- funded Food & Rapid Response Plan formalized a network and state trigger points document was prepared. Penn State Extension suggests adding a food or agriculture component to WebEOC. It was noted that food processors have an established network on WebEOC.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 2-5b. Reach out to agencies that were invited but did not participate in 2013 planning process.	All Hazards	PEMA; Silver Jackets	Staff time; USACE	October 1, 2014	Participation in 2016 State Plan update builds on 2013 success and has more than 45 participating agencies/organizations/ county representatives.	Complete and continue. PEMA encourages broad state agency participation in the annual mitigation action review and update to the state plan. A total of 61 agencies/organizations/county representatives participated in the 2018 State Plan update, including representatives from 24 organizations that did not participate in the 2013 planning process.
Action 2-5c. Identify strategic locations to deploy USACE Power Teams after a disaster.	All Hazards	PEMA; Silver Jackets; USACE	Staff time	January 2014	Establish contact with USACE Pittsburgh and Philadelphia Districts to determine POC for Power Team organization.	Ongoing. Delayed due to funding. Data entry into EP Facility Assessment Tool required including connections for a generator and size. Luzerne County Power Team visits conducted at pumping stations and other critical sites. EP Facility Assessment Tool should be added in the COOP plan.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Goal 3 - Provide a framework for active hazard mitigation planning and implementation.						
Objective 3-1: Identify opportunities for regional organizations, businesses, and universities to be engaged in hazard mitigation planning.						
Action 3-1a. Maintain a comprehensive list of relevant regional agencies, including Councils of Government (COGs), River Basin Commissions, and Metropolitan Planning Organizations (MPOs).	All Hazards	PEMA	Staff time	Continuous	Identify a champion of this activity to oversee its development by January 1, 2014.	Complete and continue. PA Silver Jackets has developed a comprehensive list of relevant regional planning agencies available at: http://silverjackets.nfrmp.us/State-Teams/Pennsylvania. Update Action Description to include that the list is available on the State Hazard Mitigation website.
Action 3-1b. Require Local Hazard Mitigation Plans to list relevant regional agencies.	All Hazards	PEMA	Staff time	Continuous	Ensure communities address this requirement in local HMPs.	Complete; remove. County HMPs are required to list relevant regional agencies. Include regional agency links in SOG update.
Action 3-1c. Assess and identify locations where regional coordination between local HMPs would be beneficial to achieving efficiencies in mitigation efforts.	All Hazards	Counties; DCED; other State Agencies as applicable	Staff time	January 1, 2013	Encourage counties to utilize university capabilities (i.e. engineering, planning, etc.) during the HM planning and implementation process.	Complete; remove. This action was completed as part of the State System DRU updates. Evacuation routes and sheltering were included as part of the DRU updates.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 3-1d. Continue to support Pennsylvania Department of Education (PDE) in its multi-hazard school planning efforts.	All Hazards	PDE; PEMA; Safe Schools Imitative; PSP; FEMA Region III	Agency Operating Budget	Continuous	Perform outreach for safe school planning guide. Customize and update outreach material based on events.	Complete and continue. A nationwide public service announcement regarding active shooters in schools was conducted. Outreach conducted in four Pennsylvania school districts. Pennsylvania All-Hazards Safe Schools Planning Toolkit developed in 2013 and available online at: http://www.pema.pa.gov/planningandpreparedness/communityandstateplanning/Pages/All-Hazards-School-Safety-Planning-Toolkit.aspx#.WahZZYLD-Ul. Schools participate annually in the National Great ShakeOut earthquake drill and national Hurricane Awareness Month.
Action 3-1e. Identify and encourage involvement of key business, industry, and infrastructure stakeholders and stakeholder associations in mitigation.	All Hazards	Local jurisdictions and Chambers of Commerce	Agency Operating Budgets	Continuous	Continue to invite a broad range of stakeholder to participate in the HM planning process.	Ongoing and continue. Local jurisdictions continue to invite a broad range of private sector representation to participate in the plan update process.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 3-1f. Coordinate with USDA on the mass food contamination analysis phase.	Mass food contamination	PEMA; Dept. of Agriculture; Conservation dis	Staff time	January 2014	Identify point of contact at Department of Agriculture and discuss integration.	Ongoing and continue. Protocols are in place to identify response steps in the event of food contamination. The process for coordinating major food recalls including stopping contaminated food distribution has been developed. Modify Measure of Success to reflect that PDA has been working on the hazard through the PADAG Rapid Response Task Force.
Objective 3-2: Enable the Pennsylvania Emergency Management Agency to encourage each participating jurisdiction to secure funding and initiate one mitigation action by 2016.						
Action 3-2a. Maintain and improve Pennsylvania’s Hazard Mitigation Planning and Project Toolkit and related training, including Standard Operating Guide, Plan Builder, Library and other tools.	All Hazards	PEMA	EMPG	Continuous	Encourage all counties to complete update process using new HM Toolkit.	Complete. Modify action. Pennsylvania's Hazard Mitigation Planning and Toolkit is no longer being used. County and university hazard mitigation plans are completed using the Standard Operating Guide (SOG). Change action to include update to the SOG. Update SOG to include Cyber-Terrorism and Opioid Addiction Response hazards.
Action 3-2b. Assist communities and counties in identifying funding streams to support the implementation of mitigation projects.	All Hazards	PEMA; DCED; DEP; Silver Jackets; Counties	Staff time	Continuous	Fund ten projects and six plans per year.	Complete and continue. A total of 20 plans and 60 projects were funded during the planning period. Referrals were made to Silver Jackets for funding that PEMA cannot support.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 3-2c. Update training courses regarding planning, project tools, as well as FEMA eGrants trainings.	All Hazards	PEMA	Staff time; FEMA support	December 31, 2016	Continue to require courses for access to eGrants. Conduct timely eGrants trainings as a part of at least 2 quarterly trainings per year. Track training and technical assistance location, date, and attendance for next SSAHMP update.	In progress and continue. Briefings are provided at quarterly meetings. FEMA IS-30, IS-31, and IS-32 training is available online.
Action 3-2d. Promote training and project tours for new members of hazard mitigation planning community, including personnel at universities, businesses, and regional organizations.	All Hazards	PEMA	EMPG	Continuous	Create and implement a policy on the role of DRU plans in the mitigation strategy of the Commonwealth in 2016 SSAHMP update.	Complete. Addressed through the DRU project. Update Measure of Success to include training and project tours for businesses and regional organizations.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 3-2e. Promote Hazard mitigation project tours to showcase successful flood mitigation projects.	Natural Hazards	PEMA	Staff time	Continuous	Provide at least two bus tours through Silver Jackets.	Complete and continue. NFIP SHMO conference tour of City Island in Harrisburg conducted in May 2017 and Muncy Resiliency Tour conducted in the Borough of Muncy, Lycoming County in 2016.
Action 3-2f. Explore funding for county EMAP compliance	All	KEMA; PEMA	Staff time and EMPG	July, 2015	Disseminate information to counties pertaining to the incorporation of EMAP compliance into HM planning.	Complete and continue. Information disseminated to counties. Chester County received EMAP accreditation in 2014 and the City of Philadelphia in 2015.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Goal 4 - Build legislative support and secure funding for mitigation efforts.						
Objective 4-1: Provide opportunities for education of all State, county, and local government officials and legislators about hazard risk and mitigation by Pennsylvania Emergency Management Agency and County Emergency Management Agencies by 2016.						
Action 4-1a. Facilitate tours or visits to mitigation projects, or areas where mitigation efforts are needed to local and county officials and state legislators.	All Hazards	Counties; Local Jurisdictions; PEMA	Staff time	July 31, 2016	Send invitation to site tours to organizations that organize jurisdictions in Pennsylvania and ask 20 legislators to attend a site tour visit by July 31, 2016.	Complete and continue. Several tours and visits were held during the planning period. Legislators were invited to the following events during the planning period: DEP/PEMA annual Flood Protection Conference, PAFPM Villanova University Tour, DRBC/Silver Jackets Tour in conjunction with Nurture Nature Center, Weather Sphere Tour. NFIP 101 session conducted in 2015 by FEMA for PA DC legislators and a session conducted in 2016 for PA legislative delegation by FEMA, PEMA, and DCED staff. 23 people representing 14 agencies and organizations participated in a walking tour 'A Workshop for Resiliency' in the Borough of Muncy, Lycoming County on March 2016 as part of the Muncy Resilience Project which is part of the Resilient PA initiative. More than 20 legislators were asked to participate during the planning period.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 4-1b. Develop and disseminate relevant information on hazard mitigation programs.	All Hazards	Counties; PEMA; DEP; DCED; Silver Jackets	FEMA Hazard Mitigation Assistance Programs	Ongoing	Coordinate with FEMA and other agencies to obtain relevant mitigation information to disseminate to the public by July 31, 2014.	Complete and annually. Brochures on PDM, FMA and HMGP programs; NFIP; and FEMA Risk MAP. The PA Silver Jackets have developed an Interagency Flood Mitigation Program Guide which has been provided to 110 municipalities and 30 CRS communities. Information also disseminated during PA Municipal League training (Floodplain Management Training, PA Construction Codes Academy).
Action 4-1c. Document and share in-state success stories and best practices.	All Hazards	PEMA; Counties	Staff time; conference fees; printing fees; and WebEx costs	Continuous	Create and disseminate a brochure that identifies success stories by December 31, 2014 and conduct one presentation on success stories each year by 2016. Add success stories to FEMA website.	Complete and continue. PA Silver Jackets documented 15 Pennsylvania success stories: http://silverjackets.nfrmp.us/Portals/0/doc/Pennsylvania/Mitigation%20Success%20Stories%20Compilation_8.25.15.pdf. Work with FEMA to add success stories to FEMA's website. Modify Measure of Success to include success stories on state hazard mitigation plan website and in digital version of the 2018 HMP.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 4-1d. Perform a “Losses Avoided” study on mitigated SRL or RL properties to communicate money saved in response and recovery so that decision makers, community officials and property owners will be interested in mitigating specific properties.	Flood	PEMA; DCED	State funding; CAP-SSSE; Risk Map funding via FEMA Region III; USACE	June 2016	New SRL and RL “Losses Avoided” analysis results included in the 2016 Plan Update.	Complete and revise. The losses avoided information in the Flood Profile was updated in this plan. Pennsylvania will begin collecting more detailed elevation and building information for mitigation projects to continue to improve and build upon losses avoided analysis.
Action 4-1e. Press for Act 166 and 167 funding to be allocated.	Flood	KEMA; PEMA; DEP	Staff time	July 2014	Coordinate with DEP to determine statistics and figures needed to present a case for Act 167 funding from a HM perspective.	Continue. Though efforts have been taken to restore Act 167 Storm Water Management Act municipal reimbursement grants, funding has not been appropriated by the PA legislature since state FY 2009-10. The grant funding queue includes approximately $1,000,000 in pending reimbursement applications. For Act 166, DEP can fast-track emergency permits during disaster declarations and has established a Hazard Mitigation Site Restoration Permit with a goal to reduce threats to property and life while restoring some level of floodplain function. DEP recommends changing the priority of this Acton to 'Low'.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 4-1f. Provide legislator webinar to explain disaster declaration and hazard mitigation funding process.	Flood; All hazards	KEMA; PEMA	Staff time; conference fees; printing fees; and WebEx costs	Continuous	Obtain a spot on legislator calendar for training/outreach. PEMA will share information/white paper with KEMA as part of this effort.	Complete and ongoing. Provided hazard mitigation information to gubernatorial transition team in November 2014. PEMA conducted a recovery briefing for the new Administration in 2015. DCED/RRT provided update on State Long-Term Recovery efforts in 2015.
Objective 4-2: By 2013, expand working relationships with at least two volunteer and professional organizations to improve mitigation efforts within the Commonwealth.						
Action 4-2a. Expand working relationship with professional organizations including: NEMA, IAEM, ASFPM, KEMA, PAFPM, APA, PSATS, PAB, CCAP, League of Citizens, and Code Enforcement Officers.	All Hazards	PEMA	Staff time; Agency operating budget	January 31, 2016	Attend at least two new organization conferences and invite two new organizations to state Emergency Management conference.	Complete and continue. During the planning period, PEMA along with partners DCED, PHMC, and DEP, participated in conferences for the following organizations: Pennsylvania Association of Floodplain Managers (PAFPM), County Commissioners Association of Pennsylvania (CCAP), American Planning Association Pennsylvania Chapter (APA-PA), and Pennsylvania State Association of Township Supervisors (PSATS). Provided updates to Luzerne County Flood Protection Authority, PAFPM, PHMC, and DCED.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 4-2b. Encourage PA-based professional organizations, with emphasis on inviting PA Association of Floodplain Managers (PAFPM) participation, to be involved in the Silver Jackets Program.	All Hazards	PEMA	Staff time; Agency operating budget	Continuous	APA, PAFPM and River Basin Commission representatives and one member of another professional organization regularly attend Silver Jackets meetings between 2013 and 2016.	In progress and continue. The following organizations are participating agencies in PA Silver Jackets: PA Association of Floodplain Managers (PAFPM), Keystone Emergency Management Agency (KEMA), American Rivers Organization (ARO), Susquehanna River Basin Commission (SRBC), Delaware River Basin Commission (DRBC), and Interstate Commission on the Potomac River Basin (ICPRB).
Action 4-2c. Promote an increase in the number of CFMs.	Floods	PAFPM; PEMA; DCED; DEP	Staff time	Continuous	Identify steps to becoming a full ASFPM chapter.	Ongoing and continue. PAFPM is discussing steps required to become a full ASFPM chapter. Remove DEP as a Lead/Support Agency.
Action 4-2d. Develop a working relationship with private insurance and financial sector companies.	All Hazards	Department of Banking and Securities; Department of Insurance; PEMA	Staff time	November 2013	Host Forum to discuss insurance issues that were identified during Lee and Sandy.	Complete and continue. FEMA and DCED convene a meeting with the PA Department of Insurance annually.
Action 4-2e. Conduct outreach to utilities for ideas to mitigate damage to lines caused by hazard outside the easements or rights of way.	Winter Storms, Subsidence/ Sinkholes	PUC and PEMA	Staff time	December 2016; Ongoing		This action was added during the 2015 Annual Review and is in progress. Add Measure of Success.

Table 6.2.4-1 Evaluation of 2013 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**EVALUATION**
Action 4-2f. Conduct Outreach with PUC and DECD to identify funding for sinkhole mitigation.	Sinkholes	PEMA and PUC	Staff time	December 2016; Ongoing		This action was added during the 2015 Annual Review and is in progress. Add Measure of Success. Move under Objective 4-4 to consolidate funding actions.
Objective 4-3: Identify statutory, regulatory, or other barriers to completing mitigation efforts within the Commonwealth, and leverage support against these barriers to implement mitigation actions by 2016.						
Action 4-3a. Identify statutory, regulatory, or other barriers that currently exist with respect to mitigation efforts and build consensus and plan integration with partners and decision makers.	All Hazards	PEMA; Office of General Counsel	Staff time	June, 2016	Continue to address and expand plan integration and eliminate barriers to mitigation through SJ Initiative and document successes. Build on Bucks County Initiative with seminars in other areas of state. Develop a list of counties in the Commonwealth that cover municipal zoning.	Ongoing and continue. Local plans include integration actions to reduce mitigation barriers and identify connectivity. DCED maintains a list of counties who have adopted county zoning ordinances. Thirteen of Pennsylvania's 67 counties have county zoning ordinances. Additional details regarding zoning and subdivision and land development ordinances (SALDO) are included in the Capability Assessment section.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 4-3b. Assist county and regional planning organizations to integrate preservation priorities into plans for economic growth, revitalization, natural resource, hazard mitigation, and emergency management planning.	All Hazards	BHP of PHMC; PEMA; FEMA	Staff time	June, 2016	Identify at-risk communities for disasters and create hazard mitigation and/or emergency management plans for their historic resources.	Complete and continue. PHMC made several presentations during the planning period to discuss NPS funding to repair historic homes. As part of the Pennsylvania Flood Risk Reduction Strategy, PHMC developed Flood-Prone Historic River Town Profiles to identify a methodology to analyze at-risk Pennsylvania river towns from a historic resource perspective. Change the Measure of Success to reference this document. In October 2016 the USACE National Nonstructural Flood Proofing Committee visited 25 historic buildings in Philadelphia to assess their vulnerability to tidal flooding, storm surge, and sea level rise. Lycoming County Planning & Development continues to address rising flood insurance rates in the County's historic river towns. Muncy Borough has been working with several entities/agencies to establish a Center for Resilience in an historic building. PHMC staff participate in the PA Cultural Resilience Network and are available to provide technical assistance to the regional Alliances for Response, local EMA personnel, and PEMA staff. Add Municipal Assistance Program to Funding Source. Consider adding PA Downtown Center as a support agency.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Objective 4-4: Encourage inclusion of at least 5 relevant mitigation projects in the Commonwealth's Capital Improvement Program by the next plan revision.						
Action 4-4a. Consider tax incentives and bonds for mitigation.	All Hazards	Pennsylvania Department of Revenue; PEMA; KEMA	State funding	December 31, 2014	Promote and gain approval for a tax-free mitigation day where people may purchase items like generators tax free.	In progress. Working through PEMA Legislative Liaison. PDM Generator requests were received and those not awarded are provided with federal and state Surplus Points of Contact.
Goal 5 - Increase awareness, understanding, and preparedness across all sectors.						
Objective 5-1: Support all-hazards mitigation and preparedness programs to educate private and public stakeholders, academia, government employees, and elected officials on the hazards pertinent to the Commonwealth.						
Action 5-1a. Develop and provide presentations on hazard mitigation programs and sponsor conference booths (exhibits).	All Hazards	PEMA; State Planning Team members	State funding	December 31, 2016	Attend and present at one conference per year.	Complete and continue. Presentations at APA- PA Chapter and PSATS annual conferences.
Action 5-1b. Schedule workshops and outreach sessions with local jurisdictions and invite home and business owners of mitigated structures to speak and share their experience with potential applicants.	All Hazards	PEMA	EMPG	December 2015	Draft lessons learned for elevation and acquisition projects the workshops and sessions by January 30, 2015.	Complete and continue. Presentation at annual Emergency Management conference in 2015.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 5-1c. Work with the Citizen Corps program to educate the public on hazard mitigation and preparedness.	All Hazards	Counties; PEMA	Citizen Corps Funding; FEMA	July 31, 2016	Meet at least annually with Citizen Corps program director to discuss how to integrate hazard mitigation and preparedness into Citizen Corps programs.	Complete and continue. Participated on Exercise Planning calls for the 2014 "Northeast Great Shake Out" Earthquake Exercise. PEMA's Strategic Planning was lead for the 2014 and 2015 exercises.
Action 5-1d. Conduct a public information campaign through various media outlets.	All Hazards	PEMA Press Office; FEMA Public Information Officer; Governor's Office of Communications & Press; DCED; FEMA Region III	Staff time; Media expenses	December 31, 2016	Create a media strategy/campaign plan by December 31, 2014. Build outreach related coordination for Long Term Recovery.	Complete and continue. Several media campaigns were completed during the planning period including: PSP/OHS 'See Something; Send Something' PSA phone application; SRBC Sandy Phone application to capture photos and show damage and need; Ready PA mobile phone application launched. In 2018 DEP released 'Guidelines for Maintaining Streams in Your Community' to provide important information about prevention and response along stream corridors.
Action 5-1e. Collaborate with the business community to implement hazard mitigation information and strategies.	All Hazards	PEMA; Chamber of Commerce; Regional Task Force Business and Labor Infrastructure Committees (or equivalent)	Staff time; Small Business Administration funds	July 31, 2016	Attend three Chamber of Commerce events by December 31, 2016.	Complete and ongoing. PEMA, DCED, FEMA Region III working with Danville, Bloomsburg, and Berwick Chambers to send NFIP webinar training dates out to respective insurance agent chamber members.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 5-1f. Collaborate with non-profit, non-governmental and civic organizations to help inform their constituents about hazard mitigation.	All Hazards	Local/County Governments; Voluntary Organizations Active in Disaster (VOAD)	Staff time	December 31, 2016	Invite VOAD groups to next SJ outreach session.	Complete and continue. PEMA VOAD lead invited to PA Silver Jackets webinars and meetings.
Action 5-1g. Collaborate with higher education institutions to incorporate hazard mitigation into relevant curricula.	All Hazards	PDE; PA Commission for Community Colleges; PA Association of Colleges and Universities	Staff time	March 31, 2015	Reach out to PA Commission for Community Colleges and PA Association of Colleges and Universities to identify candidate institutions with relevant programs by July 31, 2014.	Complete and continue. Shippensburg University and Bloomsburg University have been identified as candidate institutions. Update MOS to focus on incorporating hazard mitigation planning into relevant curricula.
Action 5-1h. Prepare hazard mitigation information to disseminate to specific audiences (i.e. multi-lingual, special needs).	All Hazards	PEMA; Counties; FEMA Region III; organizations that organize jurisdictions; NGOs	Staff time	December 31, 2015	Create a list of hazard mitigation topics and target audiences by July 31, 2015.	Continue. Participated in 2016 Altoona Citizens with Disabilities plan. Add transition to digital information and virtual venues. FEMA recommends producing hazard mitigation plan Executive Summaries in secondary languages depending on local need. To address secondary languages, include outreach to schools and boy scouts and girl scouts.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 5-1i. Develop and conduct education efforts that increase residential and business owners' knowledge and awareness of mitigation grants by conducting various outreach activities.	Flood	PEMA; Counties; FEMA Region III; organizations that organize jurisdictions	Staff time	December 31, 2015	Complete four sessions per year.	Complete and continue. Two work sessions/meetings conducted in Bucks County; PA Downtown Association-Elm Street Association. Outreach conducted for Hatboro Condominium Association. 2013 Annual Conference in State College.
Action 5-1j. Work with county and municipal officials to educate property owners about grandfathering and revisions to the NFIP program.	Flood	DCED, FEMA Region III, PEMA	CAP-SSSE and Risk MAP	Continuous	Support and document Biggert-Waters Flood Insurance Reform Act outreach.	Complete and continue. In 2014, replaced Measure of Success with: Document meeting dates and outreach for HMA in detail for 2016 SSAHMP. Included in all DCED/NFIP presentations and telephone interactions with the general public and legislators. Modify Measure of success.
Action 5-1k. Increase Pennsylvania participation in the CRS program through a State education strategy.	Flood	DCED; PEMA	Staff time	December 31, 2015	Develop a State Outreach Strategy for CRS by January 31, 2015.	Complete and continue. FEMA Region III participated in outreach as part of several County HMP updates. CRS included in all DCED presentations. FEMA Region III CRS pre-checklist used in Pennsylvania.
Objective 5-2: Prioritize outreach efforts that will result in a 10% increase in RL and SRL related grant applications between 2013 and 2016.						
Action 5-2a. Conduct one meeting annually in each region of the state targeting RL and SRL community officials who serve as HMA grant sponsors.	Flood	PEMA; DCED; Counties	EMPG; FMA; HMGP	June 30, 2016	Document meeting dates and outreach for HMA in detail for 2016 SSAHMP.	Complete and continue. USACE 2017 non-structural workshops conducted in Erie, Butler, Pittsburgh, and Montgomery Counties. Targeting Central Area via PA Silver Jacket project in 2018.

Table 6.2.4-1 Evaluation of 2013 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	EVALUATION
Action 5-2b. Assist municipalities with direct mailings to SRL property owners.	Flood	PEMA in coordination with Counties and Counties in coordination with municipalities; DCED	Staff time	December 31, 2016	Reach out to two counties per year starting with locations with highest number of RL and SRL properties.	Completed by different mechanism than planned and moved to capability. FEMA HQ sent mailings direct to SRL property owners. Columbia County also completed mailing to SRL property owners. This will move to capability with the option for FEMA direct mailing program to continue or for PEMA to encourage county and community mailings via the hazard mitigation planning process and sharing of BureauNet information following the required privacy requirements.
Action 5-2c. Use the RL/SRL marketing and implementation program successes in PA communities (e.g., Bucks, Lycoming Counties) as a platform for outreach efforts to other RL/SRL communities.	Flood	PEMA; Counties; DCED	HMGP when under a disaster declaration	December 31, 2016	Submit one story per year to FEMA website, KEMA Newsletter, PEMA Pointers, and SJ Buzz.	In progress and continue. Success stories included in SJ Buzz, PSATS, PA Boroughs Association and PA Silver Jackets Pennsylvania Mitigation Success Stories publications.
Action 5-2d. Provide an update on SRL and RL mitigation strategies and accomplishments at the annual Commonwealth of Pennsylvania Emergency Management Conference.	Flood	PEMA; DCED	Staff time	September 30 2014	Ensure slot on agenda by March 31, 2014.	Complete and continue. Briefings conducted in 2014, 2016, and 2017 (2015 was cancelled for Papal Visit). Mitigation Days were held at each of the conferences with a lineup that addressed planning, resources, and advice on mitigation implementation.

After evaluating actions from the 2013 plan, the SPT also reviewed and considered Pennsylvania's Risk Reduction Priorities. In June 2017, FEMA Region III and the Commonwealth participated in a Risk Reduction Consultation for the purpose of discussing collaboration to advance Pennsylvania's hazard mitigation program priorities and identifying progress, successes, and challenges to achieving mitigation goals. The 2017 Risk Reduction Consultation resulted in identifying seven priorities.

To ensure these seven priorities were addressed in the 2018 Mitigation Action Plan, the alignment between each priority and the mitigation action plan was identified. Where alignment between the priorities and the mitigation action plan was not clearly demonstrated, adjustments were made through the addition of objectives and actions. Table 6.2.4-2 demonstrates how each of the seven priorities aligns with and was integrated into the 2018 Mitigation Action Plan.

Table 6.2.4-2 Aligning 2017 Risk Reduction Priorities with the 2018 Hazard Mitigation Action Plan

Risk Reduction Priority 1: Engage more stakeholders to support Floodplain Managers.

Engaging additional stakeholders to support Floodplain Managers and delivering information focused on consumers and public interest is addressed in several objectives and associated actions of the mitigation action plan.

- Objective 1-15: Increase the capacity and effectiveness of Commonwealth NFIP management.
  - Action 1-15e. Increase the number of Certified Floodplain Managers (CFMs) in the Commonwealth by developing and delivering CFM training in advance of scheduled CFM exams
- Objective 2-4: Identify local Hazard Mitigation Officers and increase participation by local community representatives in the Commonwealth's Mitigation Planning Team by 50% between 2018 and 2021.
  - Action 2-4b. Bring county leads and planning champions together for regular meetings, knowledge exchanges, and trainings.
- Objective 3-1: Identify opportunities for regional organizations, businesses, and universities to be engaged in hazard mitigation planning.
  - Action 3-1a. Maintain a comprehensive list of relevant regional agencies, including Councils of Government (COGs), River Basin Commissions, and Metropolitan Planning Organizations (MPOs).
  - Action 3-1c. Identify and encourage involvement of key business, industry, and infrastructure stakeholders and stakeholder associations in mitigation.
- Objective 4-2: Expand working relationships with at least two volunteer and professional organizations to improve mitigation efforts within the Commonwealth.
  - Action 4-2a. Expand working relationship with professional organizations including: NEMA, IAEM, ASFPM, KEMA, League of Cities, and Code Enforcement Officers.
  - Action 4-2d. Develop a working relationship with private insurance and financial sector companies.

While each of the objectives and actions are focused on increasing the number of organizations supporting hazard mitigation planning, the Risk Reduction Consultation identified the need to develop targeted messaging about land use and zoning that would support the duties of Floodplain Managers.

The following action was added to align with Risk Reduction Priority 1: Action 3-1d. Work with all hazard mitigation plan stakeholders to provide increased support to Floodplain Managers. The Measure of Success for the action includes developing a standard municipal toolkit addressing land use and zoning enforcement as identified at the Risk Reduction Consultation.

Table 6.2.4-2 Aligning 2017 Risk Reduction Priorities with the 2018 Hazard Mitigation Action Plan

Risk Reduction Priority 2: Improve quality and use of data to better protect historic and natural resources before disasters.

Through the passage of legislation in 2014 which created the PA State Geospatial Coordinating Board (Act 178), improving the acquisition and coordination of data to protect historic and natural resources has been a Commonwealth focus. As discussed during the Risk Reduction Consultation, PHMC has been actively working on a two-phased plan to improve hazard mitigation for historic structures and resources in Pennsylvania.

Risk Reduction Priority 2 aligns with Objective 2-3 and associated actions. The objective and actions address both the quality of data sources and historic and natural resource protection.

- Objective 2-3: Support the collection, update, and dissemination of datasets useful for hazard mitigation planning and implementation.
    - Action 2-3b. Represent the interests of hazard mitigation on the Pennsylvania State Geospatial Coordinating Board (GeoBoard).
    - Action 2-3f. Improve electronic data sharing between municipalities, counties, PA SHPO and PEMA to ensure statewide data remains current on historic properties and may be used for risk analysis.

Risk Reduction Priority 3: Conduct outreach to elected officials to educate them about risk and mitigation.

Several objectives and associated actions focus on conducting outreach to municipal and county officials and planning champions to provide education, project tools, training on risks and hazard mitigation.

Risk Reduction Priority 3 aligns with the following objectives and associated actions.

- Objective 1-8: Encourage aggressive enforcement of floodplain and storm water management ordinances and other all-hazards regulations within the Commonwealth to reduce losses in high risk areas.
    - Action 1-8b. Conduct effective outreach with municipalities to explain value of floodplain ordinances and adopting more restrictive requirements.
- Objective 2-4: Identify local Hazard Mitigation Officers and increase participation by local community representatives in the Commonwealth's Mitigation Planning Team by 50% between 2019 and 2023.
    - Action 2-4b. Bring county leads and planning champions together for regular meetings, knowledge exchanges, and trainings.
- Objective 4-1: Provide opportunities for Pennsylvania Emergency Management Agency and County Emergency Management Agencies to educate State, county and local government officials and legislators about hazard risk and mitigation by 2023.
    - Action 4-1a. Facilitate tours for local, county, and state legislative officials focusing on mitigation projects or areas where mitigation efforts are needed.
    - Action 4-1f. Provide legislator webinar to explain disaster declaration and hazard mitigation funding process.

Risk Reduction Priority 4: Develop a PA Resilience Strategy using the Smart Growth America model.

The 2013 HMP addressed preparedness programs and outreach, but it did not specifically address planning for community resiliency. A significant community resiliency effort is underway in the Borough of Muncy, Lycoming County. With the assistance of DCED and Lycoming County, the Borough has been seeking resources to prepare a resilience plan. Refer to Table 6.2.4-1, Action 4-1a.

The following objective and action were added to the mitigation action plan to align with Risk Reduction Priority 4.

Table 6.2.4-2 Aligning 2017 Risk Reduction Priorities with the 2018 Hazard Mitigation Action Plan

• Objective 2-6: Support recovery and resiliency planning across the Commonwealth.
   o Action 2-6b. Develop a Pennsylvania Resilience Strategy using the Smart Growth America model.
In addition, Action 5-1o was added under Objective 5-1.
• Objective 5-1: Support all-hazards mitigation and preparedness programs to educate private and public stakeholders, academia, government employees and elected officials on the hazards pertinent to the Commonwealth.
   o Action 5-1o. Include recovery and resiliency planning as an outreach topic over the planning period.

Risk Reduction Priority 5: Conduct outreach on flooding impacts on the agricultural sector.
While objectives and associated actions address outreach covering all hazards, the impacts of flooding on agriculture were not specifically addressed. To further align the mitigation action plan with Risk Reduction Priority 5, Action 5-1p was added under Objective 5-1. • Objective 5-1: Support all-hazards mitigation and preparedness programs to educate private and public stakeholders, academia, government employees and elected officials on the hazards pertinent to the Commonwealth.   o Action 5-1p. Include the impact of flooding on the agricultural sector as a training and outreach topic over the planning period.
Risk Reduction Priority 6: Conduct outreach to communities with levees.
Objective 1-5 and associated actions address outreach to communities with levees. Risk Reduction Priority 6 is aligned with the mitigation action plan. Objective 1-5: Minimize risk to communities posed by levee structures by increasing participation with Federal standards developed by the Federal Emergency Management Agency and the United States Army Corps of Engineers, focusing on planning and certification if feasible.
Risk Reduction Priority 7: Increase outreach to priority communities.
Through the 2013 Hazard Mitigation Plan, a list of 110 priority communities, primarily historic river towns with high flood risk, was developed. Action 5-2a was added to the mitigation action plan to increase outreach to these communities as identified at the annual Risk Reduction Consultation. • Objective 5-2: Prioritize outreach efforts that will result in a 10% increase in RL and SRL related grant applications between 2019 and 2023.   o Action 5-2a. Increase outreach to the 110 priority communities, primarily historic river towns with high flood risk, identified as action of the 2013 SSAHMP.

The 2018 Mitigation Action Plan was prepared by incorporating comments and evaluations from the SPT along with the analysis of Risk Reduction Priorities. The list of updated goals, objectives, and actions is included in Table 6.2.4-3.

The following information is identified for each of the 116 actions:

- A general description of the mitigation action;
- The hazard it is designed to mitigate;

- The agency assigned responsibility for carrying out the strategy (the primary agency is the first listed);
- Potential funding sources in place at the time the SHMP was prepared, if applicable;
- A target completion date;
- Measure of success to demonstrate success over the planning period; and
- Priority (using the mitigation action prioritization system described in Section 6.2.3).

This Action Plan will be used to assist the SPT in accomplishing each action identified during the planning process and will be a useful tool during annual state plan reviews. Actions are arranged by goal and objective.

Table 6.2.4-3 Summary of 2018 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Goal 1 - Protect lives, property, environmental quality, and resources of the Commonwealth, including high-risk properties.						
Objective 1-1: By 2021, reduce flood-related losses (with an emphasis on reducing NFIP identified repetitive loss and severe repetitive loss properties by 5%) through promotion of the Commonwealth's flood protection program through local, county, state, and federal partners.						
Action 1-1a. Support the maintenance of existing flood protection projects and construction.	Flood	DEP; DCED; DGS; USACE; USDA; NRCS; Local Communities	DCED/CFA Act 13 Flood Mitigation Program; DEP Growing Greener Watershed Protection Grants; PENNVEST; Capital Budget; Clean Water Fund; USACE; USDA NRCS	Ongoing	Ensure existing flood protection projects are operated and maintained to ensure a state of readiness. Provide annual workshops for Project Sponsors to discuss maintenance tips and latest technology.	Low
Action 1-1b. Participate in discussions about potential solutions/policy changes regarding farm land flooding due to stream impediments.	Flood	PEMA; PDA; DCED; USDA; Penn State Extension	Agency Legislative Liaisons staff time; Legislative Officials staff time; FEMA Cooperating Technical Partners (CTP) Program	October 2023	Determine feasibility of developing supporting legislation. Develop policies to prioritize crop and livestock support infrastructure during hazard incidents, flagging farm risks as a priority.	Medium
Action 1-1c. Target SRL and RL properties for mitigation (including demolition, acquisition, and elevation) during annual HMA project review and prioritization process.	Flood	PEMA; Counties; DCED	FEMA Hazard Mitigation Assistance Programs; Staff time	December 2019	Mitigate five or more SRL properties per year. Use the list of 'shovel ready' projects from recent DRs to facilitate mitigation project application process for future funding opportunities.	High

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Objective 1-2: Increase by 5% the number of projects implemented by the Commonwealth that will mitigate the most vulnerable structures against hazards by 2023.						
Action 1-2a. Maximize use of FEMA HMA grant and other programs to support all-hazard mitigation as well as acquisition/ demolition, elevation, and relocation of flood-prone residences along with flood-proofing of non-residential structures.	Flood, All Natural Hazards	PEMA; Local jurisdictions	FEMA Hazard Mitigation Assistance Programs; CDBG-DR; USACE; USDA NRCS Emergency Watershed Protection Program	October 2023	Identify at least 100 structures to be acquired/ demolished/ elevated/ relocated with FEMA HMA grant support.	High
Action 1-2b. Increase FEMA HMGP Section 404 funding and identify Public Assistance Program Section 406 projects.	All Hazards	PEMA	FEMA Section 404 -b. Hazard Mitigation Grant Program; FEMA Section 406 - Public Assistance Program	October 2023	Identify at least five projects to be funded by FEMA HMGP Section 404 and Public Assistance Program Section 406.	Medium
Action 1-2c. Mitigate buildings and structures, including historic structures, at risk from the impacts of natural and human-made hazards.	Building and Structure Collapse	PEMA; PA SHPO	FEMA Hazard Mitigation Assistance Programs; CDBG-DR; PHMC Keystone Historic Preservation Construction Grant Program; NPS Federal Rehabilitation Investment Tax Credit Program.	October 2023	Mitigate at least five buildings and/or historic structures.	High

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Table 6.2.4-3 Summary of 2018 mitigation actions						
Objective 1-3: Identify and work toward implementation of five feasible and cost-effective projects related to the mitigation of critical buildings, state facilities, and infrastructure.						
Action 1-3a. Define critical infrastructure/key resources (CI/KR) in terms of mitigation.	All Hazards	PEMA; GOHS	Staff time	October 2018	Update the definition of critical infrastructure /key resources (CI/KR) in the Standard Operating Guide.	Medium
Action 1-3b. Establish and sustain a business, industry and infrastructure subcommittee to advance the identification of CI/KR and interdependencies of CI/KR providing essential services.	All Hazards	PEMA; DLI; DCED; OHS; DHS; GOHS; PSP; COC's	Staff time; Agency Operating Budget; PSP	June 2021	Coordinate with local Chambers of Commerce to bridge information.	Medium
Action 1-3c. Leverage support of the nine Regional Task Forces to support critical infrastructure mitigation.	All Hazards	PEMA; Regional Tasks Forces	DHS Hardening/Protection related funding; Homeland Security Grant Program.	October 2023	Complete one project through each Regional Task Force.	Low
Action 1-3d. Identify insurable state-owned flood-prone buildings and appropriate mitigation methods if located in the special flood hazard area (SFHA).	Flood	DGS; PEMA-BORM	FEMA Hazard Mitigation Assistance Programs; USACE	December 2018	Continue to coordinate with DGS to see progress of DGS database for use in SHMP work.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-3e. Evaluate state-owned structures for mitigation options for non-flood related high-priority hazards.	All Hazards	PEMA; Identified state agencies	Homeland Security Grant Programs 20% Portion	December 2021	Conduct a workshop with state agencies to identify state-owned structures vulnerable to high priority hazards.	Medium
Action 1-3f. Provide emergency electrical backup generation to key state, county, and municipal critical infrastructure.	All Hazards	PEMA, FEMA	FEMA Hazard Mitigation Assistance Programs; HMGP 5% initiative	December 2022	Continue to identify and prioritize emergency backup generation projects, including pad and patch panel installation. Submit five projects.	High
Action 1-3g. Add internet interruption to the list of reportable incidents in Knowledge Center.	Utility interruption	PEMA, counties	Staff time	December 2022	Data tracking in place for utility interruption incidences that can be used for HM planning.	Medium
Objective 1-4: Identify projects related to advanced warning within the Commonwealth by 2023.						
Action 1-4a. Support the sustainment and enhancement of Commonwealth fusion centers.	Terrorism, Civil Disturbance	PEMA; Pennsylvania State Police; OHS	Department of Homeland Security (DHS) Grant Funding	Ongoing	Continue to support the operation of Commonwealth fusion centers.	Medium
Action 1-4b. Promote reverse notification systems in high-hazard areas.	All Hazards	Counties	DHS Grant Funding; Act 78 Funding	Ongoing	Identify and catalog success stories of jurisdictions utilizing reverse notification systems.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-4c. Increase participation in PA Alert.	All Hazards	OA	DHS Grant Funding	June 2021	Increase participation in PA Alert by 25%.	Medium
Action 1-4d. Establish Water Monitoring Council Action to improve stream gauge coordination in Commonwealth.	Flood	USGS; River Basin Commissions; PEMA; DEP; NWS; USACE; Water Authorities; Municipalities; FEMA	USGS; USACE; DEP; Water Authorities; Municipalities	October 2023	A consistently meeting Council and an updated dashboard of monitoring/weather data.	Medium
Action 1-4e. Complete flood inundation mapping for high risk and high population centers.	Flood	SJ Initiative including USGS; USACE; NWS; PEMA; River Basin Commissions; FEMA	USGS; USACE	July 2021	Complete one flood inundation mapping project and related outreach per year based on funding availability.	Medium
Objective 1-5: Minimize risk to communities posed by levee structures by increasing participation with Federal standards developed by the Federal Emergency Management Agency and the United States Army Corps of Engineers, focusing on planning and certification if feasible.						
Action 1-5a. Re-examine impacts of federal levee guidance and identify necessary actions.	Flood; Levee Failure	DEP; USACE; FEMA; PEMA-BORM; DCED	Act 13 Flood Mitigation Grants; Staff time	Ongoing	Support USACE in efforts to conduct inspections and risk assessments of non-Program levees.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-5b. Support non-state and non-federal levee owners, identified in the National Levee Inventory, with information on compliance with the National Levee Safety Program and appropriate funding streams.	Flood; Levee Failure	DEP; USACE; FEMA	Act 13 Flood Mitigation Program; Staff time	Ongoing	Support USACE outreach activities with levee owners.	Low
Action 1-5c. Update emergency action plan guidelines for flood protection projects to assist project sponsors with developing project specific EAPs including inundation maps.	Flood; Levee Failure	DEP; USACE; PEMA; levee owners; County EMAs	Staff time	December 2019	When guidance is published.	Medium
Action 1-5d. Identify and work with local sponsors of state levee systems, given an unacceptable or minimally acceptable rating, to bring them back up to acceptable rating.	Flood; Levee Failure	DEP; DCED; USACE	Staff time; Capital Budget; Act 13 Flood Mitigation Program	Ongoing	Explore funding opportunities to provide support for levee project improvements.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-5e. Encourage local, state, and federal levee system sponsors to develop Emergency Action Plans.	Flood; Levee Failure	USACE; DEP; Counties; Local Municipalities	Staff time	Ongoing	Obtain Emergency Action Plans for 29% of state levee systems.	Medium
Objective 1-6: Continue to provide outreach and training opportunities for local building code enforcers throughout the Commonwealth.						
Action 1-6a. Continue to conduct statewide training for construction code officials.	All Hazards	FEMA Region III; PEMA; DCED; CERC provider	HMGP 5% Initiative	Ongoing	Continue to provide training at locations throughout Pennsylvania.	Medium
Action 1-6b. Provide briefings for code association and county officials on damage assessment expectations following a disaster.	All Hazards	PEMA; DCED; FEMA Region III	EMPG; HMGP	Ongoing	Conduct PEMA Disaster Assistance Meetings, as required. Develop the following courses: a best management practices course on damage assessment and methodologies; a disaster webinar for County tax assessors, board of appeals employees, and municipal officials.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-6c. Invite the PA Association of Building Code Officials, PA Association of Code Officials, and Council of Government organizations (COG) to outreach meetings related to building resiliency and mitigation of structures.	All Hazards	PEMA; DCED; PA Municipal League	Organizational funding	Ongoing	Invite code enforcement officials to participate in meetings and events.	Medium
Objective 1-7: Increase coordination, prioritization, and funding availability to address community needs for dam hazards.						
Action 1-7a. Build on DEP's initiative to require dam owners to complete a dam break analysis and map inundation areas for dams of high hazard potential.	Flood, Dam Failure	DEP; PEMA; Counties	Staff time; National Dam Safety Program grant; USACE Silver Jackets; Dam Owner	Ongoing	Increase percentage each year.	High
Action 1-7b. Identify and implement mitigation actions based on Silver Jacket meeting results.	Flood, Dam Failure	PEMA; DEP; USACE	Staff Time	October 2023	Completion of Screening Level Risk Assessments by USACE.	Medium
Action 1-7c. Evaluate and enforce appropriate remediation of dams.	Flood, Dam Failure	DEP	Staff time; PENNVEST loan and grant program; Act 13 Flood Mitigation Program; Growing Greener, State Capital Budget, Dam Owner	Ongoing	Report DEP annual records of dam removals.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-7d. Ensure that all high hazard dams have an Emergency Action Plan, as required.	Flood, Dam Failure	DEP; PEMA	Staff Time; Dam owner	Ongoing	Achieve 95% EAP approval.	High
Objective 1-8: Encourage aggressive enforcement of floodplain and storm water management ordinances and other all-hazards regulations within the Commonwealth to reduce losses in high risk areas.						
Action 1-8a. Continue to track floodplain management ordinance information including adopted building code(s), other relevant ordinance(s), code(s), regulation(s), etc., and the incorporation of any more restrictive requirements.	Flood, All Hazards	DCED; PEMA; FEMA Region III	Community Assistance Program – State Support Services Element (CAP-SSSE); Cooperating Technical Partners Program (CTP) Grant to Funding Source)	Continuous	Maintain or increase NFIP participation after FIRM update ordinance reviews. Promote early review and submission of ordinances to DCED.	Medium
Action 1-8b. Conduct effective outreach with municipalities to explain value of floodplain ordinances and adopting more restrictive requirements.	Flood, All Hazards	DCED; PEMA; FEMA Region III	Community Assistance Program – State Support Services Element (CAP-SSSE); PA Municipal League Training	October 2023	Reach 200 municipalities annually with ordinance related materials.	Medium
Action 1-8c. Explore the possibility of providing legal support for floodplain management ordinance enforcement to municipalities.	Flood, All Hazards	DCED; FEMA Region III; State legal counsel; municipal solicitor	Staff time	July 2019	Coordinate with DCED and meet with state and municipal legal counsel.	Low

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-8d. Revise Suggested Floodplain Provisions (model ordinance) using information obtained through the gap analysis and strategic plan (Action 1-15f).	Flood	DCED; PEMA	Staff time	December 2020	Distribute Revised Floodplain Provisions for all community ordinance updates.	Low
Objective 1-9: Promote increased implementation of urban-wild land interface (wildfire) mitigation projects by local communities by 2023.						
Action 1-9a. Conduct formal statewide community risk assessment using Risk Assessment Mitigation Strategies database.	Wildfire	DCNR Bureau of Forestry; Office of State Fire Commissioner	Staff time	December 2023	Risk assessment disseminated to all communities.	Low
Action 1-9b. Work with FIREWISE communities to complete grant applications for outreach and fuels reduction projects.	Wildfire	DCNR Bureau of Forestry; Office of State Fire Commissioner	Staff time	December 2023	Identify any support available to DCNR through the HMP process.	Low
Objective 1-10: Enhance Commonwealth efforts to address mine/quarry related hazards by increasing inter-agency cooperation.						
Action 1-10a. Support effort to complete subsidence mapping in the Commonwealth.	Subsidence, Sinkhole	DEP – Mining; DCNR; Counties impacted by surface mine related hazards	State Funding	Ongoing	Notify counties, municipalities, and state agencies about resources available to address subsidence; including mine subsidence insurance, if available.	Low

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Objective 1-11: Support the Department of Environmental Protection in addressing hazards associated with shale gas formation extraction and distribution.						
Action 1-11a. Identify mitigation options for identified impacts and consequences associated with shale gas formation extraction and distribution.	Environmental Hazard - Unconventional Oil and Gas Wells	DEP; PEMA; Counties impacted by shale gas formation extraction and distribution; PUC; PennDOT; Oil and Gas Industry	Act 13 impact fee	Ongoing	Address impacts as wells are permitted/drilled.	Low
Action 1-11b. Encourage attendance at training courses that enable counties and local governments to mitigate the negative impacts of shale gas formation extraction and distribution.	Environmental Hazard - Unconventional Oil and Gas Wells; Environmental Hazard - Gas and Liquid Pipelines	DEP; Office of State Fire Commissioner and Academy; Partnerships with private sector; Counties impacted by Marcellus Shale; Universities	Act 13 impact fee	Ongoing	Promote Office of State Fire Commissioner well drilling training and promote US Department of Transportation, Pipeline and Hazardous Materials Safety Administration, Office of Pipeline Safety (US DOT PHMSA OPS) training webinars as appropriate.	Medium
Action 1-11c: Support the development of a Hazmat and Pipeline Training facility in Pennsylvania in collaboration with a college or university.	Environmental Hazard - Gas and Liquid Pipelines	DEP; PUC; PHMSA; PEMA; Office of State Fire Commissioner and Academy; Oil and Gas Industry; Pennsylvania College or University	Act 13 impact fee; PHMSA	December 2021	Agreement in place and funding sources allocated to construct a Hazmat and Pipeline Training facility in Pennsylvania.	Medium
Action 1-11d: Promote awareness of new pipeline safety guidelines enacted as part of passage of PA Act 50 of 2017.	Environmental Hazard - Gas and Liquid Pipelines	PUC; DEP; PA One Call	Staff time	Ongoing	Include PA One Call and PA Act 50 as a topic in PEMA sponsored conferences.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Objective 1-12: Ensure reports and databases are updated annually to reflect Repetitive Loss and Severe Repetitive Loss mitigation.						
Action 1-12a. Report the successes of flood-related projects in the annual SHMP update and provide a summary in the triennial plan update. Draft annual report by October 15th and finalize for submittal to FEMA no later than October 31st of the report year.	Flood	PEMA; DCED	Staff time; CDBG-DR	Continuous (annual requirement)	Submit annual reports on time; solicit support for RL/SRL funding to compile data.	Medium
Action 1-12b. Annually review the progress of SRL and RL property mitigation to ensure accuracy of BureauNet. Submit BureauNet updates as needed, particularly for location and mitigation status.	Flood	PEMA; Counties; DCED	FEMA Hazard Mitigation Assistance Programs (management costs)	Continuous	Include information in annual report (Action 1-12e); 100% compliance needed.	Medium
Objective 1-13: Promote Natural Systems Protection mitigation in the Commonwealth between 2019 and 2023.						
Action 1-13a. Identify cooperative funding opportunities for natural system protection projects.	Flood	PEMA; DEP; NRCS	FEMA Hazard Mitigation Assistance Programs; Growing Greener; DEP Stream Improvement Program; NRCS Emergency Watershed Protection Program; DCED/CFA Act 13 Flood Mitigation Program	July 2021	Obtain hazard mitigation funds for a stream corridor restoration or wetland restoration project associated with flooding.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Objective 1-14: Encourage measures to protect Pennsylvanian's from cyber-terrorism attacks.						
Action 1-14a. Take steps to protect Pennsylvania's communities from cyber security attacks.	Cyber-terrorism	PEMA; GOHS; county and local government; local government associations (PSATS)	Staff time	October 2023	Incorporate cybersecurity measures (anti-virus software, complex passwords, firewalls, regular data backup, etc.) into local government operations.	High
Action 1-14b. Work with industry and government to improve the cyber security position of control systems within critical infrastructure.	Cyber-terrorism	PEMA; GOHS; county and local government; local chambers of commerce	Staff time	October 2023	Implement tools and resources developed by the U.S. Department of Homeland Security, Industrial Control Systems Cyber Emergency Response Team (ICS-CERT).	High
Objective 1-15: Increase the capacity and effectiveness of Commonwealth NFIP management.						
Action 1-15a. Increase NFIP support staff.	Flood	PEMA-BORM	Community Assistance Program – State Support Services Element (CAP-SSSE), Cooperating Technical Partner (CTP), State agency funding	June 2019	Hire two full-time Administrative Officers to support the NFIP.	High
Action 1-15b. Provide technical assistance to NFIP communities through Community Assistance Visits (CAV).	Flood	PEMA-BORM	CAP-SSSE, CTP, State agency funding	Ongoing-Annually	Complete 5-10 CAVs each year.	High

Table 6.2.4-3 Summary of 2018 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Action 1-15c. Deliver NFIP Training in the Commonwealth to increase local capacity for NFIP administration and enforcement.	Flood	PEMA-BORM; DCED	CAP-SSSE, CTP, State agency funding	December 2019; then Ongoing	Develop a multi-year NFIP Training Plan focused on increasing local capabilities and compliance; Deliver two or more EO273 Trainings: *Management Floodplain Development through the NFIP;* Deliver four or more one-day *NFIP Training for Floodplain Managers;* Deliver one or more advanced trainings as needed (E0282, E0284, E0291).	High
Action 1-15d. Increase awareness and local capacity enforce and support Substantial Damage requirements.	Flood	PEMA-BORM; FEMA Region III	CAP-SSSE, CTP, State agency funding	December 2019; then Ongoing	Deliver two or more Substantial Damage Trainings to assist local officials with preparedness and recovery; Present at PAFPM Conference on Damage Determinations; Include additional suggested provisions regarding substantial damages and improvements in the PA model floodplain management ordinance.	Medium
Action 1-15e. Increase the number of Certified Floodplain Managers (CFMs) in the Commonwealth by developing and delivering CFM training in advance of scheduled CFM exams.	Flood	PEMA-BORM; PAFPM	CAP-SSSE, CTP, State agency funding, PAFPM staff time	December 2020	Develop course materials building on existing resources: Deliver three or more CFM trainings in advance of the CFM exam; Increase the number of CFMs by 10%.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 1-15f. Complete a gap analysis of the Commonwealth's NFIP Program and subsequent strategic plan to address the findings.	Flood	PEMA-BORM, DCED	CAP-SSSE, CTP, State agency funding	November 2019	Release a Strategic Plan to address identified gaps in the Commonwealth's NFIP program; Build on and expand on plan in initial CAP Agreement between PEMA, DCED and FEMA to expand program as analysis a planning recommends in future funding years.	High
Action 1-15g. Continue to improve the functionality and accessibility of the PA Flood Tool.	Flood	PEMA-BORM, DCED	CAP-SSSE, CTP, State agency funding	January 2020	Let PA Flood Tool improvement contract to improve functionality to aid local officials in flood determinations and risk communication.	Medium
Goal 2 - Enhance consistent coordination, collaboration, and communications among stakeholders.						
Objective 2-1: Promote development of COOP and COG plans for critical infrastructure within the Commonwealth, focusing on water treatment, water supply, and critical goods and services suppliers.						
Action 2-1a. Identify and prioritize critical government facilities and infrastructure that require back-up systems.	All Hazards	OA with support from all State Agencies; Counties; USACE	State agency funding; DHS grants	Ongoing	Collect latitude/longitude data for identified critical facilities. Request USACE Power team review of generator sizing.	High

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 2-1b. Conduct outreach to privately-owned businesses and infrastructure that provide critical services in post-disaster situations to encourage them to develop COOP or Business Recovery Plans.	All Hazards	PEMA; OHS; DHS; DCED; DHS Protective Security Advisors and Task Forces	Staff time; DHS Grant Funding	January 2021	Complete two outreach workshops. Gather information on complementary workshops from DHS/GOHS for next SHMP update.	Medium
Objective 2-2: Promote integration of mitigation goals, objectives, and actions where appropriate in other federal, state and local planning initiatives by 2023.						
Action 2-2a. Integrate local (county level) risk assessment data into the State Plan updates and vice versa to ensure consistency between state and local plans with respect to the best available data.	All Hazards	PEMA; Municipalities; Counties	Staff time; Plans funded by Pre-Disaster Mitigation (PDM) and Hazard Mitigation Grant Program (HMGP) funding	Continuous	Coordinate with PEMA OPS to integrate HM planning data and local plans into a single PA planning portal. Continue to update the SOG and provide annual training.	Medium
Action 2-2b. Support Silver Jackets work to identify current policies, plans, regulations, and laws that should include mitigation.	All Hazards	PEMA; Other State Agencies; Silver Jackets; PAFPM	Staff time	January 2020	Include lessons learned and planning guidance for local officials in the SJ Mitigation Guide and include a link to the guide on the PA Planning Portal.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 2-2c. Identify highest priority action items for counties that do not currently have a highest priority mitigation action identified in Section 6.3.2.	All Hazards	PEMA; Municipalities; Counties	Staff time	Ongoing	Update local standard operating procedures to reflect new mitigation action prioritization method so that highest ranking actions can be identified in the 2023 SHMP update.	Low
Objective 2-3: Support the collection, update, and dissemination of datasets useful for hazard mitigation planning and implementation.						
Action 2-3a. Develop a comprehensive list of types of hazard mitigation data that decision-makers might need by December 2020.	All Hazards	PEMA; FEMA; Pennsylvania State Geospatial Coordinating Board (GeoBoard); PASSHE; Counties (GIS).	Staff time	December 2020	Share the list of identified data with stakeholders.	Medium
Action 2-3b. Represent the interests of hazard mitigation on the Pennsylvania State Geospatial Coordinating Board (GeoBoard).	All Hazards	PEMA; GeoBoard; Other State Agencies; Counties (GIS)	Staff time	Ongoing	Active participation in the GeoBoard; implementation of GeoBoard initiatives identified in the 2018 Geospatial Strategic Plan which advance hazard mitigation planning.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 2-3c. Re-evaluate state GIS database to ensure datasets include hazard mitigation, planning, and critical asset identification to enable the prioritization of mitigation projects.	All Hazards	PEMA; Counties	Staff time	October 2018	Identify all of the exact databases, and owners of those databases. Ensure data is available on PASDA.	Medium
Action 2-3d. Continue to use and improve GIS capability to prioritize hazard/critical infrastructure for mitigation.	All Hazards	PEMA; GOHS; PSP; DGS	Staff time	December 2021	Use GIS to assign mitigation priorities to critical infrastructure.	Medium
Action 2-3e. Acquire remotely sensed data, specifically, ortho-photography, as specified in the Commonwealth's Geospatial Strategic Plan.	Flood	PEMA; GeoBoard	FEMA Emergency Management Performance Grants (EMPG); National Preparedness Funds	December 2019	Acquire updated ortho-photography for Pennsylvania.	Medium
Action 2-3f. Improve electronic data sharing between municipalities, counties, PA SHPO and PEMA to ensure statewide data remains current on historic properties and may be used for risk analysis.	All Hazards	State Historic Preservation Office (PA SHPO); PEMA; FEMA	National Park Service; PHMC Preservation and Disaster Planning	Ongoing	Identify historic resource survey projects by municipality and county.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 2-3g. Designate/develop a reporting mechanism and process that allows local data to be tracked and reported regarding costs and resources associated with the opioid epidemic in order to better understand, quantify and respond to impacts.	Opioid Addiction	Opioid Task Force; PEMA	Staff Time; State Targeted Response to the Opioid Crisis Grant	2019	Track the number and costs associated with first responders, calls received, Narcan administration, medical examiner, and other identified losses as deemed necessary by the Task Force.	Medium
Objective 2-4: Identify local Hazard Mitigation Officers and increase participation by local community representatives in the Commonwealth's Mitigation Planning Team by 50% between 2019 and 2023.						
Action 2-4a. Maintain planning, emergency management, and GIS/data management contacts lists and expand contacts to include conservation districts.	All Hazards	PEMA and Area Offices; OA; Counties	Staff time	Ongoing	Consistently update and expand hazard mitigation contact lists.	Medium
Action 2-4b. Bring county leads and planning champions together for regular meetings, knowledge exchanges, and trainings.	All Hazards	PEMA; DCED; KEMA; FEMA Region III	Staff time; Agency operating budget; FEMA-sponsored training	December 2023	Provide three integrated planning workshops/ seminars throughout the state.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 2-4c. Involve appropriate county mitigation plan team members in hazard mitigation implementation activities.	All Hazards	PEMA; Counties	Staff time; EMPG; HMGP; PDM; FMA Management costs	Continuous	Offer training or meeting opportunities for county mitigation planning team members at PEMA Annual Conference. Encourage counties to conduct annual HMP reviews with mitigation plan team members.	High
Action 2-4d. Meet regularly to implement projects that tie-in goals and initiatives of multiple State Planning Team member agencies	All Hazards	PEMA; State Planning Team members	FEMA Hazard Mitigation Assistance Programs; USACE	October 2023	Identify and complete high priority mitigation actions.	High
Action 2-4e. Develop County Hazard Mitigation Suggested Curriculum.	All Hazards	PEMA; Counties	EMPG	October 2023	Encourage at least one member of the local hazard mitigation team to obtain Certified Floodplain Manager (CFM) certification.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Objective 2-5: Continue to support coordination between mitigation, planning, preparedness, and response personnel throughout the Commonwealth to ensure effectiveness in all-hazard mitigation planning.						
Action 2-5a. Improve cooperation/ coordination of agencies with real time data (gauge station data, program availability, etc.).	All Hazards	Local, county, and state public safety agencies with planning support agencies	Various	Continuous	Encourage all SPT members to share real time data in Web EOC.	Medium
Action 2-5b. Reach out to agencies that were invited but did not participate in 2018 planning process.	All Hazards	PEMA; Silver Jackets	Staff time; USACE	October 2023	Participation in the next State Plan update builds on 2018 success and has more than 55 participating agencies/organizations/ county representatives.	Medium
Action 2-5c. Identify strategic locations to deploy USACE Power Teams after a disaster.	All Hazards	PEMA; Silver Jackets; USACE	Staff time	Ongoing	Continue to work with USACE Pittsburgh and Philadelphia Districts after a disaster to identify locations to deploy Power Teams.	Medium
Objective 2-6: Support recovery and resiliency planning across the Commonwealth.						
Action 2-6a. Develop County Recovery Plans following the template designed in State Disaster Recovery Plan process.	All Hazards	PEMA; County planners and EMCs	Staff time	October 2023	Complete 12 County Recovery Plans.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 2-6b. Develop a Pennsylvania Resilience Strategy using the Smart Growth America model.	All Hazards	PEMA; County planners and EMCs	Staff time	October 2023	Statewide resiliency strategy in place and ready to disseminate to local jurisdictions.	Medium
Goal 3 - Provide a framework for active hazard mitigation planning and implementation.						
Objective 3-1: Identify opportunities for regional organizations, businesses, and academia to be engaged in hazard mitigation planning.						
Action 3-1a. Maintain a comprehensive list of relevant regional agencies, including Councils of Government (COGs), River Basin Commissions, and Metropolitan Planning Organizations (MPOs).	All Hazards	PEMA; Silver Jackets	Staff time	Continuous	Annually update a list of relevant regional agencies including hazard mitigation planning contacts.	Medium
Action 3-1b. Continue to support Pennsylvania Department of Education (PDE) in its multi-hazard school planning efforts.	All Hazards	PDE; PEMA; Safe Schools Imitative; PSP; FEMA Region III	Agency Operating Budget	Continuous	Customize and update outreach materials and conduct outreach based on current events.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 3-1c. Identify and encourage involvement of key business, industry, and infrastructure stakeholders and stakeholder associations in mitigation.	All Hazards	Local jurisdictions and Chambers of Commerce	Agency Operating Budgets	Continuous	Continue to invite a broad range of private sector stakeholders to participate in the HM planning process with a focus on infrastructure and utility stakeholders and large employers.	Medium
Action 3-1d Work with hazard mitigation stakeholders to provide increased support to Floodplain Managers.	Flood	DCED, PEMA, FEMA, Community Engagement and Risk Communication (CERC) provider, Resilience Action Partners	Staff time	December 2018	Develop a standard municipal toolkit addressing land use and zoning enforcement and train stakeholders on its use.	High
Action 3-1e. Coordinate with USDA on the mass food contamination analysis phase.	Mass food contamination	PEMA; Dept. of Agriculture; Conservation districts	Staff time	January 2020	Establish planning and response protocols with the PADAG Rapid Response Task Force.	Medium
Objective 3-2: Enable the Pennsylvania Emergency Management Agency to encourage each participating jurisdiction to secure funding and initiate one mitigation action by 2023.						
Action 3-2a. Maintain and improve Pennsylvania's Standard Operating Guide and other tools.	All Hazards	PEMA	EMPG	Continuous	Require all counties to complete HMP updates using the most current SOG.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 3-2b. Assist communities and counties in identifying funding streams to support the implementation of mitigation projects.	All Hazards	PEMA; DCED; DEP; Silver Jackets; Counties	Staff time	Continuous	Fund ten projects and six plans per year.	Medium
Action 3-2c. Update training courses regarding planning, project tools, as well as FEMA eGrants trainings.	All Hazards	PEMA	Staff time; FEMA support	Continuous	Conduct timely eGrants trainings as a part of at least two quarterly trainings per year. Track all training and technical assistance location, date, and attendance.	Medium
Action 3-2d. Promote training and project tours for new members of hazard mitigation planning community, including personnel at universities, businesses, and regional organizations.	All Hazards	PEMA	EMPG	July 2021	Develop and implement training for businesses and regional organizations.	Medium
Action 3-2e. Promote Hazard mitigation project tours to showcase successful flood mitigation projects.	Flood	PEMA; Silver Jackets	Staff time	Continuous	Provide at least two bus tours through Silver Jackets.	High

Table 6.2.4-3 Summary of 2018 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Action 3-2f. Explore funding for County EMAP accreditation.	All Hazards	PEMA	Staff time and EMPG	July 2020	Disseminate information to counties pertaining to the incorporation of EMAP compliance into HM planning.	Low
Goal 4 - Build legislative and other organizational support and leverage funding for mitigation efforts.						
Objective 4-1: Provide opportunities for Pennsylvania Emergency Management Agency and County Emergency Management Agencies to educate State, county and local government officials, and legislators about hazard risk and mitigation by 2023.						
Action 4-1a. Facilitate tours for local, county, and state legislative officials focusing on mitigation projects or areas where mitigation efforts are needed.	All Hazards	Counties; Local Jurisdictions; PEMA; DCED; FEMA	Staff time	October 2023	Coordinate local official and legislative site tours in four locations. Encourage the participation of at least 20 state legislative officials.	Medium
Action 4-1b. Develop and disseminate relevant information on hazard mitigation programs.	All Hazards	Counties; PEMA; DEP; DCED; Silver Jackets	FEMA Hazard Mitigation Assistance Programs	Ongoing	Coordinate with FEMA and other agencies to obtain relevant mitigation information to disseminate to the public.	High
Action 4-1c. Document and share in-state success stories and best practices.	All Hazards	PEMA; Counties	Staff time	Continuous	As part of the 2018 HMP update, develop online success stories to be updated and cataloged on Pennsylvania's Hazard Mitigation Plan website.	High

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 4-1d. Collect more detailed building information for mitigation projects to improve "Losses Avoided" analysis in SHMP.	Flood	PEMA; DCED	State funding and time; Reach out to partners through Silver Jackets, Communities with a large number of mitigation projects and universities to support analysis.	June 2023	Improved "Losses Avoided" analysis results included in the 2023 Plan Update.	High
Action 4-1e. Press for Act 166 and 167 funding to be allocated.	Flood	KEMA; PEMA; DEP	Staff time	June 2023	Coordinate with DEP to determine statistics and figures needed to present a case for Act 167 funding from a HM perspective.	Medium
Action 4-1f. Provide legislator webinar to explain disaster declaration and hazard mitigation funding process.	Flood; All hazards	KEMA; PEMA	Staff time; conference fees; printing fees; and WebEx costs	Continuous	Obtain a spot-on legislator calendar for training/outreach. PEMA will share information/white paper with KEMA as part of this effort.	Medium
Objective 4-2: Expand working relationships with at least two volunteer and professional organizations to improve mitigation efforts within the Commonwealth.						
Action 4-2a. Expand working relationship with professional organizations including: NEMA, IAEM, ASFPM, KEMA, League of Cities, and Code Enforcement Officers.	All Hazards	PEMA	Staff time; Agency operating budget	June 2023	Attend at least two new organization conferences and invite two new organizations to the State Emergency Management Conference.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 4-2b. Encourage PA-based professional organizations to be involved in the Silver Jackets Program.	All Hazards	PEMA; Silver Jackets	Staff time; Agency operating budget	June 2023	At least two new professional organizations regularly attend Silver Jackets meetings between 2018 and 2021.	Medium
Action 4-2c. Promote designation as an Accredited Chapter.	Floods	PAFPM; PEMA; DCED	Staff time	Continuous	Identify steps to becoming a full ASFPM chapter.	Medium
Action 4-2d. Develop a working relationship with private insurance and financial sector companies.	All Hazards	DCED; Department of Insurance; FEMA	Staff time	Annually	Convene an annual meeting with the PA Department of Insurance to address current insurance issues impacting hazard mitigation.	Medium
Action 4-2e. Outreach to utilities to develop ideas to mitigate utility damage outside of easements or rights of way.	Winter Storm; Subsidence, Sinkhole	PEMA; PUC	Staff time	December 2021	Work with utilities to mitigate damage to infrastructure outside of utility ROW.	High

Table 6.2.4-3 Summary of 2018 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Objective 4-3: Identify statutory, regulatory, or other barriers to completing mitigation efforts within the Commonwealth, and leverage support against these barriers to implement mitigation actions by 2023.						
Action 4-3a. Identify statutory, regulatory, or other barriers that currently exist with respect to mitigation efforts and build consensus and plan integration with partners and decision makers.	All Hazards	PEMA; Office of General Counsel; DCED	Staff time	June 2021	Continue to address and expand plan integration and eliminate barriers to mitigation through SJ Initiative and document successes. Develop a list of counties in the Commonwealth that cover municipal zoning.	Medium
Action 4-3b. Assist county and regional planning organizations to integrate preservation priorities into plans for economic growth, revitalization, natural resource, hazard mitigation and emergency management planning.	All Hazards	PA SHPO; PEMA; FEMA	Staff time	June 2021	Identify at-risk communities for disasters and create hazard mitigation and/or emergency management plans for historic resources.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 4-3c. Encourage counties and local municipalities to develop land bank authorities for the purpose of converting vacant or tax-delinquent properties at risk from the impacts of natural and human-made hazards into productive use.	Building and Structure Collapse	DCED; Counties; Municipalities	Staff time; Local operating budgets	October 2023	Encourage adoption of the provisions of PA Title 68 (Real and Personal Property) to encourage the development of land bank authorities.	Medium
Objective 4-4: Encourage the use of state funding for hazard mitigation for projects and plans						
Action 4-4a. Support new state-funded flood protection and prevention projects.	Flood	PEMA; DEP; DGS	FEMA Hazard Mitigation Assistance Programs; USACE; USDA Natural Resource Conservation Service (NRCS); PA State Capital Budget Project Authorization (Capital Budget); DEP Growing Greener Watershed Protection Grants; PennDOT; DCED CFA Act 13 Flood Mitigation Program	June 2021	Secure funding for at least four new state-funded flood protection/prevention projects, one of which should focus on flood fighting supplies and training.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 4-4b Provide non-federal match to project sponsors for FEMA Hazard Mitigation Assistance, NRCS, USACE and other federal funding sources.	Flood	Governor's Office	Agency Operating Budget, Capital Budget, DEP	June 2021	Allocate state funding for the non-federal match for the projects listed in funding sources listed in Action 4-4b, including funding for mitigation projects and local hazard mitigation plan updates.	High
Action 4-4c. Consider tax incentives and bonds for mitigation.	All Hazards	Pennsylvania Department of Revenue; PEMA; KEMA	State funding	October 2023	Promote and gain approval for a tax-free mitigation day were people may purchase items like generators tax free.	Low
Action 4-2d. Identify funding for sinkhole mitigation.	Subsidence, Sinkhole	PEMA; PUC; DCED	Staff time	December 2021	Complete two sinkhole mitigation projects.	Medium
Goal 5 - Increase awareness, understanding, and preparedness across all sectors.						
Objective 5-1: Support all-hazards mitigation and preparedness programs to educate private and public stakeholders, academia, government employees and elected officials on the hazards pertinent to the Commonwealth.						
Action 5-1a. Develop and provide presentations on hazard mitigation programs and sponsor conference booths (exhibits).	All Hazards	PEMA; State Planning Team members	State funding	Annually	Attend and present at one conference per year.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 5-1b. Schedule workshops and outreach sessions with local jurisdictions and invite home and business owners of mitigated structures to speak and share their experience with potential applicants.	All Hazards	PEMA	EMPG	Ongoing	Draft lessons learned for elevation and acquisition projects to present at workshops and sessions.	Medium
Action 5-1c. Work with the Citizen Corps Program to educate the public on hazard mitigation and preparedness.	All Hazards	Counties; PEMA	Citizen Corps Funding; FEMA	Annually	Meet annually with Citizen Corps program director to discuss integration of hazard mitigation and preparedness into Citizen Corps Program.	Medium
Action 5-1d. Conduct a public information campaign through various media outlets.	All Hazards	PEMA Press Office; FEMA Public Information Officer; Governor's Office of Communications & Press; DCED; FEMA Region III	Staff time; Media expenses	October 2023	Create a media strategy/campaign plan. Build outreach related coordination for Long Term Recovery	Medium
Action 5-1e. Collaborate with the business community to implement hazard mitigation information and strategies.	All Hazards	PEMA; Pennsylvania Chamber; Regional Chambers; Regional Task Force Business and Labor Infrastructure Committees (or equivalent)	Staff time; Small Business Administration funds	October 2023	Attend three Chamber of Commerce events.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 5-1f. Collaborate with non-profit, non-governmental and civic organizations to help inform their constituents about hazard mitigation.	All Hazards	Local/County Governments; Voluntary Organizations Active in Disaster (VOAD)	Staff time	October 2023	Invite VOAD groups to next SJ outreach session.	Medium
Action 5-1g. Collaborate with higher education institutions to incorporate hazard mitigation into relevant curricula.	All Hazards	PDE; PA Commission for Community Colleges; PA Association of Colleges and Universities	Staff time	October 2023	Work with PA Commission for Community Colleges and PA Association of Colleges and Universities to identify candidate institutions with relevant programs.	Medium
Action 5-1h. Prepare hazard mitigation information to disseminate to specific audiences (i.e. multi-lingual, special needs).	All Hazards	PEMA; Counties; FEMA Region III; organizations that organize jurisdictions; NGOs	Staff time	October 2023	Create a list of hazard mitigation topics and target audiences.	Medium
Action 5-1i. Develop and conduct education efforts that increase residential and business owners' knowledge and awareness of mitigation grants by conducting various outreach activities.	Flood	PEMA; Counties; FEMA Region III; state associations	Staff time	Annually	Complete four sessions per year.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 5-1j. Work with county and municipal officials to educate property owners about grandfathering and revisions to the NFIP program.	Flood	DCED, FEMA Region III, PEMA	CAP-SSSE and Risk MAP	Continuous	Document meeting dates and outreach for HMA in detail for 2018 SHMP.	Medium
Action 5-1k. Increase Pennsylvania participation in the CRS program through a State education strategy.	Flood	DCED; PEMA	Staff time	Ongoing	Implement State CRS outreach Strategy; Develop a CRS Checklist that lists common activities within the Commonwealth and corresponding points to encourage communities to participate in the program; Designate a State-CRS representative.	Medium
Action 5-1l. Increase public and private awareness about cyber threats.	Cyber-terrorism	PEMA; GOHS	Staff time	December 2021	Document public and private sector participation in the U.S. Department of Homeland Security's national public awareness campaign, 'Stop. Think. Connect.'	High
Action 5-1m. Work with Pennsylvania Department of Health to increase awareness about treating and preventing opioid addiction.	Opioid Addiction Response	PEMA; DOH	Staff time	Ongoing	Include opioid addiction response as a topic in PEMA sponsored conferences.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Action 5-1n. Brief emergency management officials on resources available to respond to opioid addiction in their community.	Opioid Addiction Response	PEMA; DOH	Staff time	Ongoing	Include opioid addiction response as a topic in emergency management officials' training including the potential for hazardous materials conditions when responding to incidents.	Medium
Action 5-1o. Include recovery and resiliency planning as an outreach topic over the planning period.	All Hazards	PEMA	Staff time	October 2023	Recovery and resiliency added to agendas for upcoming PEMA training and outreach.	Medium
Action 5-1p. Include the impact of flooding on the agricultural sector as a training and outreach topic over the planning period.	Flood	PEMA; DOA; Penn State Extension	Staff time	October 2023	Flooding impacts to the agricultural sector added to agendas for upcoming PEMA training and outreach.	High
Action 5-1q. Increase awareness about the impacts of Climate Change.	Climate Change	PEMA; DEP	Staff time	Ongoing	Include climate change as a topic in PEMA sponsored conferences.	Medium
Objective 5-2: Prioritize outreach efforts that will result in a 10% increase in RL and SRL related grant applications between 2019 and 2023.						
Action 5-2a. Increase outreach to the 110 priority communities impacted by flooding as identified by PEMA.	Flood	PEMA; FEMA; DCED	Staff time	Ongoing	Through the annual Risk Reduction Consultation, develop a strategy to outreach to priority communities and implement the strategy.	Medium

Table 6.2.4-3 Summary of 2018 mitigation actions						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Action 5-2b. Conduct one meeting annually in each region of the state targeting RL and SRL community officials who serve as HMA grant sponsors.	Flood	PEMA; DCED; Counties	EMPG; FMA; HMGP	October 2023	Document meeting dates and outreach for 2023 SHMP.	High
Action 5-2c. Use the RL/SRL marketing and implementation program successes in PA communities as a platform for outreach efforts to other RL/SRL communities.	Flood	PEMA; Counties; DCED	HMGP when under a disaster declaration	Annually	Submit one story per year to FEMA website, KEMA Newsletter, PEMA Pointers, and SJ Buzz.	Medium
Action 5-2d. Provide an update on SRL and RL mitigation strategies and accomplishments at the annual Commonwealth of Pennsylvania Emergency Management Conference.	Flood	PEMA; DCED	Staff time	Annually	Ensure slot on agenda annually in March.	Medium

6.3. Local Mitigation Strategy

6.3.1. Local Mitigation Planning Assistance

6.3.1.1. Support of Local Hazard Mitigation Planning

Pennsylvania provides strong support to local hazard mitigation planning efforts through technical and funding resources.

Pennsylvania's All-Hazard Mitigation Planning and Project Identification Toolkit (HM Toolkit) is a set of tools developed to standardize, streamline, and simplify the Commonwealth's hazard mitigation planning process. The HM Toolkit consists of a Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide (SOG) and Pennsylvania Hazard Mitigation Planning website (www.pahmp.com). Both were developed to standardize and simplify the hazard mitigation planning process and to aid counties in hazard mitigation plan development as well as project identification, tracking, and implementation.

Standard Operating Guide

In an effort to standardize mitigation planning and streamline the process of integrating local plans into the SHMP, PEMA funded the development of the SOG in 2010, update in 2013, and an in-progress update for 2018. The SOG captures FEMA requirements, clarifies and combines existing guidance, and allows communities a greater opportunity to excel in the preparation of HMPs. The step-by-step "how-to" guidance provided in the SOG makes the HMP development process seem more manageable while creating consistency among local hazard mitigation plans. Project and funding information included in the SOG gives local planning entities the tools necessary to maintain and implement the HMP in between updates. The developments of key standards in the SOG allow for simplification of the plan review process, allowing PEMA to conduct a more thorough and detailed HMP review in less time. These standards include the following.

- Model Plan Outline (MPO): An appendix to the SOG, this document provides a standard plan format which ensures that plans are uniform and contain the same type of information.
- Standard List of Hazards: Enables local entities and the Commonwealth to compare "apples to apples" by providing a standard list of hazards and hazard descriptions.
- Risk Factor (RF) Methodology: Uses five weighted Risk Categories: probability, impact, spatial extent, warning time and duration, to calculate a RF between 0 and 4. Moving forward, comparisons can be made between counties and jurisdictions as to the level of risk associated with like hazards.
- Mitigation Action Assessment: The Mitigation Action Prioritization Methodology is used to prioritize actions as high, medium, or low based cumulative scores according to five criteria: effectiveness, efficiency, multi-hazard mitigation, addressing a high-risk hazard, and addressing critical communications/critical facilities.

To ensure the SOG reflects current hazard mitigation practices and processes the SOG was updated as part of the scope of services for the 2018 SHMP. Modifications to the SOG include:

- An updated Standard List of Hazards to incorporate the new hazards added during the 2018 plan update.
- Incorporating information on historic preservation mitigation.
- Adding information on how to address climate change and assess future risk in applicable hazard profiles.
- Formalizing the requirement to follow the Model Plan Outline in Pennsylvania on the Plan Review Tool.

Local Hazard Mitigation Plan Development

PEMA supports all 67 counties as required under Commonwealth statute. The State's support is based on the inherent needs dependent upon the level of the counties' planning cadre, expertise, and need. PEMA prioritizes support for counties whose capabilities are less than others and/or experience greater risk and vulnerability by comparison.

PEMA contracted with a private firm to assist 10 counties with the update or development of their HMPs between 2013 and 2017 using EMPG funds. Counties received comprehensive services from this contractor including community outreach assistance, data collection, risk analysis, meeting and workshop set-up and facilitation, and mitigation strategy and plan development. The following counties received planning services and were chosen because of the expiration date of their existing plan: Adams, Allegheny, Bucks, Butler, Carbon, Clearfield, Cumberland, Dauphin Lycoming, and Union. All plans have been completed and have received FEMA approval.

In addition, 27 PDM counties will receive or have received PDM funding support for hazard mitigation planning as follows: Adams, Bedford, Berks, Bradford, Cameron, Cumberland, Erie, Forest, Fulton, Indiana, Jefferson, Juniata, Lancaster, Lebanon, Lehigh, Luzerne, Mercer, Mifflin, Northampton, Perry, Pike, Sullivan, Susquehanna, Union, Westmoreland, Wyoming, and York. Some counties are on both lists because they have gotten ahead of their next plan update with 2017 funding.

These 37 plans were or will be developed or updated using the standards set forth in the SOG.

In addition, between 2013 and 2017 the Pennsylvania State System of Higher Education obtained grant funding as a sub-applicant through PEMA for FEMA's PDM Grants program. The grant funding was secured to complete Disaster-Resistant University plans and facilitate necessary updates/revisions to existing emergency operations plans (EOPs) at each of the State System's fourteen universities. Additional information on these university plans and the status of local hazard mitigation plans can be found in Section 5.3.1.

Local Mitigation Plan Review

PEMA's BORM staff review and approve local hazard mitigation plans prior to submitting the plans to FEMA. BORM staff reviews each draft HMP to ensure it meets all PEMA requirements and that all elements of the Plan Review Tool have been satisfied. Should the HMP be missing plan components the plan is returned to the planning entity with comments for plan improvement and editing. PEMA encourages that multi-jurisdictional plans follow the SOG.

Pennsylvania Hazard Mitigation Planning Website

PEMA is building and expanding on its website at www.pahmp.com. The website was expanded for the SHMP to share resources, data source, and create a discussion board. The plan was broken into chapters that can be commented on and edited via the website. The next steps include share maps and data that are ready to use buy officials for county plan updates, researchers, students, and interested citizens. There is an understanding that the SHMP has the best compilation of data and research on hazards in the Commonwealth and that it can be made more accessible through sharing in new and creative ways online.

6.3.1.2. Support of Local Hazard Mitigation Projects

PEMA conducts outreach to county and local officials, universities, and other agencies as applicable to engage them in applying for both annual HMA funding and post-disaster HMGP funding. Annual notice of funding availability is publicized through county contacts, and post-disaster briefings are held for disaster-impacted areas to engage county and local officials in opportunities for mitigation funding. PEMA uses the Letter of Intent for HMGP projects and the Letter of Interest for other HMA projects to identify leads on hazard mitigation projects. If the projects described in the letters fit the eligibility guidelines, the HMPO form is completed. In addition, PEMA supports local HMA application development by providing technical assistance and trainings. In 2018, for example, PEMA partnered with the Southwestern Pennsylvania Commission (SPC) to deliver two HMA Application Development Workshops to local officials in the region. The first was held in New Castle, Lawrence County, an economically stressed and flood-prone area that was identified in the Commonwealth's application to HUD's National Disaster Resilience Competition in 2015. The second was held in Murrysville, Westmoreland County, and was attended by the County EMA and representatives of several municipalities, including the City of Pittsburgh.

Throughout Commonwealth government, hazard mitigation projects are solicited throughout the year and are identified through the local hazard mitigation planning process. When funding is available, the Hazard Mitigation Project Review Committee of the Commonwealth's Hazard Mitigation Team is convened to review, evaluate, and rank order all available mitigation projects. The process for how mitigation projects are prioritized is described in Section 6.3.1.3 Prioritizing Local Assistance.

PEMA supports local hazard mitigation projects by providing technical assistance and trainings. These trainings are described in more detail in Section 5.3.1. PEMA also uses its website to provide guidance on mitigation grant programs and supply forms and documents.

PEMA is consistently working to track progress on mitigation. BORM maintains and updates lists on mitigation project that are in progress and complete and conducts three-year monitoring of projects and particularly open space to ensure it is not developed post-mitigation.

PEMA currently tracks 1,719 closed local hazard mitigation projects, and FEMA tracks 1,795 closed, approved, or obligated with 1,603 being closed. The difference in numbers is not alarming between PEMA and FEMA datasets. Examining the data reveals several individual properties tracked in one project or separated into individual projects between the two databases. Sometimes projects are listed more than once. The OpenFEMA Dataset of HMA

Mitigated Properties is a recently released dataset. In time, the tracking between datasets will become more consistent. Table 6.3.1-1 summarizes local hazard mitigation projects that have FEMA HMA Grant Funds closed, approved or obligated from 1999 – 2018, and Table 6.3-1 shows closed PEMA mitigation projects.

Table 6.3.1-1 Number of Projects for which FEMA HMA Grant Funds are Pending/Approved/Obligated from 1999-2018 (FEMA, 2018).						
COUNTY	MITIGATION TECHNIQUE					TOTAL
	ACQUISITION	ELEVATION	FLOODPROOFING	RELOCATION	OTHER	
Adams	1	1	0	0	0	2
Allegheny	100	0	1	0	8	109
Armstrong	5	0	0	0	0	5
Beaver	30	0	0	0	0	30
Bedford	1	0	0	0	5	6
Berks	8	0	0	0	1	9
Blair	91	19	0	0	1	111
Bradford	9	0	0	0	3	12
Bucks	24	47	0	0	1	72
Butler	31	0	0	0	0	31
Centre	10	0	0	0	0	10
Chester	4	1	0	0	0	5
Clearfield	2	0	0	0	0	2
Columbia	117	0	0	0	1	118
Cumberland	1	0	0	0	0	1
Dauphin	100	0	0	25	0	125
Delaware	61	0	0	14	1	76
Elk	1	0	0	0	0	1
Fayette	1	0	0	0	0	1
Franklin	1	0	0	0	0	1
Huntingdon	12	1	0	0	0	13
Indiana	1	0	0	0	0	1
Jefferson	61	0	0	0	0	61
Juniata	2	0	0	0	0	2
Lackawanna	56	0	0	1	0	57
Lancaster	12	0	0	0	1	13
Lebanon	44	0	0	0	0	44
Lehigh	5	0	0	0	1	6

Table 6.3.1-1 Number of Projects for which FEMA HMA Grant Funds are Pending/Approved/Obligated from 1999-2018 (FEMA, 2018).

COUNTY	MITIGATION TECHNIQUE					TOTAL
	ACQUISITION	ELEVATION	FLOODPROOFING	RELOCATION	OTHER	
Luzerne	247	0	0	0	2	249
Lycoming	166	0	0	0	79	245
Mifflin	1	0	0	0	0	1
Montgomery	101	9	0	1	11	122
Montour	1	0	0	0	0	1
Northampton	1	1	0	0	0	2
Northumberland	12	0	0	0	1	13
Pike	0	1	0	0	0	1
Schuylkill	24	0	0	0	0	24
Snyder	0	2	0	0	0	2
Somerset	4	0	0	0	10	14
Sullivan	1	0	0	0	0	1
Susquehanna	24	0	0	0	0	24
Tioga	10	0	0	0	1	11
Union	19	0	0	0	0	19
Venango	0	0	1	0	0	1
Wayne	0	0	0	1	0	1
Wyoming	126	0	0	0	5	131
York	8	1	0	0	0	9
Total	**1,536**	**83**	**2**	**42**	**132**	**1,795**

Table 6.3-1 Number of Closed Properties for which FEMA HMA Grant Funds were received (PEMA, 2018).

COUNTY	PROPERTIES	COUNTY	PROPERTIES
Adams	0	Lackawanna	57
Allegheny	116	Lancaster	14
Armstrong	4	Lawrence	0
Beaver	30	Lebanon	27
Bedford	6	Lehigh	6
Berks	7	Luzerne	207
Blair	111	Lycoming	213
Bradford	15	McKean	0
Bucks	111	Mercer	0
Butler	30	Mifflin	1
Cambria	0	Monroe	0
Cameron	1	Montgomery	149
Carbon	0	Montour	1
Centre	10	Northampton	0
Chester	3	Northumberland	19
Clarion	0	Perry	0
Clearfield	2	Philadelphia	4
Clinton	0	Pike	1
Columbia	63	Potter	0
Crawford	0	Schuylkill	19
Cumberland	0	Snyder	0
Dauphin	86	Somerset	5
Delaware	133	Sullivan	1
Elk	0	Susquehanna	27
Erie	0	Tioga	8
Fayette	2	Union	21
Forest	0	Venango	0
Franklin	1	Warren	0
Fulton	0	Washington	0
Greene	0	Wayne	0
Huntingdon	13	Westmoreland	0
Indiana	1	Wyoming	114
Jefferson	54	York	8
Juniata	2	**Total**	**1,719**

Table 6.3-2 depicts local mitigation projects for which FEMA HMA grants have been obligated, approved, or are pending since approval of the previous Commonwealth 2013 SSAHMP. There are 35 projects and a total of 131 properties. Nineteen projects have been funded in Pennsylvania under the FMA, thirteen by HMGP, and three by PDM program since 2013.

Table 6.3-2 Mitigation Projects for which FEMA HMA Grant Funds are Pending/Approved/Obligated since 2013 (as of March 15, 2018).

PROJECT	COUNTY	JURISDICTION OR SUB-APPLICANT	PROGRAM FY	PROGRAM AREA	NUMBER OF PROPERTIES
Lisburn Road Acquisition Project	Cumberland	Mechanicsburg	2016	FMA	1
Borough of Ambler HM Project	Montgomery	Ambler	2016	FMA	3
Cass Twp Oak Lane - Valley Road Acquisition	Schuylkill	Pottsville	2013	HMGP	3
Center Township Butler Co Hazard Mitigation Grant program	Butler	Butler	2016	FMA	1
Cheltenham Twp Bickley Rd Acquisition 2	Montgomery	Glenside	2014	HMGP	2
Cheltenham Twp Bickley Road Acquisition	Montgomery	Glenside	2013	HMGP	2
City of Harrisburg, Sinkhole Mitigation	Dauphin	Harrisburg	2015	PDM	25
County of Adams Mitigation Project	Adams	East Berlin	2016	FMA	1
Dover Township Pine Road Acquisitions	York	York	2014	HMGP	5
Dunbar Twp Church Hill Rd Acquisition	Fayette	Dunbar	2014	HMGP	1
FMA 2014	Adams	East Berlin	2014	FMA	1
FMA 2016 Ridgway Acquisition Project	Elk	Ridgway	2016	FMA	1
FMA-2016-Lycoming CW SRL Buy-Out	Lycoming	Williamsport	2015	FMA	9
Franklin Twp McKim & Jackson Way Acquisition	Beaver	Ellwood City	2014	HMGP	11
Grant Year 2016 Lycoming County FMA SRL Acquisition	Lycoming	Cogan Station	2016	FMA	11
Hemlock Twp Acquisition #2	Columbia	Bloomsburg	2017	HMGP	11
Lower Makefield 2014-FMA Elevation Project	Bucks	Yardley	2014	FMA	3
Middletown Few Ave Acquisition	Dauphin	Middletown	2013	HMGP	2

Table 6.3-2 Mitigation Projects for which FEMA HMA Grant Funds are Pending/Approved/Obligated since 2013 (as of March 15, 2018).

PROJECT	COUNTY	JURISDICTION OR SUB-APPLICANT	PROGRAM FY	PROGRAM AREA	NUMBER OF PROPERTIES
Montour County River Drive Acquisition	Montour	Danville	2013	HMGP	1
North Coventry Twp South Hanover St Acquisition	Chester	Pottstown	2013	HMGP	1
Paradise Twp North Creek Road Acquisition	York	East Berlin	2013	HMGP	1
Pine Grove Borough Acquisition	Schuylkill	Pine Grove	2013	HMGP	6
Plumstead Township FMA Application	Bucks	Point Pleasant	2014	FMA	1
Toby Farms Chester Twp Powell Road	Delaware	Brookhaven	2014	PDM	6
Upper Southampton Township Mitigation Project	Bucks	Southampton	2013	FMA	1
Upper Southampton Township Multihazard Mitigation Project	Bucks	Southampton	2015	FMA	1
Upper St Clair Hays Road Acquisition	Allegheny	Upper St Clair	2014	HMGP	1
West Manchester Township Market Street Pump Station Floodproofing	York	York	2013	PDM	1
West Norriton Township Elevation Project	Montgomery	Norristown	2014	FMA	2
West Pittston Acquisitions	Luzerne	West Pittston	2014	FMA	2
West Whiteland Township Acquisition Project #3	Chester	Exton	2013	FMA	1
West Whiteland Township Acquisition Project #3	Chester	Exton	2016	FMA	1
West Whiteland Township Chester County Elevation Project	Chester	Exton	2014	FMA	1
Yardley Borough FMA 2015 Yardley Acquisition and Elevation Project	Bucks	Yardley	2015	FMA	3
Yardley Borough FMA-2014 Elevation Project	Bucks	Yardley	2014	FMA	8
				Total	**131**

6.3.1.3. Prioritizing Local Assistance

As described in Section 6.1, mitigation projects are created at several governmental levels and can include ongoing projects, state obligated projects, and projects identified in local Hazard Mitigation Plans. The number and cost of hazard mitigation projects will likely always exceed the amount of funds available for such activities. Therefore, a process is needed to prioritize projects using metrics such as cost effectiveness and consistency with local and state mitigation goals. Many efforts to study the appropriate mitigation actions are multi-disciplinary in nature and require coordination between jurisdictions and governmental agencies. The process used for prioritizing mitigation projects depends on the specific program from which funds are allocated. During a declared disaster, the Commonwealth along with FEMA develops a Planning strategy typically through Administrative Plan to target counties with planning needs and prioritize them based on risk and capabilities. The Hazard Mitigation Project Review Committee uses the following checklist in Table 6.3-3 to evaluate projects. It prioritizes cost-effectiveness, eliminating repetitive losses, and other factors.

Selection of mitigation projects for RL and SRL properties is based on the number of flood-related events, the dollar amount of insurance claims paid, a cost-benefit evaluation, environmental soundness, and technical feasibility. When PEMA receives project applications, it examines each to determine if it is an RL or SRL property. The Commonwealth strives to fund all plans and projects that meet application standards for any HMA grant. Though if funding became limited in the future and all grant criteria were equal, mitigating SRL properties would be first priority, RL properties would be second priority, and non- RL or SRL properties would be third priority. Acquisition is also prioritized over elevation; therefore, the prioritization of projects may be elaborated on to be SRL acquisition first, RL acquisition second, SRL elevation third, RL elevation fourth, non-RL acquisition fifth, and non-RL elevation sixth.

Local assistance provided for the 20 local Hazard Mitigation Plan updates between 2013 and 2017 was prioritized based on plan expiration update needs. Those counties with immediate plan expiration dates were offered assistance first. In the event that a chosen county was not interested in assistance, the next county with the most immediate expiration date was chosen to receive funding assistance.

Table 6.3-3 Commonwealth Hazard Mitigation Program Application Evaluation Checklist from HMPO Handbook (PEMA, 2013)

Hazard Mitigation Project Officer Handbook

Appendix 2-R. Commonwealth Hazard Mitigation Program Application Evaluation Checklist

Municipality: ____________________ **Project Number:** ____________________

County: ____________________ **Date:** ____________________

Reviewer: ____________________ **Point Total:** ____________________

☐ HMGP ☐FMA ☐PDM

***Circle Point Value of all Numbered Questions** (And Appropriate Category Questions)*

Is the problem to be mitigated and the proposed solution adequately explained? (See Application Part IV – Detailed Project Description)

Partially 1 2 3 4 5 6 7 8 9 10 Completely

Does this project solve a repetitive problem or address one that poses a significant risk if left unresolved? (See Application Part IV – Detailed Project Description)

Partially 1 2 3 4 5 6 7 8 9 10 Completely

What is the project's potential for preventing loss of life? (See Application Part IV – Detailed Project Description)

Low 1 2 3 4 5 6 7 8 9 10 High

What is the project's potential for preventing damage to homes and businesses? (See Application Part IV – Detailed Project Description)

Low 1 2 3 4 5 6 7 8 9 10 High

What is the project's impact on retaining or preserving essential community services or facilities? (See Application Part IV – Detailed Project Description)

Low 1 2 3 4 5 6 7 8 9 10 High

What is the project's potential for preventing economic hardship in the community? (See Application Part IV – Detailed Project Description)

Low 1 2 3 4 5 6 7 8 9 10 High

Does the project adequately detail the disaster damage history and dollar damages for each occurrence? (See Application Part IV – Detailed Project Description)

Inadequate 1 2 3 4 5 6 7 8 9 10 Adequate

Point Subtotal this page ____________

Appendix 2-R

Table 6.3-3 Commonwealth Hazard Mitigation Program Application Evaluation Checklist from HMPO Handbook (PEMA, 2013)

Hazard Mitigation Project Officer Handbook

Does the proposed budget adequately detail all costs associated with the successful completion of the project? (See Application Part VI – Cost Estimates)

No 1 2 3 4 5 6 7 8 9 10 Yes

Do the reductions in future damages and losses as a result of this project appear to be greater than the proposed costs?

No 1 2 3 4 5 6 7 8 9 10 Yes

Does this project area include Substantially Damaged (≥50%) properties? (See Application Part V – Project Location)

None 1 2 3 4 5 6 7 8 9 10 Many

Is the discussion of alternatives accurate, complete, and does it clearly justify the chosen project? (See Application Part VIII – Discussion of Alternatives)

Unclear 1 2 3 4 5 6 7 8 9 10 Clear

Do project work schedules and maintenance schedules appear reasonable and attainable? Is the project completed within the maximum three year performance period? (See Application Part IX – Project Work Schedule)

No 1 2 3 4 5 6 7 8 9 10 Yes

Does this project positively affect minority or special needs population (handicapped, elderly, low income, etc.)? (See Application Part X – Environmental & Historical Review)

Minimally 1 2 3 4 5 6 7 8 9 10 Completely

Have environmental effects such as wetland, air and water quality impact, hazardous materials, floodplain management been considered and addressed? (See Application Parts X & XI)

Minimally 1 2 3 4 5 6 7 8 9 10 Completely

Is the project area in the 100-year floodplain or designated floodway? (See Application Part XI – Compliance Assurances)

Minimally 1 2 3 4 5 6 7 8 9 10 Completely

Point Subtotal this page ____________

Appendix 2-R

Table 6.3-3 Commonwealth Hazard Mitigation Program Application Evaluation Checklist from HMPO Handbook (PEMA, 2013)

Hazard Mitigation Project Officer Handbook

PEMA ONLY – ELIGIBILITY & PERFORMANCE REVIEW SECTION

Applicant: ______________________ **Project Name:** ___________________________

SHMT Review total _____ **+ PEMA Section total** _____ **= FINAL Score** ______

Is the benefit-cost ratio for this program 1.0 or higher?
(If the answer to this question is NO, the project is not eligible for mitigation funding)
☐ No (0 points) ☐ Yes (10 points) ______

Does the applicant community have an approved Hazard Mitigation Plan?
☐ No (0 points) ☐ Yes (5 points) ______

Is this project identified in that plan?
☐ No (0 points) ☐ Yes (5 points) ______

Does the project demonstrate affordable operation and maintenance costs which the local jurisdiction is committed to support?
☐ No (0 points) ☐ Yes (5 points) ______

Has the applicant successfully completed a previous mitigation project?
☐ No (0 points) ☐ Yes (5 points) ______

Was the project completed within the performance period?
☐ No (0 points) ☐ Yes (5 points) ______

Was the project closed within the 90 day liquidation period?
☐ No (0 points) ☐ Yes (5 points) ______

Is the applicant a participating NFIP community? Is the applicant a CRS community?
☐ No (0 points) ☐ Yes (5 points) ______

Does this project area include Repetitive Loss and/or Severe Repetitive Loss structures?
☐ No (0 points) ☐ Yes (5 points) ______

Has the applicant actively taken steps to increase public awareness of hazards, preventative measures and emergency response to hazards?
☐ No (0 points) ☐ Yes (5 points) ______

Has the applicant committed local funds to support this project?
☐ No (0 points) ☐ Yes (5 points) ______

Appendix 2-R

6.4. Pennsylvania Repetitive Loss and Severe Repetitive Loss Mitigation Strategy

6.4.1. Introduction

RL and SRL information are woven throughout this Pennsylvania Hazard Mitigation Plan. This section contains a *Repetitive Loss and Severe Repetitive Loss Mitigation Strategy* for Pennsylvania that specifies the state's strategy to reduce the number of RL and SRL properties and specifically identifies sections of the SHMP that address this information. The SPT determined that it would be helpful to maintain the SRL strategy and expand it to be the *Repetitive Loss and Severe Repetitive Loss Mitigation Strategy,* even though this strategy will not result in increased funding. These properties reflect a priority for mitigation and are deserving of a specific strategy.

PEMA received approval for its first Severe Repetitive Loss Strategy on May 30, 2008. The 2008 strategy was revised as part of this section of the Pennsylvania 2010 Hazard Mitigation Plan and expanded to cover both RL and SRL properties in 2013. Additionally, a CD resides as Appendix G to this plan and features SRL and RL property files which have been merged with the Commonwealth's Mitigated Properties file so that mitigated repetitive loss properties are properly characterized.

6.4.2. Strategy Overview

The Commonwealth of Pennsylvania seeks to reduce the number of RL and SRL properties through a strategy that focuses on three categories:

- **Data:** Maintenance of accurate datasets is essential to characterizing the portfolio of Pennsylvania Severe Repetitive Loss and Repetitive Loss Properties. These datasets facilitate program planning, HMA grant targeting, and outreach efforts to potential project sponsoring communities as well as the property owners. The methodology that the Commonwealth will employ will compare the known mitigation project locations with the repetitive loss locations as identified by FEMA in Microsoft Excel workbooks contained in Appendix G. The Greatest Savings to the Fund (GSTF) data and methodology is no longer regularly published by FEMA. However, the data within the BureauNet database and within analysis completed by Region III's Floodplain Management and Insurance Branch accomplishes similar analysis.

- **Planning:** In Pennsylvania, counties and municipalities have developed local hazard mitigation plans that target and prioritize mitigation actions, consistent with the principle that all-hazard mitigation begins locally. Counties and municipalities serve as HMA local sponsors, applying to the PEMA for grant programs to mitigate flood-prone properties. Specifically, municipalities with RL and SRL properties must include strategies to address these properties in their hazard mitigation plans. PEMA provides data as requested from BureauNet to share with counties for HMP updates, always noting the requirement to not disclose specific property addresses publicly.

- **Outreach:** Education and awareness provided through outreach is the key to increasing the number of mitigated structures in Pennsylvania and reducing reliance on the NFIP. Outreach activities continue to be developed to provide services beyond conventional limits and segments of a community.

As of July 2018, Pennsylvania had 8,515 repetitive loss and severe repetitive loss properties, 1,486 of which have been mitigated. This is an increase of 416 mitigated properties from 2013. This information is contained in the flood hazard profile in Section 4.3.5. This section summarizes Pennsylvania data on SRL and RL claims, properties, and mitigated structures by county and provides tables and maps of this information. Table 4.3.5-9 and Table 4.3.5-10 show the number and type of RL and SRL property for each county in Pennsylvania. The tables also show how many properties for each type of building (i.e., 2-4 family, single-family, non-residential, etc.) were mitigated. Figure 4.3.5-15 shows the location of RL and SRL properties in Pennsylvania.

In order for the Commonwealth to reduce the number of these RL and SRL properties, the SPT reviewed the Mitigation Strategy of the 2013 Pennsylvania Hazard Mitigation Plan and developed 2018 mitigation goals, objectives and actions. This is detailed in the Mitigation Strategy in Section 6.2 of this Plan Update. There were many repetitive RL and SRL actions, so several were combined or noted as a capability to streamline the mitigation strategy and make it reflect actual action rather than a standing capability like accessing BureauNet.

Goals guide the selection process of actions to mitigate and reduce potential losses from hazards, including mitigation activities for repetitive loss properties. Although there are many actions incorporated in the mitigation action plans found in Section 6.2.4, the following Goals, Objectives, and Actions represent the RL and SRL mitigation strategy.

Table 6.4-1 RL and SRL related goals and objectives from full Mitigation Strategy						
ACTION DESCRIPTION	**HAZARD**	**LEAD/SUPPORT AGENCY**	**FUNDING SOURCE**	**TARGET COMPLETION DATE**	**MEASURE OF SUCCESS**	**PRIORITY**
Goal 1 - Protect lives, property, environmental quality, and resources of the Commonwealth, including high-risk properties.						
Objective 1-1: By 2021, reduce flood-related losses (with an emphasis on reducing NFIP identified repetitive loss and severe repetitive loss properties by 5%) through promotion of the Commonwealth's flood protection program through local, county, state, and federal partners.						
Action 1-1c. Target SRL and RL properties for mitigation (including demolition, acquisition, and elevation) during annual HMA project review and prioritization process.	Flood	PEMA; Counties; DCED	FEMA Hazard Mitigation Assistance Programs; Staff time	December 2019	Mitigate five or more SRL properties per year. Use the list of 'shovel ready' projects from recent DRs to facilitate mitigation project application process for future funding opportunities.	High
Objective 1-12: Ensure reports and databases are updated annually to reflect Repetitive Loss and Severe Repetitive Loss mitigation.						
Action 1-12b. Annually review the progress of SRL and RL property mitigation to ensure accuracy of BureauNet. Submit BureauNet updates as needed, particularly for location and mitigation status.	Flood	PEMA; Counties; DCED	FEMA Hazard Mitigation Assistance Programs (management costs)	Continuous	Include information in annual report (Action 1-12e); 100% compliance needed.	Medium

Table 6.4-1 RL and SRL related goals and objectives from full Mitigation Strategy

ACTION DESCRIPTION	HAZARD	LEAD/SUPPORT AGENCY	FUNDING SOURCE	TARGET COMPLETION DATE	MEASURE OF SUCCESS	PRIORITY
Goal 5 - Increase awareness, understanding, and preparedness across all sectors.						
Objective 5-2: Prioritize outreach efforts that will result in a 10% increase in RL and SRL related grant applications between 2019 and 2023.						
Action 5-2b. Conduct one meeting annually in each region of the state targeting RL and SRL community officials who serve as HMA grant sponsors.	Flood	PEMA; DCED; Counties	EMPG; FMA; HMGP	October 2023	Document meeting dates and outreach for 2023 SHMP.	High
Action 5-2c. Use the RL/SRL marketing and implementation program successes in PA communities as a platform for outreach efforts to other RL/SRL communities.	Flood	PEMA; Counties; DCED	HMGP when under a disaster declaration	Annually	Submit one story per year to FEMA website, KEMA Newsletter, PEMA Pointers, and SJ Buzz.	Medium
Action 5-2d. Provide an update on SRL and RL mitigation strategies and accomplishments at the annual Commonwealth of Pennsylvania Emergency Management Conference.	Flood	PEMA; DCED	Staff time	Annually	Ensure slot on agenda annually in March.	Medium

PEMA is working to mitigate RL and SRL properties and is working with counties with large numbers of repetitive loss properties. The Commonwealth has had several success stories in RL and SRL mitigation. For example, homes were elevated in a county in southeastern Pennsylvania that experienced repeated flood losses.

The Commonwealth's prioritization process for selecting projects and properties for mitigation is described in Section 6.3.1. In particular, PEMA works to mitigate RL and SRL properties through FEMA's HMA program. The Commonwealth strives to fund all plans and projects that meet application standards for any HMA grant. Though if funding became limited in the future and all grant criteria were equal, mitigating SRL properties would be first priority, RL properties would be second priority, and non- RL or SRL properties would be third priority. Acquisition is also prioritized over elevation, therefore the prioritization of projects may be elaborated on to be SRL acquisition first, RL acquisition second, SRL elevation third, RL elevation fourth, non-RL acquisition fifth, and non-RL elevation sixth.

Prioritization has resulted in mitigating 1,486 RL and SRL properties in Pennsylvania. The State and local capabilities to fund and mitigate RL and SRL properties are discussed in Sections 5.3. Pennsylvania will also continue to pursue ways to improve on RL mitigation as indicated by several of the above actions.

Sections 5.3 and 6.3.1 of the Hazard Mitigation Plan describes the Commonwealth's process provide local mitigation planning assistance. In particular, Section 6.3.1 describes how the Commonwealth supports the development of local mitigation plans.

6.4.3. Review of Implementation Actions from 2013 RL and SRL Strategy

The following represents a summary of actions identified in the 2013 RL and SRL Strategy and progress related to these actions since 2013.

Table 6.4-2 Progress Report of SRL Strategy

2013 RL & SRL STRATEGY ACTIONS	PROGRESS & EDITS FOR 2018 UPDATE
Action 1-1f. Target SRL and RL properties for mitigation including demolition, acquisition and elevation, through HMA funding through prioritization during annual HMA project review and prioritization process.	Complete and continue. A total of 416 SRL properties were mitigated between 2014 and 2018 with an average of 104 properties mitigated per year. Details pertaining to several of these projects are highlighted in Section 4.3.5.
Action 1-1g. Incorporate prioritizing of SRL and RL property mitigation into the PEMA-HM strategy and the Administrative Plan post-flood-related disaster.	Complete and move to capability. RL and SRL projects are prioritized in the grant review process by PEMA. Accomplished in FEMA-4099-DR (PA Hurricane Sandy) and FEMA-4149-DR (PA – Severe Storms, Tornadoes, and Flooding, 10/1/13).
Action 1-1h. Include the targeting of SRL and RL structures for mitigation in the mitigation strategies section of multi-jurisdictional or county §322 plan with SRL or RL properties.	Complete and move to capability. RL and SRL properties are identified in County or multi-jurisdictional plans. This requirement is facilitated by the FEMA Plan Review Tool and Pennsylvania's All-Hazard Mitigation Planning Standard Operating Guide. The State Hazard Mitigation Planner also assists by sharing exports of RL and SRL properties from BureauNet with counties following the required privacy requirements.
Action 1-12b. Improve the accuracy of geo-locational data on RL and SRL properties by researching matches for properties with incomplete and/or out-of-date address based on rural road designations that have changed.	Ongoing and move to capability. The BureauNet data has been consistently and regularly updated since 2010. Not only has the rural route and geocoding information improved dramatically, the mitigation status and additional fields found for RL and SRL properties have improved.
Action 1-12c. Align RL and SRL property data with validated FEMA NFIP RL and SRL property data annually.	Ongoing and move to capability. The BureauNet data has been consistently and regularly updated since 2010. Not only has the rural route and geocoding information improved dramatically the mitigation status and additional fields found for RL and SRL properties have improved.
Action 1-12d. Use the Greatest Savings to the Fund (GSTF) data and methodology to promote the cost-effectiveness of SRL property mitigation for HMA grant applications.	Changed. The GSTF analysis changed with the 2013 updates to the HMA program. This particular data set is not produced and shared by FEMA at this time. Pennsylvania has elected to continue the spirit of this initiative through the priority communities selected for outreach and mitigation in the annual Risk Reduction Consultation collaboration between State and Federal partners. This initiative identifies priority communities and in general focused on historic river towns with high flood risk. See new Action 5-2a focused on outreach to high priority communities.

Table 6.4-2 Progress Report of SRL Strategy

2013 RL & SRL STRATEGY ACTIONS	PROGRESS & EDITS FOR 2018 UPDATE
Action 1-12f. Examine the FEMA-PEMA SRL and RL data sets to seek properties that could potentially be mitigated through the FEMA RFC, SRL, or other HMA funding programs or any other funding sources on an annual basis.	Ongoing and move to capability. The SRL and RL data is regularly reviewed and used to prioritize mitigation action in Pennsylvania.
Action 1-13a. Update annually the list of completed SRL and RL mitigated properties and use GIS or other methods to merge FEMA's SRL and RL database with Pennsylvania's mitigated properties database. Update the merged database when each HMA grant closes or whenever local data becomes available.	Modify. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Revise action to incorporate actions 1-13b, 1-13c, 1-13d, and 1-13e. Though this is generally viewed as a capability for Pennsylvania, it should be kept as an action due to the importance of annual review and reporting on this topic.
Action 1-13b. Complete FEMA Form AW-501 for each mitigated property and provide to FEMA through FEMA database or submittal to Region III upon project close-out.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.
Action 1-13c. Use GIS to merge the Increased Cost of Compliance SRL and RL database with Pennsylvania's mitigated properties database annually.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.
Action 1-13d. Ensure that the latitude and longitude of each property is confirmed during project close-out as well as during sponsoring community's three-year mitigation compliance inspection for completed properties. Update mitigated properties Excel workbooks to assure accurate status of mitigated RL and SRL properties.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.
Action 1-13e. Contact counties with SRL properties to confirm the number and type of mitigated properties and source of funding, if known. This approach can be used to establish an ongoing process of verifying addresses by gathering latitude and longitude data and will ensure currency of the FEMA RL and SRL data sets.	Incorporate into Action 1-13a. There were numerous repetitive actions that related to the same topic to keep BureauNet information up to date. Actions 1-13b, 1-13c, 1-13d, and 1-13e should be removed and the general requirement captured in Action 1-13a.
Action 4-1d. Perform a "Losses Avoided" study on mitigated SRL or RL properties to communicate money saved in response and recovery so that decision makers, community officials, and property owners will be interested in mitigating specific properties.	Complete and revise. The losses avoided information in the Flood Profile was updated in this plan. Pennsylvania will begin collecting more detailed elevation and building information for mitigation projects to continue to improve and build upon losses avoided analysis.
Action 5-2a. Conduct one meeting annually in each region of the state targeting RL and SRL community officials who serve as HMA grant sponsors.	Complete and continue. USACE 2017 non-structural workshops conducted in Erie, Butler, Pittsburgh, and Montgomery Counties. Targeting Central Area via PA Silver Jacket project in 2018.

Table 6.4-2 Progress Report of SRL Strategy

2013 RL & SRL STRATEGY ACTIONS	PROGRESS & EDITS FOR 2018 UPDATE
Action 5-2b. Assist municipalities with direct mailings to SRL property owners.	Completed by different mechanism than planned and moved to capability. FEMA HQ sent mailings direct to SRL property owners. Columbia County also completed mailing to SRL property owners. This will move to capability with the option for FEMA direct mailing program to continue or for PEMA to encourage county and community mailings via the hazard mitigation planning process and sharing of BureauNet information following the required privacy requirements.
Action 5-2c. Use the RL/SRL marketing and implementation program successes in PA communities (e.g., Bucks, Lycoming Counties) as a platform for outreach efforts to other RL/SRL communities.	In progress and continue. Success stories included in SJ Buzz, PSATS, PA Boroughs Association and PA Silver Jackets Pennsylvania Mitigation Success Stories publications.
Action 5-2d. Provide an update on SRL and RL mitigation strategies and accomplishments at the annual Commonwealth of Pennsylvania Emergency Management Conference.	Complete and continue. Briefings conducted in 2014, 2016, and 2017 (2015 was cancelled for Papal Visit). Mitigation Days were held at each of the conferences with a lineup that addressed planning, resources, and advice on mitigation implementation.

6.4.4. Partnerships

The SPT was integral in the development of the 2018 RL & SRL strategy. Section 3.2. of this 2013 Hazard Mitigation Plan Update describes the composition and role of the SPT in the plan update process. Table 6.4-3 below depicts the membership of the 2018 SPT.

Table 6.4-3 Summary of agencies participating on the State Planning Team in 2018.

Community Affairs and Development	Penn State Capital College
County Commissioners Association of Pennsylvania	Penn State University Extension - Agriculture
Cumberland County Planning Department	Pennsylvania Department of Transportation (PennDOT)
Delaware Valley Regional Planning Commission	Pennsylvania Association of Floodplain Managers
Department of Agriculture	Pennsylvania Emergency Management Agency
Department of Banking and Securities	Pennsylvania Historical and Museum Commission
Department of Community and Economic Development	Pennsylvania Housing Finance Agency
Department of Conservation and Natural Resources	Pennsylvania Municipal League
Department of Drug and Alcohol Programs	Pennsylvania Office of Attorney General
Department of Environmental Protection	Pennsylvania State Association of Township Supervisors
Department of General Services	Pennsylvania State Police
Department of Health	Pennsylvania's State System of Higher Education
Department of Homeland Security	PENNVEST
Department of Human Services	Perry County
Department of Labor & Industry	Public Health Management Corporation
Department of Meteorology and Atmospheric Science, The Pennsylvania State University	Public Utility Commission
Fayette County Emergency Management	SEDA-Council of Governments
Federal Emergency Management Agency, Region III	Tri County Regional Planning Commission
Franklin County Department of Emergency Services	U.S. Department of Homeland Security
Governor's Office of Homeland Security	U.S. Geological Survey - Pennsylvania Water Science Center
Lehigh County Emergency Management Agency	United States Army Corps of Engineers
Millersville University Disaster Research Center	Michael Baker International, Inc., Vernon Land Use, LLC, and Nurture Nature Center
Northern Tier Regional Planning and Development Commission	

Achieving and working through this revised RL and SRL strategy will require the Commonwealth to continue with the members of the SPT as well as reach out to other groups. In particular, the Commonwealth should seek partnerships with local governments. PEMA will continue to seek assistance to implement this RL and SRL strategy through close cooperation with its public and private sector partners.

6.5. Mitigation Success

Mitigation success in the Commonwealth have been obtained by maintaining strong partnerships with a broad range of stakeholders and utilizing multiple funding sources. Not only does the Commonwealth have 131 projects funded through HMA which are closed, approved, or obligated since 2013 (see Table 6.3.1), but PEMA along with its partners have made great strides through improved capabilities detailed below. A list summarizing many of these key successes is included in Table 6.5-1 below.

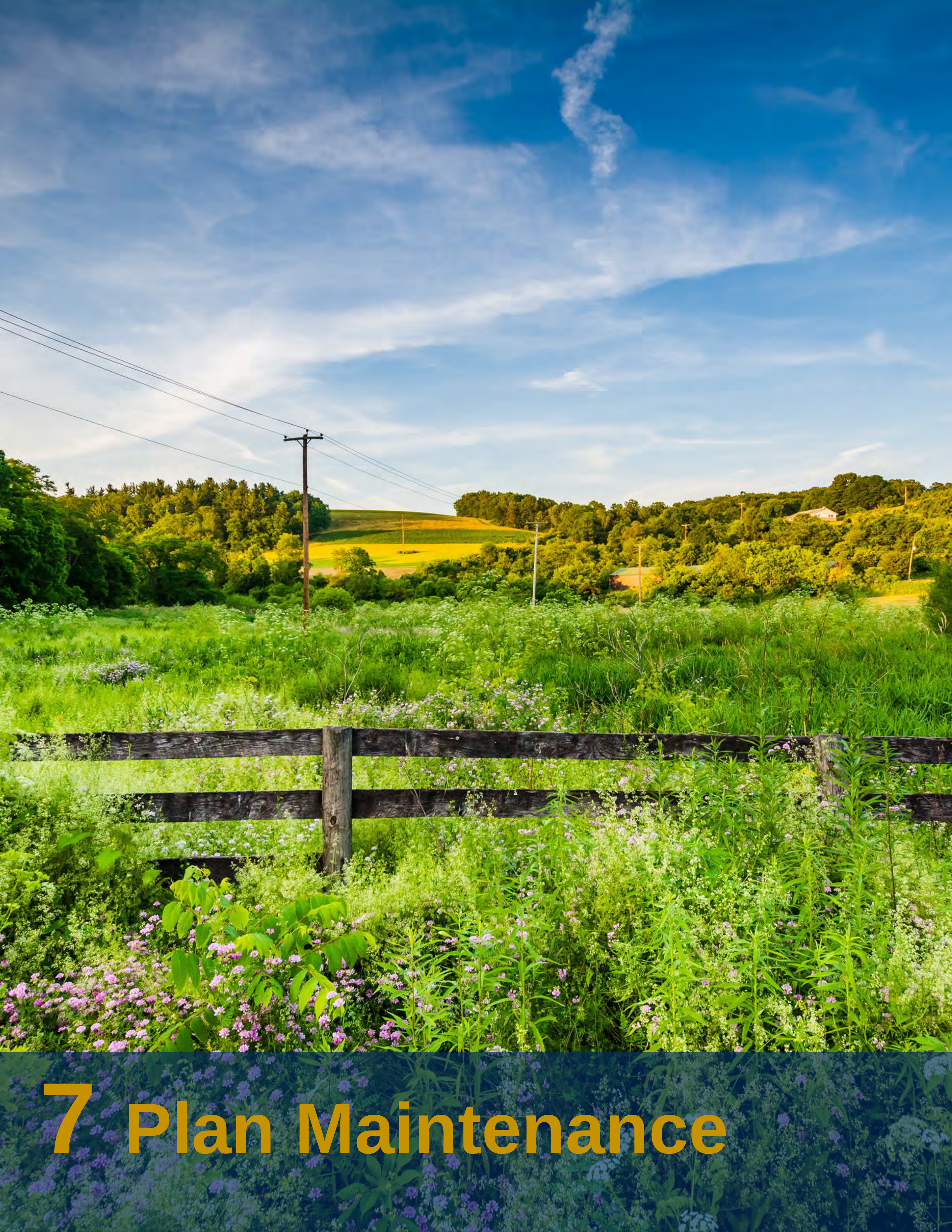
Table 6.5-1 Key Mitigation Success since 2013.

SUCCESS TITLE	SUCCESS SUMMARY DESCRIPTION
County HMP's	• 37 County HMP updated using the Standard Operating Guide.
Training/Workshops	• PEMA holds an annual conference and provides briefings at quarterly meetings. Mitigation Days held at each conference to address planning, resources, and advice on mitigation implementation. • NFIP 101 sessions conducted in 2015 and 2016 for PA legislative delegation. • USACE 2017 non-structural workshops conducted in Erie, Butler, Pittsburgh, and Montgomery counties. • DCED/PA Municipal League delivered training through the PA Construction Codes Academy. Between 2013 and 2017, 8,117 people received training through 268 classroom courses, archived webinars, and online training. • Several tours conducted: PAFPM Villanova University Tour; DRBC/Silver Jackets Tour in conjunction with Nurture Nature Center; NFIP SHMO conference tour of City Island in Harrisburg (2017); Muncy Resiliency Tour (2016). • During the planning period, PEMA along with partners DCED, PHMC, and DEP, participated in conferences for the following organizations: Pennsylvania Association of Floodplain Managers (PAFPM), County Commissioners Association of Pennsylvania (CCAP), American Planning Association Pennsylvania Chapter (APA-PA), and Pennsylvania State Association of Township Supervisors (PSATS).
Increased RL/SRL Capabilities	• Implementation completed over the past two state HMP updates (2010 and 2013) has resulted in the shift of a significant number of RL/SRL actions to capabilities. • PEMA's project ranking criteria have been developed and incorporated into RL and SRL mitigation. • RL and SRL properties are identified in County or multi-jurisdictional plans; facilitated by the FEMA Plan Review Tool and the SOG. • BureauNet has been consistently and regularly updated since 2010. • Rural route and geocoding information has improved dramatically. • The mitigation status and additional fields found for RL and SRL properties have improved.
Flood Protection Monitoring/Dam/Levee Safety	• DEP Project Inspection monitors 110 projects for over 90 municipal sponsors in conjunction with the USACE.

Table 6.5-1 Key Mitigation Success since 2013.	
SUCCESS TITLE	**SUCCESS SUMMARY DESCRIPTION**
	• Through inspection, DEP identifies potential work and provides sponsors with information on how they can apply for DCED Flood Mitigation Grants. • Fifty-five (55) dam remediation projects completed between 2013 and 2017. • DEP has an inventory of the 46 levees currently inspected under USACE's Inspection of Completed Works Program. • The DEP Guidance Document for developing Emergency Action Plans for levees and floodwalls was finalized in July 2013. • DEP's Stream Improvement Program provided funding to restore stream channels damaged in floods and to stabilize streambanks affected by erosion with between 15 to 20 projects annually.
Flood Protection Education/Tools/ Certifications	• PA Silver Jackets continually updates Best Pennsylvania Flood Protection, Preparedness documents for Public and Municipal Officials. • PA Silver Jackets documented 15 Pennsylvania success stories; available online. • Flood inundation mapping completed for 100 miles of the Susquehanna River. • Approximately 718 floodplain ordinances were adopted between 2013 and 2017. • EMAP accreditation received by Chester County in 2014 and the City of Philadelphia in 2015.
Improving Real Time Data	• PEMA knowledge center hazard mitigation buildout completed in 2017. • Virtual warning project in Huntingdon, Dauphin, and Lancaster counties completed in 2016. Stream gauges used real-time during flood events. • DHS Special Event reporting was conducted in 2015 for the Papal visit to Philadelphia. • FDA- funded Food & Rapid Response Plan formalized a network and state trigger points document was prepared. Protocols are in place to identify response steps in the event of food contamination.
Shale Gas Impacts/Plans/Training	• TENORM study complete; study identifies little potential for harm to workers or the public from radiation exposure due to oil and gas. • Emergency Response Plans (ERP's) template has been made available to the response community. • Training plans and curriculum have been developed and are being offered. • The Office of State Fire Commissioner has conducted 100 classes for well drilling professionals and emergency responders. A total of 2,292 people trained.
SHPO Historic Preservation	• PA SHPO, PEMA, and counties promote partnership and funding opportunities for collecting and updating data, including the PHMC Keystone Historic Preservation Grant Program, and the federal Certified Local Government Program. Four counties (Monroe, Bucks, Pike, and Montour) participated in PHMC pilot program.

Table 6.5-1 Key Mitigation Success since 2013.

SUCCESS TITLE	SUCCESS SUMMARY DESCRIPTION
	• As part of the Pennsylvania Flood Risk Reduction Strategy, PHMC developed Flood-Prone Historic River Town Profiles to identify a methodology to analyze at-risk Pennsylvania river towns from a historic resource perspective. • Phase 1: Disaster Planning for Historic Properties Initiative identified hundreds of historic resources in four counties. Phase 2: Completion of the Pennsylvania River Town Historic District Survey and Assessment report to evaluate and prioritize historic districts in the SFHA when preparing hazard mitigation plan updates. • PHMC staff participates in the PA Cultural Resilience Network and are available to provide technical assistance to the regional Alliances for Response, local EMA personnel, and PEMA staff. • USACE National Nonstructural Floodproofing Committee visited 25 historic buildings in Philadelphia in 2016 to assess vulnerability to tidal flooding, storm surge, and sea level rise.
Commonwealth Geospatial Strategic Plan	• The PA State Geospatial Coordinating Board (GeoBoard) was created through the passage of Act 178 in 2014. • The GeoBoard advises the Governor and public on geospatial issues, uniform data standards, and coordination across different sectors. • The Commonwealth Geospatial Strategic Plan was adopted in 2018 with the goals of: creating a sustainable business model; facilitating the development of statewide authoritative datasets; ensuring and promoting public access to geospatial data and services; and enhancing collaboration, cooperation, and coordination.
Commonwealth Fusion Centers	• The PSP Pennsylvania Criminal Intelligence Center (PaCIC) won three national awards. • Won National Network of Fusion Centers 2015 Fusion Center of the Year Award. • Two state employees received the Michael Schooler Critical Infrastructure Protection Award and the Excellence in the Field of Fusion Center Outreach Award. • PSP won the Association of Law Enforcement Intelligence Units award: 2016 LEIU General Chairman's Award.
Recovery and Resiliency Planning	• State and local efforts are underway to support recovery and resiliency planning. • The State Disaster Recovery Plan includes a template for County recovery plans. • Muncy Borough, Lycoming County has been working with several entities/agencies to establish a Center for Resilience in an historic building and has issued an RFP to prepare a community a resilience plan.



7 Plan Maintenance

7. Plan Maintenance

7.1. Update Process Summary

Monitoring, evaluating, and updating this plan are critical to maintaining its value and success in the Commonwealth'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 and updating 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.

In the years between the 2004 and 2007 plans, plan maintenance was led by PEMA. In this time frame, several modifications were undertaken in order to meet Enhanced Plan Status. The plan was updated to more fully integrate with other plans, especially the State Emergency Operations Plan and local hazard mitigation plans. PEMA also incorporated local planning efforts and research documents into the risk and capability assessments of the existing plan. In the years between plans, PEMA also began exploring an information management system for tracking actions and projects based on NEMIS and the National Tool. PEMA did not maintain the plan in isolation, though; all Commonwealth agencies and departments were asked to review their mitigation actions and examine whether their organization had funding sources that could aid in completing mitigation actions. For a more complete discussion of the 2004-2007 triennial update, please see Section 3.1.

The plan maintenance procedure for 2007-2010 focused on having PEMA prepare any plan updates and submit them to the State Flood Budget Task Force, an entity incorporating the Office of Administration, Office of the Governor, PEMA, DEP, DCNR, and the Office of Administration for review and evaluation. This Task Force was charged with reviewing goals and objectives to determine their applicability to the changing situations and policies of the Commonwealth. They were also responsible for reviewing the risk assessment and capabilities to determine if the information needed to be changed, updated, or removed. Reporting was to be compiled and added to the Elements of Change document accompanying the 2007 Plan. Due to technical, administrative, and financial constraints, this plan maintenance process could not be completed.

The plan maintenance procedure for 2010-2013 was led by PEMA's Bureau of Recovery and Mitigation and assisted by the USACE Silver Jackets and (for more information, see Section 3.2). The USACE Silver Jackets was established to support implementation of the flood-related mitigation actions of the SSAHMP. Separate meetings to review the SSAHMP annually were planned but did not occur due to the volume of disaster response related work handled by BORM between 2010 and 2013. A great deal of progress was made towards implementation the mitigation strategy, though separate plan review meetings did not take place.

The Silver Jackets was an effective method for maintenance on the SSAHMP and will be used moving forward to maintain and implement the 2013 SSAHMP update. Membership in the PA Silver jackets includes:

Federal

- USACE
- FEMA Region III
- NOAA and NWS
- USGS
- HUD
- NRCS
- EDA

Commonwealth

- PennDOT
- PA Insurance Department
- PA Department of Agriculture
- PEMA
- DCED
- DEP
- DCNR
- PA SHPO

Regional

- Susquehanna River Basin Commission (SRBC)
- Delaware River Basin Commission (DRBC)
- Interstate Commission on the Potomac River Basin (ICPRB)

Professional

- PA Association of Floodplain Managers (PAFPM)
- Keystone Emergency Management Agency (KEMA)
- American Rivers Organization (ARO)

Annual SHMP review meetings were held in October of 2014, 2015, 2016, and 2017. The SPT and Silver Jackets were invited to these meetings. In 2016, another set of in-depth meetings focused on the SHMP update began concluding around the start of the 2018 SHMP update. Moving forward, the same plan of annual October meetings will be hosted by PEMA and a five-year update for 2023 will begin in 2021.

7.2. Monitoring, Evaluating and Updating the Plan

The Commonwealth recognizes that the Hazard Mitigation Plan is not a static document and requires regular review and evaluation. The plan will be monitored for changes in the conditions under which the plan was developed, such as new or revised state laws, major disaster declarations, or availability of funding. PEMA-BORM will take will take the lead in monitoring, evaluating, and conducting future updates. BORM will be assisted in this effort by the USACE Silver Jackets program, facilitated by PEMA's Area Offices, SHMO, Hazard Mitigation Planner, DEP Emergency Preparedness Liaison Officer, the DCED NFIP Coordinator, and/or the Bureau of Recovery and Mitigation to ensure the support of and representation from federal, state, and regional organizations and agencies. Additional members of the 2018 SPT and other interested parties will be encouraged to join and build the Silver Jackets.

The Commonwealth Hazard Mitigation Plan will be reviewed annually. In instances where there is a disaster declaration, a meeting of the Silver Jackets will be held soon after the disaster event to gather lessons learned. A meeting will also be held after a disaster event in order to bring in all Commonwealth agencies, describe what the disaster declaration means, and determine if any agencies have projects that could be funded through the declaration. In non-disaster settings, BORM supported by the Silver Jackets group will review the plan for changes in policy and will ensure that the plan addresses the current and expected conditions. Members will also review the risk assessment and capabilities portion of the plan to determine if this information needs to be updated or modified. Mitigation strategies and their associated actions will be reported upon by the party, agency, or department responsible for their implementation, and will include which implementation processes worked well, difficulties encountered, how coordination efforts were proceeding, and which strategies or processes need to be revised or strengthened.

Goals, objectives, and actions will be reviewed annually and in the event of a disaster to determine whether they need to be modified to reflect new conditions. Findings will be appended to the existing plan. Objectives pertinent to HMGP are also reviewed after each disaster and are formalized with the preparation of the Administrative Plan; this provides a roadmap to consistency between funding programs. A new Administrative Plan will be added after each disaster, if applicable.

PEMA, with assistance by the Silver Jackets, will then create a list of recommendations that suggests ways to update the plan. PEMA will be responsible for making the necessary changes to the plan. The revised plan will be submitted for approval to FEMA, and upon approval, will be incorporated into the State Emergency Operations Plan. FEMA will be notified that the plan was changed. The plan will be updated after each disaster event to include a post-disaster mitigation strategy that outlines Commonwealth priorities for future disaster events. This plan maintenance process will be modified as appropriate should a significant fiscal or personnel constraint arise. The five-year update of the State Mitigation Plan will be completed, FEMA Approved, and State Adopted before the 2023 Anniversary date.

A key component of the annual review of the SHMP will be ensuring continued compliance of 44 CFR 13.11. At each review, the Commonwealth will ensure that it still complies with federal statutes and regulations that pertain to grant funding. This will additionally ensure proper distribution of grant funding. In addition, the Commonwealth of Pennsylvania will amend its plan whenever necessary to reflect changes in State or Federal laws and statues as required in 44 CFR 13.11(d).

Minutes from meetings related to the plan will be filed and saved so that they may be included in the Planning Process Appendix for the 2018 SHMP update. Other information pertinent to the Commonwealth’s progress with hazard mitigation, such as news articles, should also be saved in this file for incorporation in the updated SHMP appendix.

The Pennsylvania's Silver Jackets Team was recognized in September of 2013 for being the Silver Jackets team of the year. This award recognizes everything that the team accomplished since being established during the 2010 SSAHMP update and illustrates that their role in implementing the 2018 SHMP continues to be an excellent choice.

7.3. Continued Public Involvement

PEMA will involve the public during periodic evaluations of the SHMP by providing an opportunity to submit comments about the plan. The public will have access to the plan online and through www.pahmp.com. The public is encouraged to submit comment on the plan at any time. Relevant comments will be incorporated into the plan's next update. Additionally, information in the plan will be modified for ease of use online for local officials, students writing papers, and other interested in hazard mitigation in the Commonwealth.

PEMA's Bureau of Recovery and Mitigation will also distribute ReadyPA preparedness and mitigation information at meetings. Information on upcoming events relating to hazard mitigation planning will be announced in newsletters, newspapers, mailings, and on the PEMA website (www.pema.pa.gov). The Bureau of Recovery and Mitigation will also engage the public by encouraging the use of the PA Alert system, which provides citizens and partners with timely information on emergency and weather alerts, health notifications, tax notifications, and updates. When applicable, contact information for PEMA will be included in alert notices to encourage two-way communication. Additionally, the Bureau of Recovery and Mitigation supports individual counties with information and materials as well as personnel to support local hazard mitigation efforts.

7.4. Monitoring Progress of Mitigation Actions

7.4.1. Project Reporting

PEMA's Bureau of Recovery and Mitigation is responsible for monitoring and tracking progress of mitigation measures taken on a Commonwealth-wide basis by the individual actions of Commonwealth agencies and departments as well as the counties and their jurisdictions. PEMA will provide FEMA with the status of properties acquired, relocated, elevated, or retrofitted. The Bureau, through the SPT, will also assign personnel to follow up with other agencies' staff on a quarterly basis as to the progress of state-obligated mitigation measures. PEMA staff will submit quarterly project reports to FEMA to address all active projects in all grant areas. They also track project awards and progress in the grants management database. Once a project has a Letter of Intent or Interest, it will become part of the PEMA Hazard Mitigation Fiscal and Project database.

Projects will be divided for evaluation by the subject matter of each project and assigned to appropriate staff members. PEMA staff shall develop an evaluation document that addresses outcomes or the success of projects. The team will assess new information provided through research and disaster assessment reports to update the baseline data. The team will review the level of coordination among state agencies. This review is key to the success in implementing the plan.

7.4.2. Project Closeout Process

"Project closeout" is the process that finalizes a completed mitigation project that FEMA has funded. Closeout will be conducted based on FEMA Region III closeout procedures. Projects and activities funded through other federal or state grant programs, state general funds, or that can be achieved without targeted funding will be completed as dictated by the funding source or state program with administrative oversight for the activity of the project.

The PEMA administrative closeout process for HMGP is a 12-step process that is carried out by PEMA, the applicant, and FEMA. As established in the PEMA process, final site visit inspections are required with both the applicant and PEMA present at the conclusion of the project. Additionally, all acquisition projects have a mandatory three-year mitigation compliance inspection to ensure the property is still being maintained as open space. According to HMA Guidance, municipalities are responsible for this triennial maintenance; they must report to compliance to the Commonwealth, who in turn reports to FEMA. There are twelve main steps to completing the close-out process:

1. Site Stabilization
2. Sub-grantee Closeout Request Letter (R-25)
3. Site Visits/Photos/Latitude-Longitude by PEMA/FEMA
4. Codes Compliance Letter (R-26)
5. NFIP RL Update Worksheet AW-501 (R-27 & R-28)
6. PEMA will conduct a desk audit of project file
7. PEMA Financial Reconciliation/Revised Budget
8. PEMA Close-out Request Letter to FEMA Region III
9. HMGP Quarterly Webinars/Reports continue
10. FEMA Close-out Letter received
11. Open Space Requirements/Subsequent transfer
12. Monitoring, Reporting, and Inspection

Additional details on the Project Closeout and full grants management process are outlined in PEMA's HMPO Handbook.

8 Plan Adoption

8. Plan Adoption

The 2018 State Hazard Mitigation Plan was submitted by the Pennsylvania State Hazard Mitigation Officer to FEMA on June 29, 2018. FEMA reviewed and provided comments on the plan August 20, 2018. These comments were addressed to re-submit to FEMA on September 17, 2018 and received approval-pending-adoption on October 5, 2018. The Commonwealth of Pennsylvania adopted the plan on October 10, 2018. Full approval from FEMA was received on October 16, 2018, and was effective as of October 10, 2018.

This section of the plan includes a copy of the adoption resolution passed by PEMA. A completed Standard and Enhanced State Mitigation Plan Regulation Checklist can be found in *Appendix B – Plan Review Tool*.

Commonwealth of Pennsylvania
2018 State Hazard Mitigation Plan Update
State Adoption Resolution

WHEREAS, the Commonwealth of Pennsylvania is most vulnerable to natural and human-made hazards which may result in loss of life and property, economic hardship, and threats to public health and safety, and

WHEREAS, section 322 of the Disaster Mitigation Act of 2000, Public Law 106-390, (DMA 2000) requires state governments to develop and submit for approval to the President a mitigation plan that outlines processes for identifying their respective natural hazards, risks, and vulnerabilities, and

WHEREAS, the Commonwealth of Pennsylvania acknowledges the requirements of section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving post-disaster Hazard Mitigation Grant Program funds, and

WHEREAS, the Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan update has been developed through the efforts of the Pennsylvania Emergency Management Agency, members of the State Hazard Mitigation Planning Team, and other state, regional, and local agencies and organizations, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan update, and

WHEREAS, the Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan recommends mitigation activities that will reduce losses to life and property affected by both natural and human-made hazards that face the Commonwealth and its municipal governments and will be amended as necessary to ensure continual compliance with 2 CFR Part 200, and all federal and state laws and statutes,

NOW THEREFORE BE IT RESOLVED by the Pennsylvania Emergency Management Agency and the Pennsylvania Emergency Management Council that:

- The Commonwealth of Pennsylvania State Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of Pennsylvania, and
- The respective officials and agencies identified in the implementation strategy of the Commonwealth of Pennsylvania 2018 State Hazard Mitigation Plan are hereby directed to implement the recommended activities assigned to them.

ADOPTED, this 10th day of October 2018.

Richard D. Flinn, Jr.
Director, Pennsylvania Emergency Management Agency

U.S. Department of Homeland Security
Region III
One Independence Mall, 6th Floor
615 Chestnut Street
Philadelphia, PA 19106-4404

FEMA

October 16, 2018

Mr. Richard D. Flinn, Jr., Director
Pennsylvania Emergency Management Agency
1310 Elmerton Avenue
Harrisburg Pennsylvania 17110

Re: Commonwealth of Pennsylvania State Hazard Mitigation Plan Approval

Dear Mr. Flinn:

The U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) Region III Mitigation Division, Risk Analysis Branch has approved the updated Commonwealth of Pennsylvania State Hazard Mitigation Plan effective, October 10, 2018 through October 9, 2023, in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR), §201.

A FEMA-approved state mitigation plan is a condition of receiving certain non-emergency Stafford Act assistance and FEMA mitigation grants from the following programs:

- Public Assistance Categories C-G (PA C-G)
- Fire Management Assistance Grants (FMAG)
- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation (PDM)
- Flood Mitigation Assistance (FMA)

State mitigation plans must be updated and resubmitted to the FEMA Region III Mitigation Division, Risk Analysis Branch for approval. If the plan is not updated by the expiration date indicated on this FEMA approval letter, the plan is considered lapsed and FEMA will not obligate funds until the mitigation plan is approved by FEMA.

If at any time over the plan approval period FEMA determines that the commonwealth is not complying with all applicable federal statutes and regulations in effect, with respect to the periods for which it receives funding or is unable to fulfill mitigation commitments, FEMA may take action to correct the noncompliance (44 CFR §§201.3(b)(5) and 201.4(c)(7)).

The commonwealth is responsible for communicating with local and tribal officials, as applicable, interested in applying through the commonwealth for FEMA assistance. FEMA encourages states to communicate with the appropriate officials regarding mitigation plan status and eligibility requirements. At a minimum of every six (6) months, FEMA will provide to the commonwealth written information on mitigation plans, including but not limited to:

- Local and tribal, as applicable, mitigation plan expiration dates
- Consequences of not having a FEMA-approved local or tribal, as applicable, mitigation plan with respect to eligibility for HMA programs;
- Availability of mitigation planning training and technical assistance; and
- Upcoming funding opportunities.

The commonwealth is responsible for reviewing and submitting approvable mitigation plans to FEMA. If the commonwealth is not submitting approvable mitigation plans, FEMA will provide feedback as well as technical assistance or training, as needed.

In addition, FEMA will provide a reminder to the commonwealth, at a minimum, twelve (12) months prior to the plan expiration date, of the consequences of not having a FEMA-approved mitigation plan with respect to eligibility for the FEMA assistance programs that require FEMA-approved mitigation plan as a condition of eligibility. To maintain eligibility for PA C-G, FMAG, HMGP, PDM and FMA, the commonwealth must submit a draft of the next plan update prior to the end of the approval period, and allow sufficient time for the review and approval process, including any revisions, if needed, and for formal adoption by the commonwealth following determination by FEMA that the plan has achieved a status of "Approvable Pending Adoption".

Finally, we look forward to working with you to discuss the status of Pennsylvania's mitigation program each year over the approval period.

If we can be of assistance, please contact April Cummings, Director, Mitigation Division (Acting), at (215) 931-5635 or april.cummings@fema.dhs.gov.

Sincerely,

for MaryAnn Tierney
Regional Administrator

cc: Jeffrey Thomas, Executive Deputy Director
Thomas Hughes, State Hazard Mitigation Officer