Armstrong County Hazard Mitigation Plan

October 2019

Prepared for:

Armstrong County, Pennsylvania
131 Armsdale Road | Kittanning, PA 16201

TETRA TECH

Submitted by:
TETRA TECH, INC.
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EXECUTIVE SUMMARY

The 2019 update to the Armstrong County Hazard Mitigation Plan (HMP) was prepared in accordance with the Disaster Mitigation Act of 2000 (DMA 2000). DMA 2000 requires states and local governments to prepare HMPs to remain eligible to receive pre-disaster mitigation grant funds made available in the wake of federally declared disasters. Additionally, DMA 2000 effectively improves the disaster planning process by increasing hazard mitigation planning requirements for hazard events. DMA 2000 requires participating municipalities to (1) document their hazard mitigation planning process, and (2) identify hazards; potential losses; and mitigation needs, goals, and strategies.

The Armstrong County HMP represents the work of citizens, elected and appointed government officials, business leaders, and volunteer and nonprofit groups to protect community assets, preserve economic viability of the community, and save lives. DMA 2000 regulations require formal updates and adoptions of local plans every 5 years to reassess risks and update local strategies to manage and mitigate those risks. To comply, Armstrong County and inclusive jurisdictions actively participated in updating the County HMP. Extensive outreach efforts by Armstrong County's Department of Public Safety resulted in participation from all 45 municipalities. Upon completion and approval of the HMP, participating jurisdictions will continue to address and implement findings and recommendations of this plan update.

Table ES-1 identifies municipal governments that actively participated in the HMP update process.

Table ES-1. Participating Jurisdictions in the 2019 Armstrong County HMP Update

Jurisdictions		
Apollo Borough	Gilpin Township	Pine Township
Applewold Borough	Hovey Township	Plumcreek Township
Atwood Borough	Kiskiminetas Township	Rayburn Township
Bethel Township	Kittaning Borough	Redbank Township
Boggs Township	Kittaning Township	Rural Valley Borough
Bradys Bend Township	Leechburg Borough	South Bend Township
Burrell Township	Madison Township	South Bethlehem Township
Cadogan Township	Mahoning Township	South Buffalo Township
Cowanshannock Township	Manor Township	Sugarcreek Township
Dayton Borough	Manorville Borough	Valley Township
East Franklin Township	North Apollo Borough	Washington Township
Elderton Borough	North Buffalo Township	Wayne Township
Ford City Borough	Parker City	West Franklin Township
Ford Cliff Borough	Parks Township	West Kittanning Borough
Freeport Borough	Perry Township	Worthington Borough

During the plan update process, Armstrong County and its participating municipalities engaged in the following planning process steps:

1. Identified and prioritized hazards that may affect the County and its municipalities.
2. Assessed the County's and each municipality's vulnerabilities to these hazards.
3. Identified mitigation actions that can reduce those vulnerabilities.

4. Developed a strategy for implementing those actions, including identifying the agency (or agencies) responsible for each implementation.

Throughout the planning process, the general public was offered an opportunity to comment on the existing HMP and provide suggestions for the updated version. The County hosted two Planning Team meetings that were open to the public during which residents could provide input on the HMP.

The following hazards were identified by the Planning Team as presenting the highest risk to the County and its municipalities:

- Dam Failure
- Drought
- Earthquake
- Environmental Hazards
- Flood, Flash Flood, and Ice Jams
- Invasive Species
- Landslide
- Levee Failure
- Pandemic
- Radon Exposure
- Subsidence and Sinkholes
- Terrorism
- Tornado/Wind
- Transportation Accidents
- Utility Interruption
- Wildfire
- Winter Storm

To mitigate the effects of those hazards, the Planning Team identified the following goals for hazard mitigation over the next 5 years:

1. **Goal 1:** Increase public awareness and education on both the potential impacts of natural hazards and activities to reduce those impacts.
2. **Goal 2:** Prevent injury/death and damage from natural and human-made hazards.
3. **Goal 3:** Protect the citizens of Armstrong County as well as public and private property from the impacts of natural and human-caused hazards.
4. **Goal 4:** Improve emergency services and capabilities to protect public health and safety.

Objectives and actions to be implemented are discussed in the Mitigation Action Plan in Section 6 of this HMP.

Additionally, Planning Team members will meet annually to evaluate the status of plan implementation and prepare a summary report of HMP status and any needed updates. The mitigation evaluation will address changes as new hazard events occur, as the area develops, and as more information becomes available pertaining to hazards and their impacts. The evaluation will include an assessment of whether the planning process and actions have been effective, whether development or other issues warrant changes to the HMP or its priorities, if progress toward the communities' goals is satisfactory, and whether changes are warranted. The public is encouraged to give feedback (1) by directly contacting the County Hazard Mitigation Planning Team Coordinator, (2) during recurring review meetings, and (3) during the 5-year revision process.

To request information or provide comments regarding this plan, please contact the Armstrong County Department of Public Safety. Contact information is provided below:

Mailing Address:	Hazard Mitigation Planning Team c/o Armstrong County Department of Public Safety 131 Armsdale Road Kittanning, PA 16201
Contact Name:	Becky Waugaman, Emergency Preparedness Coordinator, Department of Public Safety
Telephone:	(724) 548-3368
Fax:	(724) 548-3326

CERTIFICATION OF ANNUAL REVIEW MEETINGS

The Armstrong County Hazard Mitigation Planning Team has reviewed this Hazard Mitigation Plan (HMP). See Section 7 of this document for further details regarding this certification section. The Armstrong County Department of Public Safety HMP Coordinator hereby certifies the review.

YEAR	DATE OF MEETING	PUBLIC OUTREACH ADDRESSED?*	SIGNATURE
2015	N/A	N/A	The annual review meeting was not conducted.
2016	N/A	N/A	The annual review meeting was not conducted.
2017	N/A	N/A	The annual review meeting was not conducted.
2018	N/A	N/A	The annual review meeting was not conducted. Armstrong County began the 5-year update process.

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

RECORD OF CHANGES

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

Section	Page

Appendices

SECTION 1 INTRODUCTION

This section presents background information, describes the purpose, and defines the scope of the 2019 update of the Armstrong County Hazard Mitigation Plan (HMP).

1.1 BACKGROUND

Across the United States, natural and human-caused disasters have led to increasing levels of deaths, injuries, property damage, and interruptions of business and government services. The time, money, and effort spent to recover from these disasters exhausts resources, diverting attention from important public programs and private agendas.

Armstrong County, Pennsylvania, has experienced a significant number of statewide or County-specific disaster declarations since 1954. The emergency management community, citizens, elected officials, and other stakeholders in Armstrong County recognize the impact of disasters on their community and have concluded that proactive efforts need to be taken to reduce the impact of natural and human-caused hazards. To that purpose, Armstrong County is committed to updating and maintaining the Armstrong County HMP.

"Hazard mitigation" describes actions taken to prevent or reduce the long-term risks to life and property caused by a hazard event. Pre-disaster mitigation actions are taken in advance of a hazard event and are essential to breaking the typical disaster cycle of damage, reconstruction, and repeated damage. With careful selection, mitigation actions can be long-term, cost-effective measures taken to reduce the risk of loss.

The Armstrong County Hazard Mitigation Steering Committee (composed of Armstrong County officials) and the Planning Team (composed of Armstrong County officials, municipal representatives, and emergency responders) has updated this HMP. Armstrong County contracted Tetra Tech, Inc. (Tetra Tech) to prepare the 2019 HMP update.

The HMP update is the result of several months of collaboration between the citizens and officials of the County and representatives from Tetra Tech to develop a pre-disaster, multi-hazard mitigation plan that will guide the County toward greater disaster resistance while respecting the character and needs of the community.

1.2 PURPOSE

The purpose of this HMP is to minimize the effects that natural, technological, and man-made hazards have on the people, property, environment, and business operations within Armstrong County. This document exists to provide the background information and rationale for the mitigation actions that the Steering Committee, Planning Team, and municipal representatives have chosen to implement across the County.

The document is governed by the Disaster Mitigation Act of 2000 (DMA 2000) and its implementing regulations (Title 44 *Code of Federal Regulations* [CFR] §201.6, published February 26, 2002). Local jurisdictions must comply with the DMA 2000, and these regulations to remain eligible for funding and technical assistance from state and federal hazard mitigation programs.

1.3 SCOPE

The implementation actions outlined within this HMP apply to Armstrong County and any municipalities within the County that adopt this plan. Only those municipalities that have participated in the plan update process may adopt this plan and will be eligible for state and federal hazard mitigation funding. For the purpose of this plan, municipal participation was defined as providing information (e.g., via completion and submission of an Evaluation of Identified Hazards Worksheet, Capability Assessment Survey, Mitigation Strategy 5-Year Plan Review Worksheet, and/or Municipal Risk Factor Analysis) and participation by an official municipal representative at a planning meeting or in individual outreach.

1.4 AUTHORITY AND REFERENCE

This HMP was prepared in accordance with the following regulations and guidance:

- FEMA “Local Mitigation Planning Handbook,” March 2013
- FEMA “Integrating Hazard Mitigation into Local Planning,” March 1, 2013
- FEMA “Plan Integration: Linking Local Planning Efforts,” July 2015
- Local Mitigation Plan Review Guide, October 1, 2011
- DMA 2000 (Public Law 106-390), October 30, 2000
- 44 CFR Parts 201 and 206 (including February. 26, 2002; October. 1, 2002; October. 28, 2003; and Sept. 13, 2004 Interim Final Rules)
- FEMA “How-To Guide for Using HAZUS-MH for Risk Assessment” (Document No. 433), February 2004
- FEMA Mitigation Planning How-To Series (FEMA 386-1 through 4), 2002
  Available on-line at: http://www.fema.gov/fima/planhowto.shtm.
- FEMA “Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards,” January 2013
- Commonwealth of Pennsylvania’s All-Hazard Mitigation Planning Standard Operating Guide, October 18, 2013

A full set of references used in updating the HMP is included in Appendix A.

SECTION 2 COUNTY PROFILE

Section 2 of the Armstrong County Hazard Mitigation Plan (HMP) discusses the geography and environment, community facts, population and demographics, and land use and development in Armstrong County.

2.1 GEOGRAPHY AND ENVIRONMENT

Armstrong County is a rural county located in the western portion of the Commonwealth of Pennsylvania. The County is located within the Pittsburgh metropolitan area. It is bordered to the North by Clarion County, to the northeast by Jefferson County, to the east by Indiana County, to the south by Westmoreland County, to the southwest by Allegheny County, and to the west by Butler County (Armstrong County Tourist Bureau, 2018).

"Armstrong County encompasses 654 square miles of rolling hills, farmland, forests of maple, oak and cherry, and flat river valleys. The Allegheny River valley meanders from north to south throughout the county. In addition, there are three lakes and numerous other small rivers and streams. The developed areas (residential, commercial and industrial uses) of Armstrong County comprise approximately one-fourth of the county's total land area. About 37% of the population in Armstrong County lives in an urbanized area or cluster (borough or village), while the remaining 63% of the population lives in areas that the U.S. Census Bureau defines as "rural." Most development can be found along the major roads and in the various boroughs and villages" (Armstrong County, 2005).

Armstrong County does not contain any major interstate highways but has a number of key regional highways, including: US Route 422, PA Route 28, PA Route 66, PA Route 68, PA Route 85, PA Route 268, and PA Route 285. PA Route 28 offers access between Pittsburgh and Route 422 near Kittanning. Route 422 runs west from East Franklin Township, near West Kittanning to the City of Butler. Route 422 also runs east from East Franklin Township near West Kittanning east through Indiana County, and terminates in Ebensburg, where it connects to U.S. Route 22. PA Route 68 runs through the northern portion of Armstrong County and connects Butler and Clarion. These roads allow for transportation throughout Armstrong County, neighboring counties, and to the City of Pittsburgh.

2.2 COMMUNITY FACTS

Armstrong County was created on March 12, 1800 from parts of Lycoming, Allegheny, and Westmoreland counties. It consists of 45 municipalities: 1 city, 28 townships and 16 boroughs. Armstrong County's seat is Kittanning Borough, which has a population of 4,044.

Armstrong County's economy and settlement patterns have historically been guided and supported by the rich natural resources in the region. Early settlement of Armstrong County was slow due to the limited transportation systems throughout the County. The transportation network had been improved by the year 1850 with the completion of the Pennsylvania Canal and the Kittanning & Warren Railroad. These improvements allowed for the expansion of industry, which included iron furnaces, grist mills, and saw mills, but the primary industry within Armstrong County was still agriculture.

The discovery of oil in Parker during the 1860s resulted in a population boom as natural gas and other resources throughout the County helped to influence population growth. Armstrong County has produced sand, gravel, glass, clay, brick, steel, iron, natural gas, and quarried stone. Today, Armstrong County's major industries include agriculture, brick making, and iron and steel-sheet manufacturing. Growing industries within Armstrong County include electro-optics and advanced manufacturing technologies (Armstrong County, 2005). The County remains predominantly rural, and its natural landscapes offer numerous recreational activities.

Figure 2-1 shows a base map of Armstrong County.

Figure 2-1. Base Map of Armstrong County

Source: PASDA, Armstrong County

2.3 POPULATION AND DEMOGRAPHICS

Population and demographic data provide baseline information about residents. Changes in demographics or population may be used to identify higher-risk populations. Maintaining up-to-date data on demographics will allow the County to better assess magnitudes of hazards and develop more specific mitigation plans. Baseline demographic information for Armstrong County is provided in Table 2-1.

Table 2-1. Armstrong County Population Statistics

Municipality	2000 Census	2010 Census	2016 Estimate	Population Change 2000-2016	Population Change 2000-2016 (%)	Population Density Per Square Mile
Apollo Borough	1,765	1,647	1,567	-198	-12.64%	4708.4
Applewold Borough	356	310	341	-15	-4.40%	4829.2
Atwood Borough	112	107	94	-18	-19.15%	44.8
Bethel Township	1,290	1,183	1,319	29	2.20%	74.8
Boggs Township	979	941	812	-167	-20.57%	37.8
Bradys Bend Township	939	783	772	-167	-21.63%	61.7
Burrell Township	749	684	596	-153	-25.67%	30.9
Cadogan Township	390	344	313	-77	-24.60%	313.5
Cowanshannock Township	3,006	2,893	2,849	-157	-5.51%	62.6
Dayton Borough	543	559	502	-41	-8.17%	1474.2
East Franklin Township	3,900	4,089	3,994	94	2.35%	129.1
Elderton Borough	358	355	367	9	2.45%	1110.6
Ford City Borough	3,451	3,035	2,900	-551	-19.00%	3872.5
Ford Cliff Borough	412	371	446	34	7.62%	5072.0
Freeport Borough	1,962	1,813	1,797	-165	-9.18%	1391.4
Gilpin Township	2,587	2,500	2,629	42	1.60%	145.1
Hovey Township	93	97	50	-43	-86.00%	44.9
Kiskiminetas Township	4,950	4,776	4,678	-272	-5.81%	116.0
Kittanning Borough	4,787	4,044	3,920	-867	-22.12%	3191.9
Kittanning Township	2,359	2,265	2,001	-358	-17.89%	73.3
Leechburg Borough	2,386	2,152	2,105	-281	-13.35%	4554.3
Madison Township	943	824	861	-82	-9.52%	26.8
Mahoning Township	1,502	1,420	1,503	1	0.07%	56.1
Manor Township	4,231	4,183	4,230	-1	-0.02%	244.8
Manorville Borough	401	410	470	69	14.68%	2131.1
North Apollo Borough	1,426	1,302	1,311	-115	-8.77%	2130.4
North Buffalo Township	2,942	3,015	2,973	31	1.04%	118.8
Parker City	799	840	656	-143	-21.80%	874.4
Parks Township	2,754	2,749	2,660	-94	-3.53%	192.6
Perry Township	404	352	374	-30	-8.02%	23.3
Pine Township	499	413	381	-118	-30.97%	84.8
Plumcreek Township	2,304	2,382	2,228	-76	-3.41%	55.1
Rayburn Township	1,811	1,907	1,690	-121	-7.16%	157.2

Municipality	2000 Census	2010 Census	2016 Estimate	Population Change 2000-2016	Population Change 2000-2016 (%)	Population Density Per Square Mile
Redbank Township	1,296	1,063	1,019	-277	-27.18%	32.7
Rural Valley Township	922	876	892	-30	-3.36%	413.3
South Bend Township	1,259	1,186	1,013	-246	-24.28%	52.2
South Bethlehem Borough	444	481	471	27	5.73%	3150.8
South Buffalo Township	2,785	2,636	2,614	-171	-6.54%	94.6
Sugarcreek Township	1,557	1,529	1,548	-9	-0.58%	57.2
Valley Township	681	648	756	75	9.92%	43.8
Washington Township	1,029	923	886	-143	-16.14%	39.0
Wayne Township	1,117	1,198	1,200	83	6.92%	26.4
West Franklin Township	1,935	1,849	1,760	-175	-9.94%	70.7
West Kittanning Borough	1,199	1,168	1,265	66	5.22%	2801.0
Worthington Borough	778	639	699	-79	-11.30%	930.1
Armstrong County	**72,392**	**68,941**	**67,512**	**-4,880**	**-7.23%**	**103.4**

Sources: U.S. Census Bureau 2000, 2010, and 2018

Table 2-2. Demographics for Armstrong County

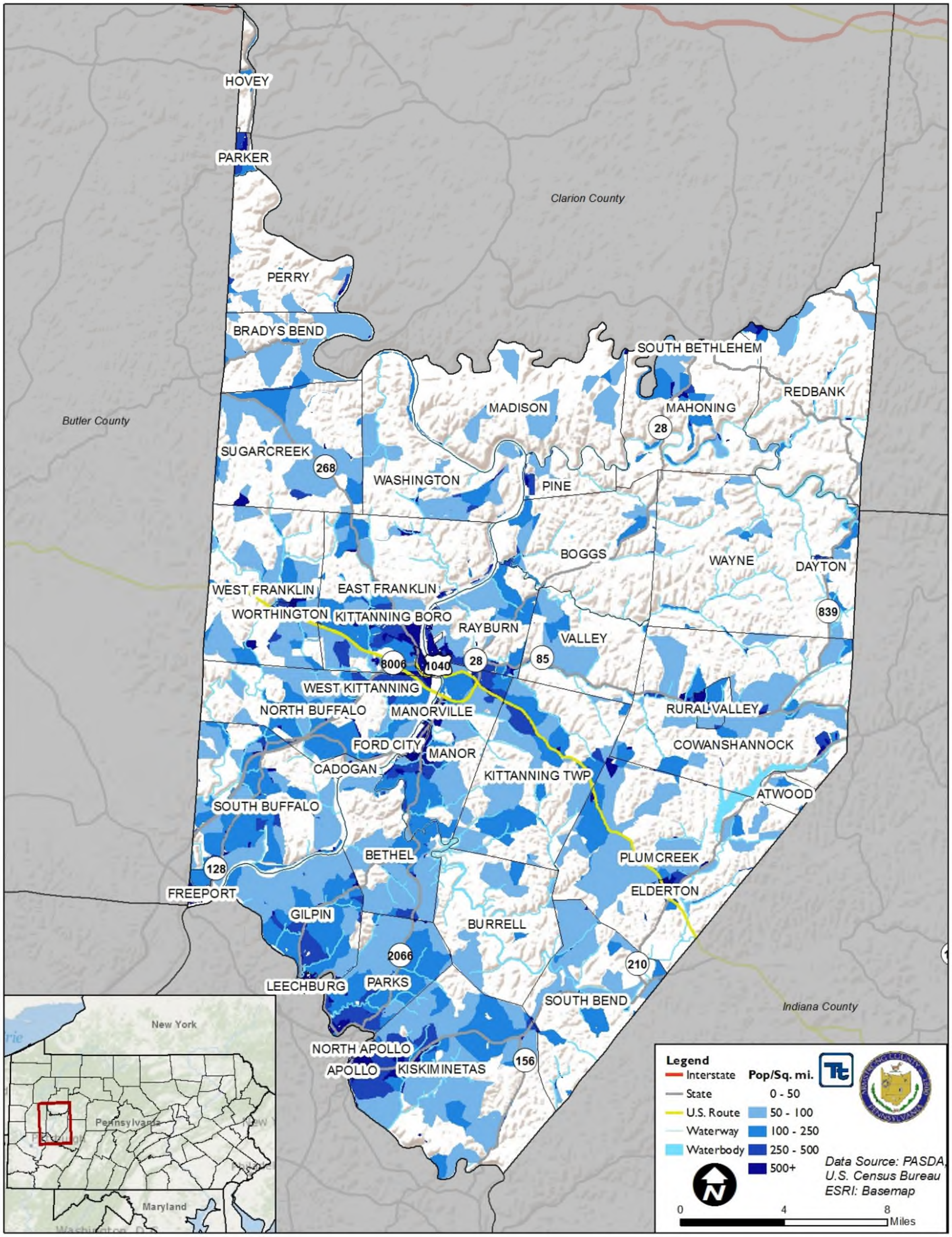
Demographics	2000 Census	2010 Census	2016 Estimates
Total population	72,392	68,941	67,512
Male	35,204	34,013	33,505
Female	37,188	34,928	34,007
Median age (years)	40.4	44.5	46.0
Under 5 years	3,913	3,605	3,429
18 years and over	55,818	54,752	54,308
65 years and over	13,053	12,687	13,666
Total households	29,005	28,713	28,250
Group quarters population	1,175	650	Not Available

Source: U.S. Census Bureau 2010, 2018

As shown in the tables above, Armstrong County's 2010 Census population was 68,941. Based on this data, the population density of Armstrong County is 103 persons per square mile, which is considerably lower than the Pennsylvania statewide average of 284 persons per square mile. The Borough of Ford Cliff has the highest population density all the municipalities in the County (5072.0 persons per square mile) (U.S. Census 2010). A significant number of the municipalities in Armstrong County have population densities above the statewide average. However, many municipalities in the County have low population density. A low population density means that people are spread throughout the County rather than clustered in groups. Dispersing information, instructions, and resources during a disaster response effort to residents in low-density areas is more difficult than in more densely populated areas because individuals are not centralized. Armstrong County 2010 population density data is illustrated on Figure 2-2.

While low-density areas provide challenges to disseminating hazard mitigation information, a low population density also means that hazards will not affect as many people. For example, diseases may not spread as quickly because citizens are in contact with less people. Similarly, fires are less likely to spread to other structures because of the large distances between them. The magnitude of an event is typically smaller in a less-populated area because each event affects fewer people and properties.

Figure 2-2. Armstrong County 2010 Population Distribution



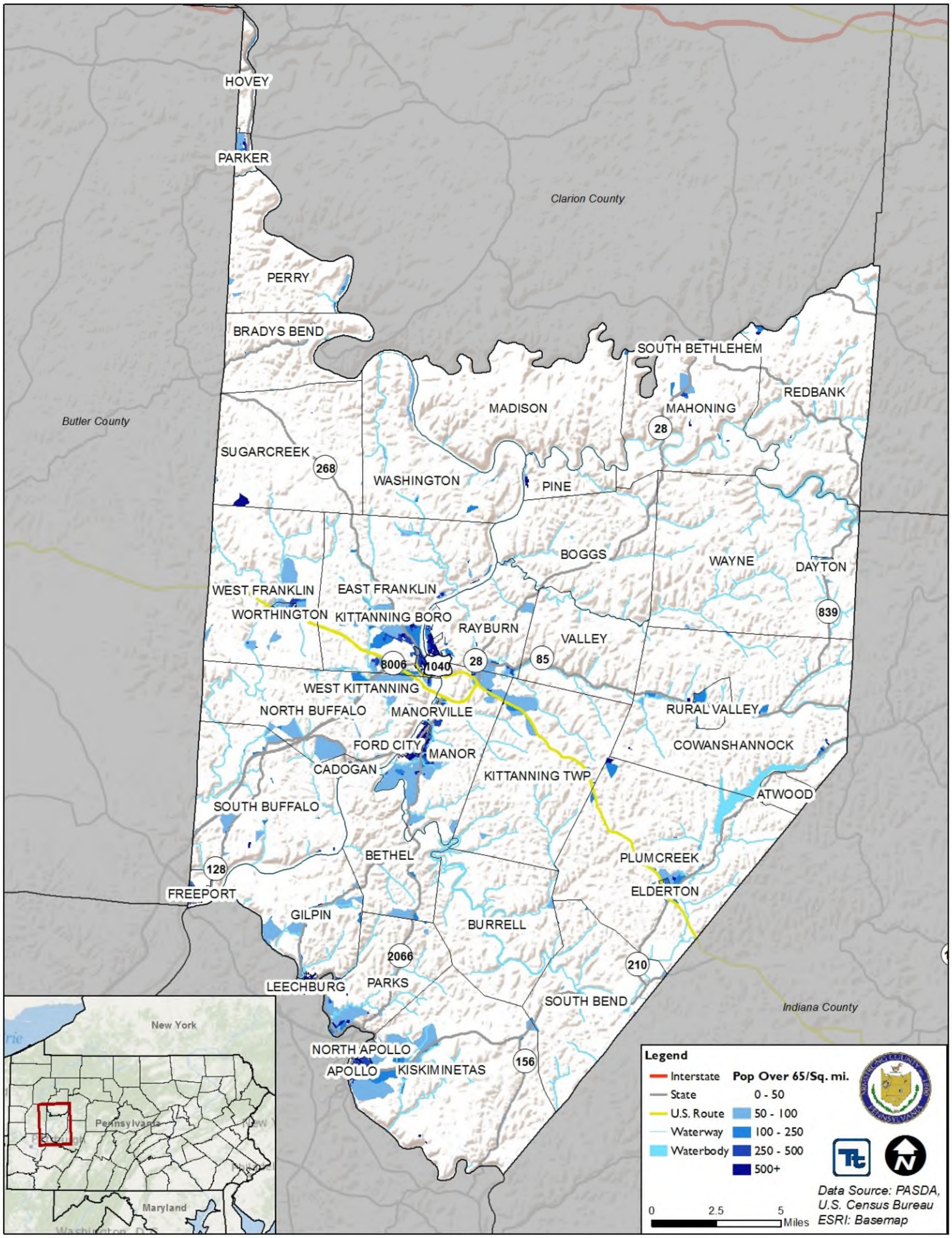
Source: U.S. Census Bureau 2010

The Disaster Mitigation Act of 2000 (DMA 2000) requires that HMPs consider socially vulnerable populations. These populations can be more susceptible to hazard events based on a number of factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. For the purposes of this study, vulnerable populations shall include (1) the elderly and younger populations (persons aged 65 and over; persons aged 5 and younger) and (2) those living in low-income households.

Approximately 18 percent of Armstrong's population is age 65 or older, compared with 15.4 percent across Pennsylvania. These residents may have special needs. For example, many residents in this age bracket may be unable to drive; therefore, special evacuation plans may need to be created for them. They may also have hearing or vision impairments that could make receiving emergency instructions difficult. Both older and younger populations have higher risks for contracting certain diseases. Armstrong County's combined under-5-years-of-age and over-65 populations represent approximately 23.6 percent of its population.

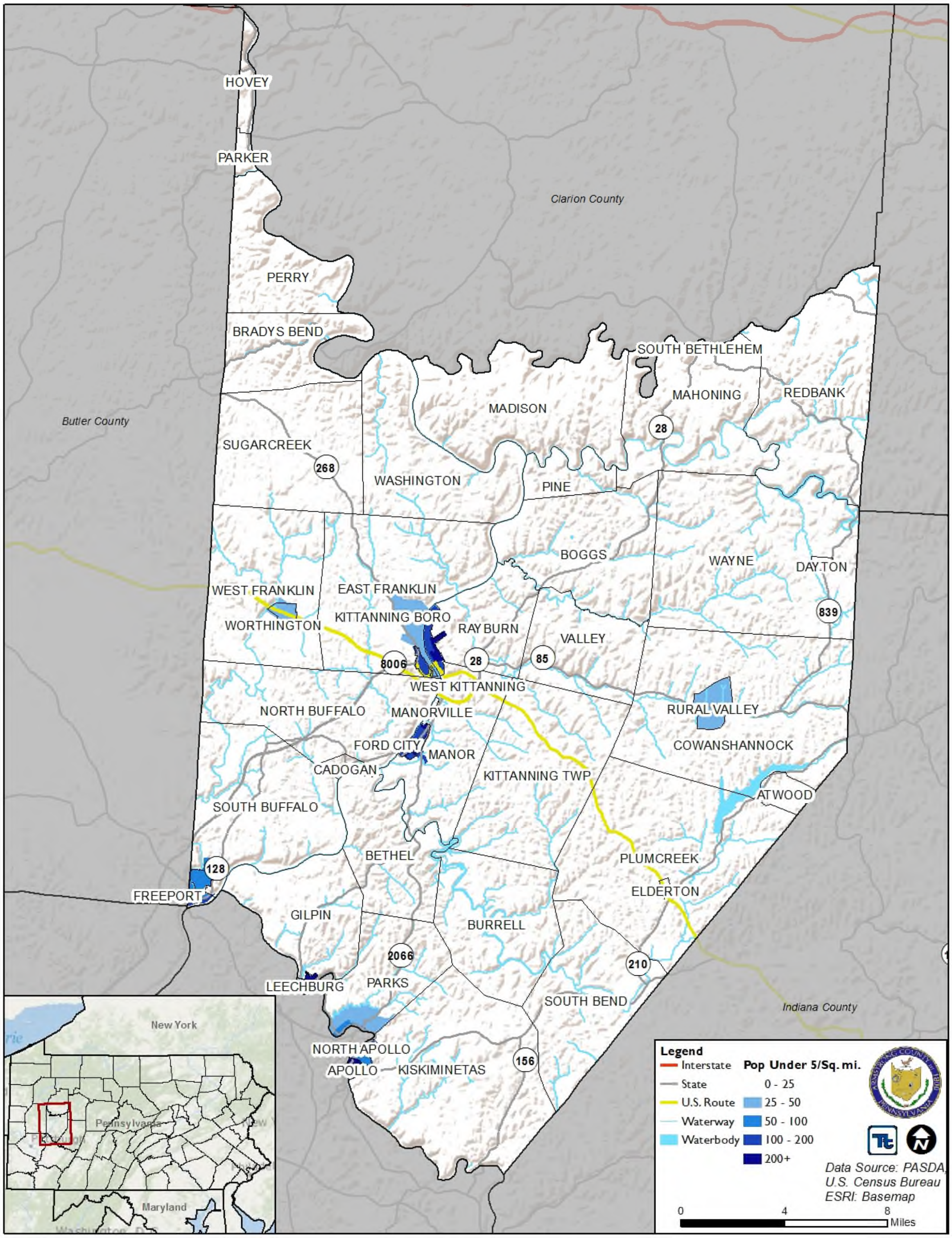
Figure 2-3 and Figure 2-4 illustrate the distribution of these populations for Armstrong County.

Figure 2-3. Armstrong County Population Over 65 Years



Source: U.S. Census Bureau 2010; FEMA 2018

Figure 2-4. Armstrong County Population Under 5 Years



Source: U.S. Census Bureau 2010; FEMA 2018

Only 0.9 percent of Armstrong's population lives in group quarters, compared to 3.4 percent across Pennsylvania. The term *group quarters* refers to people living in communal settings, which can include inmates in a prison, students in a dorm, or elderly or mentally disabled individuals living in group care homes. Residents living in group quarters are often special needs populations. It is important to ensure that each group quarters facility has its own emergency plan to account for the unique needs of its residents during a hazard event.

Table 2-3 below provides population estimates for each municipality in Armstrong County and for the County as a whole. The population of the entire County is estimated to be 62,788 by the year 2040, which represents a net population decrease of just over 9,604 people in a 30-year period. While the County will experience an overall population loss, some individual municipalities are expecting to experience a slight increase in population. Population loss typically means that some structures may become vacant and infrastructure will age, as little new development (and subsequent infrastructure updates) will be necessary. It is important for Armstrong County to properly maintain its existing infrastructure and develop plans to manage or redevelop vacant properties.

Table 2-3. Armstrong Population Projections by Municipality

Municipality Name	2000 Census	2010 Census	2020 Projected	2030 Projected	2040 Projected	% Change 2010-2040
Apollo Borough	1,765	1,647	1,522	1,401	1,278	-27.6%
Applewood Borough	356	310	282	257	230	-35.4%
Atwood Borough	112	107	97	90	82	-26.8%
Bethel Township	1,290	1,183	1,154	1,080	1,032	-20.0%
Boggs Township	979	941	916	883	858	-12.4%
Bradys Bend Township	939	783	703	640	573	-39.0%
Burrell Township	749	684	675	635	610	-18.6%
Cadogan Township	390	344	313	285	255	-34.6%
Cowanshannock Township	3,006	2,893	2,963	2,930	2,952	-1.8%
Dayton Borough	543	559	541	541	534	-1.7%
East Franklin Township	3,900	4,089	4,147	4,279	4,372	12.1%
Elderton Borough	358	355	348	343	336	-6.1%
Ford City Borough	3,451	3,035	2,816	2,562	2,353	-31.8%
Ford Cliff Borough	412	371	338	307	275	-33.3%
Freeport Borough	1,962	1,813	1,737	1,619	1,526	-22.2%
Gilpin Township	2,587	2,500	2,333	2,211	2,066	-20.1%
Hovey Township	93	97	95	97	97	4.3%
Kiskiminetas Township	4,950	4,776	4,447	4,209	3,906	-21.1%
Kittanning Borough	4,787	4,044	3,680	3,349	2,999	-37.4%
Kittanning Township	2,359	2,265	2,253	2,194	2,161	-8.4%
Leechburg Borough	2,386	2,152	1,990	1,811	1,639	-31.3%
Madison Township	943	824	768	699	640	-32.1%
Mahoning Township	1,502	1,420	1,391	1,332	1,288	-14.2%
Manor Township	4,231	4,183	4,082	4,017	3,907	-7.7%
Manorville Borough	401	410	404	407	405	1.0%
North Apollo Borough	1,426	1,302	1,262	1,173	1,115	-21.8%
North Buffalo Township	2,942	3,015	3,066	3,129	3,188	8.4%
Parker City	799	840	827	844	844	5.6%
Parks Township	2,754	2,749	2,748	2,744	2,745	-0.3%
Perry Township	404	352	377	357	363	-10.1%
Pine Township	499	413	375	341	306	-38.7%
Plumcreek Township	2,304	2,382	2,351	2,381	2,380	3.3%

Municipality Name	2000 Census	2010 Census	2020 Projected	2030 Projected	2040 Projected	% Change 2010-2040
Rayburn Township	1,811	1,907	1,941	2,011	2,060	13.7%
Redbank Township	1,296	1,063	1,101	1,002	980	-24.4%
Rural Valley Township	922	876	836	793	752	-18.4%
South Bend Township	1,259	1,186	1,102	1,021	950	-24.5%
South Bethlehem Borough	444	481	477	496	502	13.1%
South Buffalo Township	2,785	2,636	2,628	2,540	2,497	-10.3%
Sugarcreek Township	1,557	1,529	1,566	1,567	1,584	1.7%
Valley Township	681	648	629	604	577	-15.3%
Washington Township	1,029	923	903	834	793	-22.9%
Wayne Township	1,117	1,198	1,338	1,445	1,570	40.6%
West Franklin Township	1,935	1,849	1,776	1,696	1,618	-16.4%
West Kittanning Borough	1,199	1,168	1,134	1,103	1,066	-11.1%
Worthington Borough	778	639	617	561	524	-32.6%
Armstrong County	**72,392**	**68,941**	**67,049**	**64,820**	**62,788**	**-13.3%**

Source: Pennsylvania Department of Environmental Protection (PA DEP) 2012

According to the 2012–2016 American Community Survey, less than 1 percent of Armstrong's population speaks English less than "very well." While currently a low percentage, future hazard mitigation strategies should consider addressing language barriers to ensure that all residents can receive emergency instructions. Table 2-4 summarizes race and ethnicity population information for Armstrong County.

Table 2-4. Race and Ethnicity in Armstrong County

Race and Ethnicity	2010 Census	% of Population	2016 Estimates	% of Population
One race	68,413	99.2%	66,971	99.2%
White	67,565	98.0%	66,101	97.9%
Black or African American	553	0.8%	634	0.9%
American Indian and Alaska Native	45	0.1%	14	0.0%
Asian	150	0.2%	182	0.3%
Pacific Islander	9	0.0%	0	0.0%
Other	91	0.1%	40	0.1%
Two or more races	528	0.8%	541	0.8%
Hispanic or Latino	366	0.5%	456	0.7%

Source: U.S. Census Bureau 2010, 2016

According to the 2012–2016 American Community Survey 5-Year Estimates, Armstrong County has 32,427 residential properties. These properties may be vulnerable to various natural hazards, in particular, flooding and windstorms. Damage to residential properties is not only expensive to repair or rebuild but also devastating to the displaced residents.

Approximately 12.9 percent of the County's residential properties are vacant, compared to 11.3 percent across Pennsylvania. Vacant buildings are particularly vulnerable to arson and criminal activity. Because vacant properties have not been maintained, many are structurally deficient and at risk of collapsing.

Approximately 24.3 percent of the County's population rents their home, compared to 31 percent across Pennsylvania. Renters are more transient than homeowners; therefore, communicating with renters may be more difficult than communicating with homeowners. Similarly, tourists would be a harder population to communicate with during an emergency event. Communication strategies should be developed to ensure that these populations could be given proper notification.

Table 2-5 summarizes characteristics of the residential properties in Armstrong County.

Table 2-5. Housing Characteristics in Armstrong County

Housing Characteristics	2010 Census	2016 Census Estimate
Total housing units	32,520	32,427
Owner-occupied housing units	21,668	21,373
Renter-occupied housing units	7,045	6,877
Vacant housing units	3,807	4,177
Median value (dollars)	89,100*	$95,700
Housing units with a mortgage	11,282	10,713
Housing units without a mortgage	10,386	10,660

Source: U.S. Census Bureau 2010, U.S. Census Bureau 2016
** The median value was taken from the 2006-2010 ACS 5-Year Estimates. It was not available in the 2010 Census dataset.*

In 2016, the median household income in the County was $45,879, which was lower than the Commonwealth of Pennsylvania's estimated median household income ($53,115). Armstrong County's 2016 estimated per capita income of $24,634 was also lower than the Commonwealth's 2016 estimated per capita income of $30,137. Approximately 9.7 percent of families' incomes in Armstrong County were below poverty level, and 13.2 percent of its individuals' incomes were below poverty level. Emergency responders may experience challenges in connecting with individuals within this economic bracket for several reasons, including less access to the Internet within these communities. Additionally, many low-income families and individuals may not own vehicles, and therefore could be a more vulnerable population during an evacuation. Table 2-6 summarizes economic characteristics of Armstrong County's population.

Table 2-6. Economic Characteristics in Armstrong County

Economic Characteristics	2010 Census Estimate	2016 Census Estimate
Median household income	$42,752	$45,879
Median family income	$52,085	$57,019
Per capita income in 2016	$21,828	$24,634
Families below poverty level (%)	8.7%	9.7%
Individuals below poverty level (%)	11.7%	13.2

Source: U.S. Census Bureau 2010, U.S. Census Bureau 2016

Figure 2-5 illustrates population distribution for residents with incomes below the poverty level.

Figure 2-5. Armstrong County Population Below the Poverty Level

Source: U.S. Census Bureau 2010; FEMA 2017

2.4 LAND USE AND DEVELOPMENT

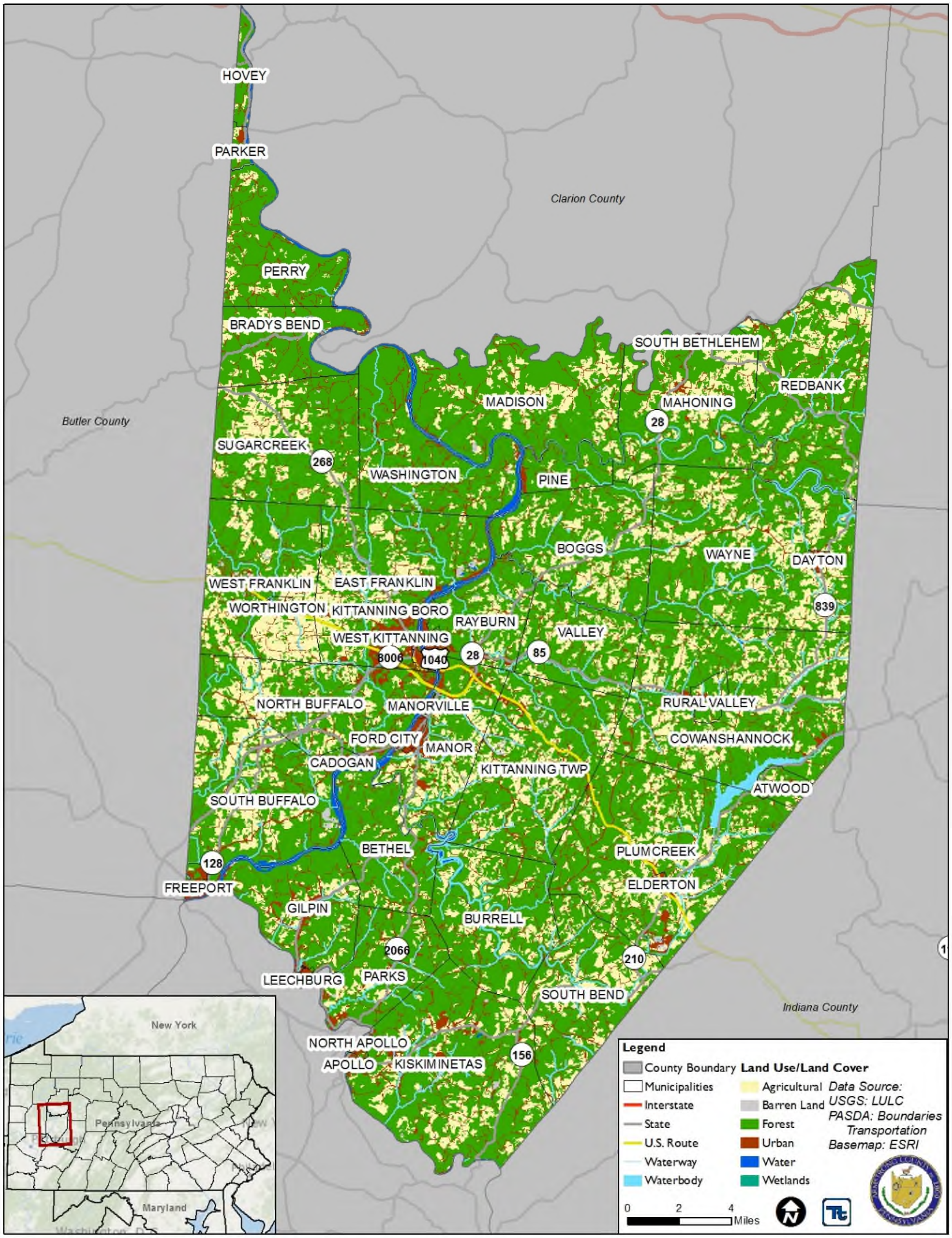
Armstrong County's existing land use patterns are greatly influenced and shaped by surrounding natural features, such as rolling hills, farmland, forests, and river valleys. These features have largely determined the location of transportation corridors and development activities as well as agricultural practices.

Of the County's total land area of 654 square miles, approximately 74 percent is categorized as forest or some agricultural use and 26 percent is classified as "other." There is a significant concentration of woodland located in the northern third of Armstrong County and along the eastern half as well. Agricultural land is scattered throughout the County as well, with a noticeable concentration in the west central region. Developed, non-farm areas are primarily located in and around the boroughs mainly located in the central and southern regions of the County. Typically, these areas make up most of Armstrong County's commercial and institutional land uses (Armstrong County, 2005).

Armstrong County has a countywide Subdivision and Land Development Ordinance in place which applies to any municipality within the County which had no Land Development Ordinances in effect (Armstrong County, 2016). Currently, this Subdivision and Land Development Ordinance applies to all municipalities except for the Borough of Apollo, which adopted their own Subdivision and Land Development Ordinance in 1999 (Armstrong County Planning and Development Dept., 2018).

Agricultural use of land in Armstrong County has stayed relatively the same since 2002 with only a minor decrease in the total acreage of agricultural area (USDA, 2002) between 2002 and 2012. That decline has slowed in recent years; however, according to the U.S. Department of Agriculture, the County has had a 6 percent increase of its farmland acres between 2007 and 2012 (USDA, 2012). During that same time period, the number of farms in the County decreased by 1 percent, from 794 farms in 2007 to 783 farms in 2012 (USDA, 2012). This change is evidenced by the change in the average size of farms in the County, from 154 acres in 2007 to 165 acres in 2012. In 1981, Pennsylvania passed a law enable the creation of Agricultural Security Areas. Presently, there are 19 townships which have Agricultural Security Areas. They include Bethel, Boggs, Burrell, East Franklin, Gilpin, Kiskiminetas, Kittanning, Mahoning, Manor, North Buffalo, Parks, Plumcreek, Redbank, South Bend, South Buffalo, Valley, Sugarcreek, Wayne, and West Franklin Township (Armstrong Conservation District). These locally formed areas encourage farming to continue and exclude farmers from ordinances that would restrict normal farming practices. In 2016, 47,730 acres (more than 30 percent) of the County's total farmland is enrolled in its agricultural security program (PA Dept. of Agriculture, 2016).

Figure 2-6. Armstrong County Land Use and Land Cover



Source: U.S. Geological Survey (USGS) 2011

2.5 DATA SOURCES AND LIMITATIONS

The County Profile section of this HMP was developed with information from the following sources:

1. Armstrong County Comprehensive Plan (Armstrong County 2005).
2. U.S. Census Bureau. 2010. “2010 Decennial Census.”
3. U.S. Census Bureau. 2011. “2006-2010 American Community Survey ACS, 5 Year Estimates.”
4. U.S. Census Bureau. 2017. “2012-2016 American Community Survey ACS, 5 Year Estimates.”
5. U.S. Census Bureau. “American Factfinder - 2012-2016 American Community Survey Armstrong County.”

Data sources used to develop the HMP in general are listed in Section 1.4. Data sources used to perform geographic information system (GIS) analysis for the risk assessment are listed in Section 4.1. These sources were key in understanding the current demographic makeup of the community as well as in framing the foundation of the plan. The sources listed provided the underlying context of the plan and allowed the Planning Team to understand critical vulnerabilities in the County. Throughout the course of the planning process, the Planning Team continually sought additional data sources to augment the information included in the Plan. The Planning Team made multiple requests for existing jurisdictional documents (e.g., jurisdictional HMPs and other relevant information).

SECTION 3 PLANNING PROCESS

A successful planning process builds partnerships and brings together members representing government agencies, the public, and other stakeholders to reach consensus on ways the community will prepare for and respond to those hazards most likely to occur. Applying a comprehensive and transparent process adds validity to the Hazard Mitigation Plan (HMP). Participants involved in the HMP planning process gained better understanding of problems and issues and helped devise solutions and actions for the community, resulting in a revised set of common community values and widespread support for directing financial, technical, and human resources to agreed-upon actions.

The planning process was an integral part of updating the Armstrong County HMP. This section describes the planning process used to update the HMP with participation from all 45 of the County's municipalities. This section also describes the hazard mitigation Steering Committee, Planning Team, meetings and documentation, public and stakeholder participation, multi-jurisdictional planning, and existing planning mechanisms implemented during the HMP update process. Additional details about the process of updating each section of this HMP appear at the beginning of those sections.

3.1 UPDATE PROCESS AND PARTICIPATION SUMMARY

In accordance with the Disaster Mitigation Act of 2000 (DMA 2000) requirements, this plan documents the following topics:

- Planning process
- Hazard identification
- Risk assessment
- Mitigation strategy: goals, actions, and projects
- Formal adoption by the participating jurisdictions
- Pennsylvania Emergency Management Agency (PEMA) and Federal Emergency Management Agency (FEMA) approval

The PEMA All-Hazard Mitigation Planning Standard Operating Guide lays out the standard planning process in Pennsylvania to create and update HMPs (including this HMP), and is cited in Appendix A, under Authorities and References. Hazard vulnerabilities and the risk assessment are described in Section 4 (Risk Assessment), and the mitigation strategy is described in Section 5 (Mitigation Strategy) of this HMP.

Public participation and planning meetings served as the main forum for gathering information to update the HMP. The Steering Committee and Planning Team were afforded access to information in relevant and approved plans, policies, and procedures for Armstrong County. Opportunities for public participation included two public meetings, distribution of information at municipal meetings, and chances to review and comment on the draft HMP update. To develop all sections of the HMP, the Planning Team used meetings, e-mail correspondence, and teleconferences to solicit input from County, municipal, and other stakeholders, including members of the general public. Most information received for this update came from Armstrong County, its municipalities, and the Steering Committee. Through this planning process, the County established a comprehensive approach to reduce the effects of hazards on the County and its municipalities.

3.2 THE PLANNING TEAM

Recognizing the need to manage risk within the Count, and to meet the requirements of the DMA 2000, the Armstrong County Department of Public Safety (DPS) led the update to the 2014 HMP. Ms. Becky Feracioly, Emergency Preparedness Coordinator, developed a Steering Committee to provide guidance and direction to the planning effort and to ensure the resulting document will be embraced both politically and by the constituency within the planning area. Ms. Feracioly served as chair of the Steering Committee and the lead planner and point of contact for the planning process. The Steering Committee was composed of the following individuals:

- Bill Hamilton, Emergency Management Agency (EMA) Director, Armstrong County DPS
- Becky Feracioly, Emergency Preparedness Coordinator, Armstrong County DPS
- Rick Palilla, Executive Director, Armstrong County Department of Planning and Development
- Darin Alviano, Executive Director, Armstrong County Department of Planning and Development (upon taking the position after Mr. Palilla)
- Tony Subbio, Project Manager, Tetra Tech, Inc. (Tetra Tech)

The Steering Committee was charged with the following tasks:

- Providing guidance and overseeing the planning process on behalf of the general planning partnership (Planning Team).
- Attending and participating in meetings.
- Assisting with the development and completion of certain planning elements, including:
    - Reviewing and updating the hazards of concern
    - Developing a public and stakeholder outreach program
    - Assuring the data and information used in the plan update process is best available
    - Reviewing and updating the hazard mitigation planning goals and objectives
    - Identifying and screening of appropriate mitigation strategies and activities
    - Reviewing and updating plan maintenance procedures
- Reviewing and commenting on plan documents prior to submission to PEMA and FEMA.

A Planning Team was assembled to represent each of the municipalities participating in the HMP update as well as invited stakeholders and members of the Steering Committee. The following organizations were invited to participate on the Planning Team:

Armstrong County Jurisdictions				
Armstrong County	Dayton Borough	Kittanning Township	Perry Township	Valley Township
Apollo Borough	East Franklin Township	Leechburg Borough	Pine Township	Washington Township
Applewold Borough	Elderton Borough	Madison Township	Plumcreek Township	Wayne Township
Atwood Borough	Ford City Borough	Mahoning Township	Rayburn Township	West Franklin Township
Bethel Township	Ford Cliff Borough	Manor Township	Redbank Township	West Kittanning Borough
Boggs Township	Freeport Borough	Manorville Borough	Rural Valley Borough	Worthington Borough
Bradys Bend Township	Gilpin Township	North Apollo Borough	South Bend Township	
Burrell Township	Hovey Township	North Buffalo Township	South Bethlehem Borough	
Cadogan Township	Kiskiminetas Township	City of Parker	South Buffalo Township	
Cowanshannock Township	Kittanning Borough	Parks Township	Sugarcreek Township	
Educational Institutions				
Armstrong School District	Kiski Area School District	ARIN Intermediate Unit 28	Orchard Hills Christian Academy	Worthington Baptist Christian Academy
Apollo Ridge School District	Leechburg Area School District	Lenape Vo Tech	Grace Christian School	Butler County Community College at Armstrong
Freeport Area School District	Redbank Valley School District	Divine Redeemer School	Grace Baptist School	Indiana University of Pennsylvania

Karns City Area School District				
Hospital				
Armstrong County Memorial Hospital (ACMH)				
Fire Departments				
Apollo Hose Company No. 2	East Franklin Township Vol Fire Dept	Host Team- County Hazmat Team	Manor Township Volunteer Fire Co	South Buffalo Township Vol Fire Dept
Apollo Hose Company No. 3	Elderton District Volunteer Fire Company	Kiski Township Fire Department #1	North Apollo Volunteer Fire Department	Sugarcreek Township Vol Fire Dept
Applewold Volunteer Fire Department	Ford City Hose Company No. 1	Kittanning Hose Company No. 4	Parker City Volunteer Fire Company	Washington Township Vol Fire Dept
Bethel Township Volunteer Fire Dept	Ford Cliff Volunteer Fire Company	Kittanning Hose Company No. 6	Parks Township Volunteer Fire Dept	Water Rescue Task Force
Burrell Township Volunteer Fire Dept	Freeport Volunteer Fire Company	Kittanning Hose Hook & Ladder Co No. 1	Pine Township Volunteer Fire Company	Water Rescue Task Force
Dayton Volunteer Fire Company	Gilpin Township Volunteer Fire Dept	Kittanning Township Volunteer Fire Dept	Rayburn Township Volunteer Fire Dept	West Kittanning Fire Department
Distant Area Volunteer Fire Department	Hawthorne Fire Department	Leechburg Volunteer Fire Company	Rural Valley Volunteer Fire Company	Worthington W Franklin Twp Vol Fire Dept
Police Departments				
Apollo Police Department (PD)	Freeport PD	Leechburg PD	Parks PD	West Kittanning PD
East Franklin PD	Gilpin PD	Manor PD	Pennsylvania State Police - Kittanning	Worthington PD
Elderton PD	Kiskiminetas PD	New Bethlehem PD	Rural Valley PD	
Ford City PD	Kittanning PD	North Buffalo PD	South Buffalo PD	
Emergency Medical Services (EMS) Agencies				
Citizens Ambulance Service	East Brady EMS	Freeport EMS	Lower Kiski Emergency Medical Services (EMS) Task Force 340	Sugarcreek EMS
Clarion Hospital Emergency Medical Services (EMS)	Ford City EMS	Kittanning EMS	Oklahoma EMS	
Retirement, Personal Care, and Nursing Homes				
ACMH Skilled Nursing Unit	Kittanning Care Center	Premier Armstrong	Sugar Creek Rest	
Neighboring Jurisdictions				
Allegheny County	Clarion County	Jefferson County	Venango County	Westmoreland County
Butler County	Indiana County			
Other Stakeholders				
Armstrong Power, LLC	EQT Corporation	Rosebud Mining Company	Tourist Bureau	Wal-Mart Associates, Inc.
Chamber of Commerce	Nearly 300 facilities storing hazardous materials	Snyder Associated Companies, Inc.	USDA Armstrong County, Kittanning Field Office	West Hills Area Water Pollution Control Authority (WPCA)
Electro-Optics Center	PEMA Western Area	Southwestern Pennsylvania Commission	USDA/Cooperative Extension	Woodard & Curran

For a complete list of individual invitees, participants, attendance at meetings, completion of worksheets, or submission of comments, please refer to Appendices C through E.

The Planning Team acknowledged that important steps in developing a comprehensive HMP were identifying hazards that specifically affect Armstrong County, and assessing their likelihood of occurrence, along with potential damage to the people, property, and environment of the County. The Planning Team chose to focus on an all-hazards approach rather than to narrow the focus to natural disasters only.

As the contract consultant, Tetra Tech guided the Steering Committee and Planning Team through the HMP update planning process. More specifically, Tetra Tech was tasked with:

- Assisting with the organization of a Steering Committee and Planning Team
- Assisting with the development and implementation of a public and stakeholder outreach program
- Collecting data
- Facilitating and recording attendance at meetings
- Assisting with the review, update, and ranking of the hazards of concern, and hazard profiling, and risk assessment
- Assisting with the review and update of mitigation planning goals and objectives
- Assisting with the review of progress of past mitigation strategy
- Assisting with the screening of mitigation actions and the identification of appropriate actions
- Assisting with the prioritization of mitigation actions
- Authoring of the draft and final HMP documents

3.3 MEETINGS AND DOCUMENTATION

Tetra Tech assisted the County in drafting planning documents, preparing meeting materials, and facilitating meetings. The Steering Committee reviewed documentation, provided validation, and acted as an advocate for the HMP update.

Table 3-1 lists dates and descriptions of meetings held by the Armstrong County Steering Committee and Planning Team as part of the process of updating the Armstrong County HMP.

Table 3-1. Public and Planning Meetings

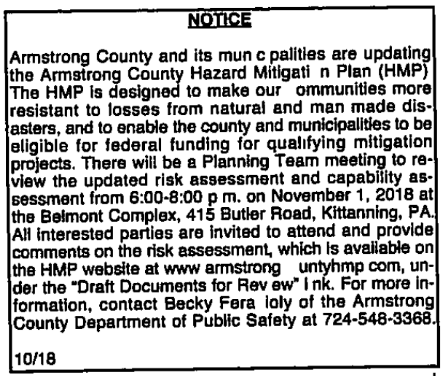
Date	Description of Meeting
January 26, 2018	Kickoff Meeting with the Steering Committee
March 14, 2018	Kickoff Meeting with Planning Team members, including a 5-year plan review and plan update process, evaluation of identified hazards, capability assessment, and mitigation strategy review.
November 1, 2018	Planning Team Meeting to review the results of the risk assessment and the capabilities assessment to that point. The Planning Team members identified problem areas and issues throughout the County for each hazard.
December 5, 2018	Mitigation Solutions Workshop to review mitigation goals, objectives, actions, and current plan status with the Planning Team.
December 6, 2018 – July 31, 2019	Direct outreach and teleconference discussions with municipalities, to garner as much participation in the planning process as possible.
October 17, 2019	Public HMP Draft Review Meeting to receive comments on the draft HMP.
TBD	HMP adoption by County Commissioners.

The Steering Committee followed up each meeting with meeting notes that documented all agenda topics, decisions, and action items identified. The meeting minutes were posted to the project website. Documentation from all meetings is located in Appendix C.

Armstrong County residents were informed of the planning process through various sources, including newspaper-announced public notices and announcements on the Armstrong County HMP project website (http://www.armstrongcountyhmp.com).

The Risk Assessment Review Meeting and the Draft Review Meeting were advertised as public meetings (see Figure 3-1). No members of the general public attended. Any subsequent supporting documentation provided by County residents will be included in Appendix E (Public and Stakeholder Participation).

Figure 3-1. Public Meeting Public Notices



NOTICE

Armstrong County and its mun c palities are updating the Armstrong County Hazard Mitigati n Plan (HMP) The HMP is designed to make our ommunities more resistant to losses from natural and man made disasters, and to enable the county and municipalities to be eligible for federal funding for qualifying mitigation projects. There will be a Planning Team meeting to review the updated risk assessment and capability assessment from 6:00-8:00 p m. on November 1, 2018 at the Belmont Complex, 415 Butler Road, Kittanning, PA. All interested parties are invited to attend and provide comments on the risk assessment, which is available on the HMP website at www armstrong untyhmp com, under the "Draft Documents for Rev ew" l nk. For more information, contact Becky Fera loly of the Armstrong County Department of Public Safety at 724-548-3368.

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Armstrong County Hazardous Mitigation Plan meeting planned for Oct. 17

Session will be for the public and officials to review draft of upcoming five-year plan

| OCTOBER 14, 2019

BY NICK VERCILLA
STAFF REPORTER

A meeting for the public and municipal officials to review the draft of the upcoming County Hazardous Mitigation Plan (HMP), will take place from 6-8 p.m. Oct. 17, at the Belmont Complex in East Franklin Township. As previously reported in the Leader Times, the county, every five years, is required by PEMA (Pennsylvania Emergency Management Authority) and FEMA (Federal Emergency [...]

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3.4 PUBLIC AND STAKEHOLDER PARTICIPATION

To maximize the effectiveness of the HMP, the Planning Team fostered continual public and stakeholder engagement. Input was encouraged and collected through a variety of methods. Four worksheets/surveys— the Hazard/Risk Identification Survey, Risk Factor Analysis Survey, Capabilities Assessment Survey, and Mitigation Strategy 5-Year Plan Review Worksheet (Mitigation Review Worksheet)—were given to representatives from each municipality in Armstrong County. All 46 jurisdictions (the County and 45 municipalities) provided information so that their input could be reviewed and incorporated into the updated HMP.

The following entities with vested interest in development of the updated HMP were given the opportunity to participate in the planning process by attending a Planning Team or public meeting, or by offering comments on the project website: local, state, and federal agencies; neighboring jurisdictions (i.e., Allegheny, Butler, Clarion, Indiana, Jefferson, Venango, and Westmoreland Counties); community leaders; educators; healthcare facilities; and other relevant private and nonprofit groups. Invitations to participate in meetings were sent to those stakeholders. Appendix E includes a copy of the Planning Team meeting invitation list and sample copies of invitation letters sent. Meeting invitations were also sent to all municipalities including elected officials and Emergency Management Coordinators. Additionally, direct outreach by phone or one-on-one meetings was conducted with municipalities who were unable to attend other meetings or who had questions about worksheets, participation requirements, the planning process, or mitigation project selection. Twenty-six municipalities in Armstrong County had representatives attending at least one meeting; the other 19 participating municipalities were contacted individually.

Through public notices published in the local newspapers, the groups listed in Section 3.2 and the general public were invited to visit the project website, review the draft County HMP update, and send comments to DPS. Copies of the public notices and other forms of public and stakeholder outreach are presented in Appendix E.

Throughout the course of the entire planning process, the following stakeholder organizations participated:

- Armstrong County Housing Authority
- Citizens Ambulance Service
- West Hills Area Water Pollution Control Authority (WPCA)
- Armstrong County Memorial Hospital

- EQT Corporation
- Woodard & Curran
- Armstrong Power, LLC
- Freeport Fire Department
- Butler County Community College at Armstrong
- Lower Kiski Emergency Medical Services (EMS) Task Force 340

Table 3-2 in Section 3.5 of this HMP shows the overall municipal participation in the planning process.

3.5 MULTI-JURISDICTIONAL PLANNING

Armstrong County took a multi-jurisdictional approach to preparing the HMP so that the HMP would apply to the County and all participating municipalities. The County was able to provide resources (e.g., data, geographic information system [GIS], etc.) to which the municipalities might not have had access. However, Armstrong County depended on municipal buy-in because the municipalities have the legal authority to enforce compliance with land use planning and development directives. Armstrong County undertook an intensive effort to involve all 45 municipalities in the update process.

Each municipality was given the opportunity to participate in this process. Municipal officials and representatives were invited to attend Planning Team and public meetings; were provided worksheets to update the hazards of concern, capabilities, and mitigation strategy; and were asked to review and prioritize the mitigation actions. Municipal participation culminated in the formal adoption of the HMP; copies of municipal adoption resolutions are in Appendix F. Table 3-2 indicates the ways each municipality participated in the planning process. In some cases, a municipality was unable to attend a Planning Team meeting; therefore, an individual follow-up meeting with each municipality was held by Armstrong County Steering Committee representatives to cover the meeting material and provide municipal support on the topics presented.

Table 3-2. Participation Matrix

Jurisdiction	Meetings				Contacted Individually	Worksheets				2019 Plan Adoption Date
	Planning Team Kickoff Meeting	Risk Assessment Meeting	Mitigation Strategy Workshop	HMP Draft Review Meeting		Risk Assessment Survey Received	Risk Factor Analysis Survey	Capabilities Assessment Survey Received	Mitigation Review Worksheet Received	
Armstrong County	X	X	X	X		X	N/A	X		TBD
Apollo Borough			X			X	X		X	TBD
Applewold Borough					X	X	X	X		TBD
Atwood Borough						X	X	X	X	TBD
Bethel Township			X				X			TBD
Boggs Township	X					X	X		X	TBD
Bradys Bend Township						X		X	X	TBD
Burrell Township	X	X				X	X	X	X	TBD
Cadogan Township					X			X		TBD
Cowanshannock Township			X			X	X	X	X	TBD
Dayton Borough	X					X		X	X	TBD
East Franklin Township	X		X	X		X	X	X	X	TBD
Elderton Borough	X					X	X	X	X	TBD
Ford City Borough	X		X	X		X	X	X		TBD
Ford Cliff Borough					X		X			TBD
Freeport Borough	X					X				TBD
Gilpin Township						X	X	X		TBD
Hovey Township					X	X		X		TBD
Kiskiminetas Township					X	X	X	X		TBD
Kittanning Borough	X		X	X		X	X	X		TBD
Kittanning Township				X	X		X			TBD
Leechburg Borough						X				TBD
Madison Township						X		X	X	TBD
Mahoning Township						X	X	X		TBD
Manor Township	X	X				X	X	X	X	TBD
Manorville Borough			X			X	X	X	X	TBD
North Apollo Borough					X	X	X	X		TBD
North Buffalo Township						X		X	X	TBD

Jurisdiction	Meetings				Contacted Individually	Worksheets				2019 Plan Adoption Date
	Planning Team Kickoff Meeting	Risk Assessment Meeting	Mitigation Strategy Workshop	HMP Draft Review Meeting		Risk Assessment Survey Received	Risk Factor Analysis Survey	Capabilities Assessment Survey Received	Mitigation Review Worksheet Received	
City of Parker						X		X		TBD
Parks Township						X		X	X	TBD
Perry Township						X		X	X	TBD
Pine Township		X		X			X	X		TBD
Plumcreek Township		X				X	X	X	X	TBD
Rayburn Township						X	X	X	X	TBD
Redbank Township						X		X	X	TBD
Rural Valley Borough							X	X		TBD
South Bend Township		X				X		X		TBD
South Bethlehem Borough	X					X	X	X	X	TBD
South Buffalo Township						X		X	X	TBD
Sugarcreek Township						X		X	X	TBD
Valley Township						X		X	X	TBD
Washington Township		X	X	X			X			TBD
Wayne Township						X		X	X	TBD
West Franklin Township	X	X				X	X	X	X	TBD
West Kittanning Borough	X		X	X		X	X	X	X	TBD
Worthington Borough	X	X				X	X	X	X	TBD

Notes:
TBD = To be determined after plan is approved-pending adoption by FEMA Region III.

SECTION 4 RISK ASSESSMENT

4.1 UPDATE PROCESS SUMMARY

In accordance with the Federal Emergency Management Agency (FEMA) Local Mitigation Planning Handbook, risk is the potential for damage, loss, or other impacts created by the interaction of natural hazards with community assets. Armstrong County's risk assessment is organized into the following sections:

- Section 4.2 outlines the hazard identification process for both natural and human-caused hazards of concern for further profiling and evaluation.
- Section 4.3 profiles the hazards of concern (location and extent, range of magnitude, past occurrence, and future occurrence) and assesses vulnerability.
- Section 4.4 summarizes the risk assessment methodology, ranking results, potential losses, and future development and vulnerability.

The Steering Committee and Planning Team evaluated the 2014 Hazard Mitigation Plan (HMP) hazards of concern by examining the historic events that have taken place in the County since the last plan update and reviewing the Commonwealth's 2013 HMP and 2018 HMP. In addition, the Steering Committee and Planning Team completed the risk assessment worksheet (Evaluation of Identified Hazards and Risk Worksheet). The worksheet listed hazards profiled in the 2014 HMP and requested that participants identify whether the frequency of occurrence, magnitude of impact, and/or geographic extent of each hazard increased, decreased, or did not change since the preparation of the 2014 HMP. The worksheet also provided the opportunity to assess hazards not profiled in the HMP to determine if those hazards should be included as part of the update. Responses from the worksheets were reviewed by the Steering Committee to identify a list of hazards to profile in the 2019 HMP, removing four hazards of concern. The deleted hazards of concern are building and structure collapse, drowning, hurricanes/tropical storms/Nor'Easters, and urban fires and explosions. Hurricanes/tropical storms/Nor'Easters are addressed in the Tornadoes and Windstorms hazard profile (Section 4.3.13) and the Flood, Flash Flood, and Ice Jams hazard profile (Section 4.3.5), as their effects in western Pennsylvania are generally limited to wind and flooding. The other three hazards were deleted because they did not have significant effects in the County. Each hazard profile also includes an additional subsection that discusses the effect of climate change on vulnerability. Refer to copies of the completed worksheets in Appendix D.

4.2 HAZARD IDENTIFICATION

4.2.1 Disaster Declarations

In reviewing and updating Armstrong County's hazards of concern, the Steering Committee and Planning Team reviewed additional information and historical records from a wide range of sources. The following section discusses the Presidential Disaster and Emergency Declarations, Gubernatorial Disaster Declarations or Proclamations, and Small Business Administration Disaster Declarations that have affected Armstrong County.

Presidential Disaster and Emergency Declarations are issued when it has been determined that state and local governments need assistance in responding to a disaster event. Since 1955, declarations have been issued for various hazard events, including hurricanes or tropical storms, severe winter storms, and flooding. A unique Presidential Emergency Declaration, Emergency Declaration 3235, was issued in September 2005. Through this declaration, President George W. Bush declared a state of emergency existed for the Commonwealth of Pennsylvania and ordered federal aid to supplement Commonwealth and local response efforts to help people evacuate from their homes due to Hurricane Katrina. A summary of declarations affecting the County is provided in the tables below.

Table 4.2-1 lists Presidential Disaster and Emergency Declarations issued from 1972 through October 2018 that have affected Armstrong County. Additional declarations beyond October 2018 can be found on the Federal Emergency Management Agency (FEMA) website at: https://www.fema.gov/disasters.

Table 4.2-1. Presidential Disaster and Emergency Declarations Affecting Armstrong County

Declaration Number	Date	Event
EM-3356	October 2012	Hurricane Sandy
DR-1898	April 2010	Severe Winter Storms and Snowstorms
DR-1649	June 2006	Severe Storms, Flooding, and Mudslides
DR-1557	September 2004	Tropical Depression Ivan
DR-1219	June 1998	Flooding, Severe Storms, and Tornadoes
DR-1093	January 1996	Flooding
DR-1085	January 1996	Blizzard
DR-754	October 1985	Hurricane Gloria
DR-485	September 1975	Severe Storms, Heavy Rains, Flooding
DR-340	June 1972	Flood (Agnes)

In addition to these Presidentially-declared events, 24 events warranted Gubernatorial Disaster Declarations or Proclamations that included Armstrong County, as shown in Table 4.2-2 (PEMA 2018).

Table 4.2-2. Gubernatorial Disaster Declarations or Proclamations Affecting Armstrong County

Date	Event
January 2018	Proclamation of Disaster Emergency – Opioid Crisis

Date	Event
March 2017	Proclamation of Emergency – Severe Winter Storm
January 2016	Proclamation of Disaster Emergency – Severe Winter Weather
August 2015	Proclamation of Disaster Emergency – Severe Storms
January 2015	Proclamation of Disaster Emergency – Severe Winter Weather
February 2014	Proclamation of Emergency – Severe Winter Weather
January 2014	Proclamation of Emergency – Regulations – Severe Cold
June 2013	Proclamation of Emergency – High Winds, Thunderstorms, Heavy Rain, Tornado, Flooding
October 2012	Proclamation of Emergency – Hurricane Sandy
April 2012	Proclamation of Emergency – Spring Winter Storms
August 2011	Proclamation of Emergency - Severe Storms and Flooding (Lee/Irene)
January 2011	Proclamation of Emergency - Severe Winter Storm
February 2010	Proclamation of Emergency - Severe Winter Storm
April 2007	Proclamation of Emergency - Severe Winter Storm
February 2007	Proclamation of Emergency - Severe Winter Storm
February 2007	Proclamation of Emergency - Regulations
September 2006	Proclamation of Emergency - Tropical Depression Ernesto
September 2005	Proclamation of Emergency - Hurricane Katrina
February 1978	Blizzard
January 1978	Heavy Snow
July 1976	Flood
February 1974	Truckers’ Strike
February 1972	Heavy Snow
January 1966	Heavy Snow

Armstrong County has also received Small Business Administration Disaster Assistance for a number of disaster events. A Small Business Administration Disaster Declaration qualifies communities for access to affordable, timely, and accessible financial assistance. Table 4.2-3 lists Small Business Administration Disaster Declarations issued for Armstrong County from 1981 through October 2018 (PEMA 2018), including those declarations for which Armstrong County was declared as an adjacent county.

Table 4.2-3. Small Business Administration Disaster Declarations Affecting Armstrong County

Date	Event
July 2017	Fire
September 2013	Storms and Severe Weather
July 2013	Severe Storms and Flooding
June 2009	Severe Storms and Flooding
July 2008	Fire
August 2007	Severe Storms and Flooding
August 2002	Severe Storms from May 2002
August 2000	Flooding
April 1990	Petroleum Spill

4.2.2 Summary of Hazards

As part of the plan update process, the Steering Committee and Planning Team reviewed the hazards of concern detailed in the 2014 version of the plan as well as those identified in the State Hazard Mitigation Plan (HMP). They also considered the history of hazard events occurring in Armstrong County as well as events occurring after the completion of the 2014 version of the plan. This review of historical events included an evaluation of all emergency and disaster declarations in the Commonwealth, with a focus on those in which Armstrong County was designated for federal assistance.

Further, all jurisdictions participating in the plan update process were provided a *Hazard Identification/ Evaluation of Risk* worksheet to help identify the hazards—natural and non-natural—that each community believed posed significant risk to Armstrong County, including any that may not have been considered in either the 2014 version of the plan or the State HMP. Completed worksheets submitted by the municipalities are included in Appendix D. Following review of the 2014 hazards list and completion of the *Hazard Identification/ Evaluation of Risk* worksheet, additional hazards were considered in need of a risk assessment. The Steering Committee and Planning Team decided to remove the following hazards that were addressed in the 2014 version of the HMP:

1. Building and structure collapse
2. Drowning
3. Hurricanes/tropical storms/Nor'Easters
4. Urban fires and explosions

Based on all available information and input from the municipalities, the Steering Committee and Planning Team selected the following natural and non-natural hazards for consideration in this plan:

Natural Hazards

- Drought
- Earthquake
- Flood, Flash Flood, Ice Jam
- Invasive Species
- Landslides
- Pandemic
- Radon Exposure
- Subsidence and Sinkholes
- Tornado and Windstorm
- Wildfire
- Winter Storm

Non-Natural Hazards

- Dam Failure
- Environmental Hazards
- Levee Failure
- Terrorism
- Transportation Accidents
- Utility Interruption

These hazards have been profiled individually in Section 4.3 of this plan.

4.3.1 Dam Failure

This section provides a profile and vulnerability assessment of the dam failure hazard in Armstrong County. A dam is an artificial barrier allowing storage of water, wastewater, or liquid-borne materials for many reasons (flood control, human water supply, irrigation, livestock water supply, energy generation, containment of mine tailings, recreation, or pollution control). Many dams fulfill a combination of these stated functions (Association of State Dam Safety Officials 2013). They are an important resource in the United States.

Man-made dams can be classified according to type of construction material used, methods applied in construction, slope or cross-section of the dam, how a dam resists forces of water pressure behind it, means used to control seepage, and, occasionally, purpose of the dam. Materials used for construction of dams include earth, rock, tailings from mining or milling, concrete, masonry, steel, timber, miscellaneous materials (plastic or rubber), and any combination of these materials (Association of State Dam Safety Officials 2013).

More than a third of the dams in the United States are 50 or more years old. Approximately 14,000 of those dams pose a significant hazard to life and property if failure occurs. About 2,000 unsafe dams are dispersed throughout the United States in almost every state.

Dams typically fail when spillway capacity is inadequate and excess flow overtops the dam, or when internal erosion (piping) through the dam or foundation occurs. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-filled water that rushes downstream, damaging or destroying anything in its path (Federal Emergency Management Agency [FEMA] 2015).

Dam failures can result from one or a combination of the following:

- Overtopping caused by floods that exceed capacity of the dam
- Deliberate acts of sabotage
- Structural failure of materials used in dam construction
- Movement or failure of the foundation supporting the dam
- Settling and cracking of concrete or embankment dams
- Piping and internal erosion of soil in embankment dams
- Inadequate maintenance and upkeep (FEMA 2013a).

Regulatory Oversight of Dams

Potential for catastrophic flooding caused by dam failures led to enactment of the National Dam Safety Act (Public Law 92-367), which for 30 years has protected Americans from dam failures. The National Dam Safety Program (NDSP) is a partnership among states, federal agencies, and other stakeholders that encourages individual and community responsibility for dam safety. Under FEMA's leadership, state assistance funds have allowed all participating states to improve their programs through increased inspections, emergency action planning, and purchases of needed equipment. FEMA has also expanded existing and initiated new training programs. Grant assistance from FEMA provides support for improvement of dam safety programs that regulate most dams in the United States (FEMA 2013).

Pennsylvania Department of Environmental Protection

The Pennsylvania Department of Environmental Protection (PADEP) holds responsibility for dam safety. The Division of Dam Safety provides for the regulation and safety of dams and reservoirs throughout the Commonwealth in order to protect the health, safety, and welfare of its citizens and their property. This division is required to ensure proper planning, design review, construction review, maintenance monitoring, and supervision of dams and reservoirs. This requirement is mandated by the Dam Safety and Encroachments Act, as amended, and the Pennsylvania Code. The Division of Dam Safety directs and coordinates field investigations with regional offices on authorized projects during construction; provides program guidance and coordination to regional program staff in the periodic inspection of all existing dams to determine their condition and safety; and directs, coordinates, and develops policies and technical standards in the area of dam safety for the PADEP (PADEP 2018).

The Dam Safety & Encroachments Action (Act 325 of 1978) and the Amendment for "High-Hazard Dam" Act 325 provides for the regulation of dams and reservoirs, water obstructions, and encroachments in the Commonwealth in order to protect the health, safety, and welfare of people and property. The Pennsylvania Code Title 25, Chapter 105, Dam Safety and Water Management, provides for the comprehensive regulation and supervision of dams, reservoirs, water obstructions, and encroachments in the Commonwealth in order to protect the health, safety, and welfare of people and property. The Run-of-the River Dam Act (Act 91 of 1998) is administered by the PADEP and the PA Fish & Boat Commission and regulates the run-of-the-river (low-head) dams in the Commonwealth (PADEP 2018).

Hazard Potential Category 1 dams are those "where its failure could result in significant loss of life, excessive economic losses, and significant public inconvenience" (PADEP 2009). Hazard Potential Category 2 dams are those "where its failure could result in the loss of a few lives, appreciable property damage, and short-duration public inconvenience" (PADEP 2009). Owners of dams classified as Hazard Categories 1 or 2 ("high-hazard" dams) are required to create an Emergency Action Plan (EAP) that describes the dam, the inundation area if the dam were to catastrophically fail, and procedures for responding to the dam failure (such as notification to the vulnerable population). Armstrong County should receive copies of EAPs and inundation maps for high-hazard dams whose failure could impact local residents; however, the County does not currently have copies of the EAPs and inundation maps.

U.S. Army Corps of Engineers Dam Safety Program

The U.S. Army Corps of Engineers (USACE) is responsible for safety inspections of some federal and non-federal dams in the United States that meet the size and storage limitations specified in the National Dam Safety Act. USACE has inventoried dams and has surveyed each state's and federal agency's capabilities, practices, and regulations regarding design, construction, operation, and maintenance of the dams. USACE has also developed guidelines for inspection and evaluation of dam safety (USACE 2018). The USACE National Inventory of Dams (NID) provides the most recent dates of inspection of the following Armstrong County dams, as shown in Table 4.3.1-1.

Table 4.3.1-1. Dams Located in Armstrong County

Dam Name	River	Primary Purpose	City	Inspection Date	EAP Last Reviewed
Allegheny Lock and Dam 05	Allegheny River	Navigation	Freeport	October 10, 2012	December 8, 2014
Allegheny Lock and Dam 06	Allegheny River	Navigation	Freeport	October 3, 2012	December 8, 2014
Allegheny Lock and Dam 07	Allegheny River	Navigation	Kittanning	August 27, 2014	December 8, 2014
Allegheny Lock and Dam 08	Allegheny River	Navigation	Kittanning	November 5, 2014	December 8, 2014
Allegheny Lock and Dam 09	Allegheny River	Navigation	Rimer	October 8, 2014	December 8, 2014
Ambrose Mine Dam	Tributary Allegheny River	Recreation	N/A	July 2, 2012	N/A
Cherry Run No 1 Dam	Tributary Cherry Run	Other	N/A	June 20, 2014	N/A
Cherry Run No 2 Dam	Tributary Cherry Run	Other	N/A	June 20, 2014	N/A
Cooling Pond A Dam	Tributary Crooked Creek	Other	N/A	July 25, 2014	N/A
Crooked Creek Dam	Crooked Creek	Flood Control	Ford City	July 19, 2012	January 30, 2015

Dam Name	River	Primary Purpose	City	Inspection Date	EAP Last Reviewed
David Mine Equalization Pond No 3 Dam	Tributary Long Run	Other	N/A	April 14, 2015	N/A
David Mine Sedimentation Pond No 1 Dam	Tributary Long Run	Other	N/A	April 14, 2015	N/A
David Mine Sedimentation Pond No 2 Dam	Tributary Long Run	Other	Maysville	April 14, 2015	N/A
Keystone Station Dam	Plum Creek	Other	N/A	October 14, 2014	July 1, 2014
Mahoning Creek Dam	Mahoning Creek	Recreation	Putneyville	May 24, 2012	January 30, 2015

Source: USACE 2018
N/A Not Available

Federal Energy Regulatory Commission Dam Safety Program

The Federal Energy Regulatory Commission (FERC) has the largest dam safety program in the United States. FERC cooperates with a large number of federal and state agencies to ensure and promote dam safety and, more recently, homeland security. A total of 3,036 dams are part of regulated hydroelectric projects and are included in the FERC program. Two-thirds of these dams are more than 50 years old. Concern about their safety and integrity grows as dams age, rendering oversight and regular inspection especially important (FERC 2016). FERC staff inspect hydroelectric projects on an unscheduled basis to investigate the following:

- Potential dam safety problems
- Complaints about constructing and operating a project
- Safety concerns related to natural disasters
- Issues concerning compliance with terms and conditions of a license (FERC 2016)

Every 5 years, an independent consulting engineer, approved by FERC, must inspect and evaluate projects with dams higher than 32.8 feet (10 meters) or with total storage capacity of more than 2,000 acre-feet (FERC 2016).

FERC monitors and evaluates seismic research in geographic areas where seismic activity is a concern. This information is applied to investigate and analyze structures of hydroelectric projects within these areas. FERC staff also evaluates effects of potential and actual large floods on safety of dams. FERC staff visit dams and licensed projects during and after floods, assess extents of damage, and direct any studies or remedial measures the licensee must undertake. FERC's *Engineering Guidelines for the Evaluation of Hydropower Projects* guides FERC engineering staff and licensees in evaluations of dam safety. The publication is frequently revised to reflect current information and methodologies (FERC 2016).

FERC requires licensees to prepare EAPs and conducts training sessions on developing and testing these plans. The plans outline an early warning system in the event of an actual or potential sudden release of water from a dam failure. The plans include operational procedures that may be implemented during regulatory measures, such as reducing reservoir levels and downstream flows, as well as procedures for notifying affected residents and agencies responsible for emergency management. These plans are frequently updated and tested to ensure that all applicable parties are informed of the proper procedures in emergencies (FERC 2016).

4.3.1.1 Location and Extent

Dam failures cause serious downstream flooding either because of partial or complete dam collapse. Failures are usually associated with intense rainfall and prolonged flood conditions; however, dam breaks may occur during dry periods as a result of progressive erosion of an embankment. The greatest threat from a dam break is to areas immediately downstream.

There are many sources that track the number and classification of dams in Armstrong County. According to the USACE, there are 15 dams located in the County that are both publicly and privately owned (USACE 2018). This database does not provide dam classifications. According to data obtained from Armstrong County, there are 14 dams in the County, 2 of which are classified as high-hazard dams (Category 1 and 2). Table 4.3.1-2 provides the definitions of dam classifications in Pennsylvania. Table 4.3.1-3 and Figure 4.3.1-1 identify the dams and their locations in Armstrong County.

Table 4.3.1-2. PADEP Dam Classification Definition

Size Category		
Category	**Impoundment Storage (Acre-Feet)**	**Dam Height (Feet)**
A	Equal to or greater than 50,000	Equal to or greater than 100
B	Less than 50,000 but greater than 1,000	Less than 100 but greater than 40
C	Equal to or less than 1,000	Equal to or less than 40
Hazard Potential Category		
Category	**Population at Risk**	**Economic Loss**
1	Substantial (Numerous homes or small businesses or a large business or school)	Excessive such as extensive residential, commercial, or agricultural damage, or substantial public inconvenience
2	Few (A small number of homes or small businesses)	Appreciable such as limited residential, commercial, or agricultural damage, or moderate public inconvenience
3	None expected (no permanent structures for human habitation or employment)	Significant damage to private or public property and short-duration public inconvenience such as damage to storage facilities or loss of critical stream crossings
4	None expected (no permanent structures for human habitation or employment)	Minimal damage to private or public property and no significant public inconvenience

Source: 25 Pa. Code § 105.91.

Table 4.3.1-3. Dams in Armstrong County

Dam Name	Municipality	Stream	Type	Class	Permittee
Schrecengost	Cowanshannock Township	South Br South Fork Pine Creek	Earth	C-4	Edward Shirley
Keystone Station	Plumcreek Township	Plum Creek	Earth	A-1	Genon Ne Management Company
David Mine Sedimentation Pond No 2	Kiskiminetas Township	Tributary of Long Run	Earth	C-1	Canterbury Coal Company
David Mine Equalization Pond No 3	Kiskiminetas Township	Tributary of Long Run	Earth	C-3	Canterbury Coal Company
David Mine Sedimentation Pond No 1	Kiskiminetas Township	Tributary of Long Run	Earth	C-4	Canterbury Coal Company
Diversion	Plumcreek Township	Tributary of Crooked Creek	Concrete	C-4	Reliant Energy Keystone Station
Ambrose Mine	East Franklin Township	Tributary of Allegheny River	Earth	C-4	Samuel W. Montgomery
Buffalo Creek Intake	West Franklin Township	Buffalo Creek	Concrete	C-4	Moonlight Mushrooms, Inc.

Dam Name	Municipality	Stream	Type	Class	Permittee
Cooling Pond A	Plumcreek Township	Tributary of Crooked Creek	Earth	B-4	Reliant Energy Keystone Station
Kiski Beagle Club	Kiskiminetas Township	Tributary of Long Run	Earth	C-4	Kiski Beagle Club
Rainbow Lake	Boggs Township	Tributary of North Fork Pine Creek	Earth	B-4	Mountain Trails Resort, Inc.
Cherry Run No 1	Plumcreek Township	Tributary of Cherry Run	Earth	C-4	Mike Studer
Cherry Run No 1	Plumcreek Township	Tributary of Cherry Run	Earth	C-4	Keystone Coal Mining Corporation
Cherry Run No 2	Plumcreek Township	Tributary of Cherry Run	Earth	C-4	Keystone Coal Mining Corporation

Source: Armstrong County; PADEP Dam Safety 2018

Figure 4.3.1-1. Dams in Armstrong County

Sources: ESRI, Armstrong County; PADEP Dam Safety 2018

4.3.1.2 Range of Magnitude

Extent or magnitude of a dam failure event can be measured in terms of classification of the dam. FEMA has three classification levels of dam hazard potential: low, significant, and high. The classification levels build on each other. The hazard potential classification system should be used with the understanding that failure of any dam or water-retaining structure could represent a danger to downstream life and property (FEMA 2004). Each FEMA classification level of dam hazard potential is described as follows:

- Low-hazard potential dams are those where failure or misoperation would result in no probable loss of human life and low economic or environmental losses. Losses are principally limited to the owner's property.
- Significant-hazard potential dams are those where failure or misoperation would result in no probable loss of human life but could cause economic loss, environmental damage, disruption of lifeline facilities, or impact other concerns. Significant-hazard potential dams are often located in predominantly rural or agricultural areas.
- High-hazard potential dams are those where failure or misoperation will probably cause loss of human life.

Table 4.3.1-4 lists USACE-developed classifications of hazard potentials of dam failures, based only on potential consequences of a dam failure; this classification does not take into account probability of failure.

Table 4.3.1-4. U.S. Army Corps of Engineers Hazard Potential Classification

Hazard Category	Direct Loss of Life[2]	Lifeline Losses[3]	Property Losses[4]	Environmental Losses[5]
Low	None (rural location, no permanent structures for human habitation)	No disruption of services (cosmetic or rapidly repairable damage)	Private agricultural lands, equipment, and isolated buildings	Minimal incremental damage
Significant	Rural location, only transient or day-use facilities	Disruption of essential facilities and access	Major public and private facilities	Major mitigation required
High	Certain (one or more) extensive residential, commercial, or industrial development	Disruption of essential facilities and access	Extensive public and private facilities	Extensive mitigation cost or impossible to mitigate

1 Categories are assigned to overall projects, not individual structures at a project.

2 Loss-of-life potential is based on inundation mapping of area downstream of the project. Analysis of loss-of-life potential should take into account the population at risk, time of flood wave travel, and warning time.

3 Lifeline losses include indirect threats to life caused by the interruption of lifeline services from project failure or operational disruption; for example, loss of critical medical facilities or access to them.

4 Property losses include damage to project facilities and downstream property and indirect impact from loss of project services, such as impact from loss of a dam and navigation pool, or impact from loss of water or power supply.

5 Environmental impact downstream caused by the incremental flood wave produced by the project failure, beyond what would normally be expected for the magnitude flood event under which the failure occurs.

Source: USACE 2016

Dam failures can pose a serious threat to communities located downstream from major dams. The impact of a dam failure is dependent on the volume of water impounded by the dam and the amount of population or assets located downstream. Catastrophic failures are characterized by the sudden, rapid, and uncontrolled release of impounded water or any other fluid or semifluid from a dammed impoundment or water body. PA DEP defines a high-hazard dam as "any dam so located as to endanger populated areas downstream by its failure" [Def. added May 16, 1985, P.L. 32, No. 15]. High-hazard dams receive inspections twice each year: once by a professional engineer on behalf of the owner and once by a PA DEP inspector (PA DEP, 2018).

Dam failures may or may not leave enough time for evacuation of people and property, depending on their abruptness. Seepages in earth dams usually develop gradually, and if the embankment damage is detected early, downhill residents have at least a few hours or days to evacuate. Failures of concrete or masonry dams tend to occur suddenly, sending a wall of water and debris down the valley at more than 100 mph. Survival would be a matter of having the good fortune not to be in the flood path at the time of the break. Dam failures due to the overtopping of a dam normally give sufficient lead time for evacuation.

The greatest threat to Armstrong County is a failure of the Allegheny Lock and Dam 07, which is located just 0.3 miles from Kittanning, Pennsylvania. This dam is registered with the National Register of Historic Places for its contribution to maritime history on the Allegheny River. It continues to play a sizeable role in the Allegheny River Navigation System by permitting access to the river and resources north of Kittanning. The dam is approximately 20 feet high and 916 feet long. It rests on gravel-filled cylindrical sheet piling and has a moderate downstream apron and derrick stone to provide additional stabilization. The dam is invisible if viewed from upstream and has buoys and warning signs to alert river traffic of its proximity.

Because flooding is the most common secondary effect of dam failure, if a failure is severe, a large amount of water will enter riverbeds and overflow the stream banks for miles. A dam failure at Allegheny Lock and Dam 07 could lead to flooding in Kittanning as well as severely impact river traffic on the Allegheny River.

4.3.1.3 Past Occurrence

There have been no recorded dam failures in Armstrong County. In addition, there have been no FEMA disaster declarations associated with dam failures.

4.3.1.4 Future Occurrence

Likelihood of a dam failure in Armstrong County is difficult to predict. Dam failure events are infrequent and usually coincide with events that cause them, such as earthquakes, landslides, and excessive rainfall and snowmelt. However, the risk of such an event increases for each dam as the dam's age increases or frequency of maintenance decreases.

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

Additionally, future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Because dam overtopping is often caused by excessive rainfall, it is appropriate to relate the future vulnerability of dams directly with the potential for increased rainfall.

Based on Risk Factor Methodology Probability Criteria (further defined in Section 4.4) and assuming regular maintenance and inspections of the dams in Armstrong County, dam failures are considered unlikely in the County.

4.3.1.5 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed and/or vulnerable within the identified hazard area. Regarding the dam failure hazard, dam failure inundation areas were not available, so a qualitative assessment was conducted. The following sections evaluate and estimate potential impact of flooding in Armstrong County, presenting:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) the economy; and (5) future growth and development
- Effects of climate change on vulnerability

Overview of Vulnerability

The dam failure hazard is of significance to Armstrong County because 14 dams are present across Armstrong County, two of which are classified as high-hazard by PADEP. Warning time for dam failure is often limited. These events are frequently associated with other natural hazard events, such as earthquakes, landslides, or severe weather, thereby limiting their predictability and compounding the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard. Direct and indirect losses associated with dam failures include injury and loss of life, damage to structures and infrastructure, agricultural losses, utility failure (power outages), and stress on community resources.

Data and Methodology

At this time, spatial data was not available to conduct an exposure analysis on the County's population, building stock, and critical facilities. Over time, additional data can be obtained to allow better analysis of this hazard. Available information and a preliminary assessment are included below.

Impact on Life, Health, and Safety

The entire population residing within a dam failure inundation zone is considered exposed and vulnerable. Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the net economic impact to their family. The population over the age of 65 is also highly vulnerable because they are more likely to seek or need medical attention that may not be available because of isolation during a flood event, and they may have more difficulty evacuating.

There is often limited warning time for dam failure. These events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard.

Impact on General Building Stock and Critical Facilities

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

Impact on the Economy

For more information regarding impacts of dam failure and flooding on the economy, refer to Section 4.3.5 (Flood, Flash Flood, Ice Jams).

Impact on the Environment

Similar to levee failure events, environmental impacts of a dam failure event pose significant water quality and debris disposal issues. Flood waters can cause issues with sanitary sewer systems by inundating wastewater treatment plants and causing raw sewage to flow from the sewer system and contaminate residential and commercial properties. Oil, fertilizers, pesticides, and other chemicals can pollute the waterway and surrounding areas if not located in a secure location. It could take weeks to regain adequate water supply and wastewater treatment capabilities; cleanup and disposal of contaminated and flood-damaged building material and contents would also be necessary once the floodwater subsides. Subsequent removal of contaminated soil would also be required (PEMA 2013).

Future Growth and Development

As discussed in Section 4.4, areas targeted for future growth and development have been identified across the County. Areas of growth could be impacted by dam failure if within identified hazard areas. The County intends to discourage development in vulnerable areas and encourage higher regulatory standards at the local level.

Effect of Climate Change on Vulnerability

Climate is defined not just as average temperature and precipitation, but also by type, frequency, and intensity of weather events. Both globally and at the local scale, climate change can alter prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (U.S. Environmental Protection Agency [EPA] 2006).

PADEP was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of potential impacts of global climate change on the Commonwealth. The climate of Pennsylvania is already changing and will continue to change over the course of this century. Since 1900, temperatures in the northeastern U.S. have increased an average of 1.5°F. The majority of this warming has occurred since 1970. In terms of winter temperatures, the northeastern U.S. has seen an increase in the average temperature by 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007).

In addition to the effect of increased temperatures, precipitation is expected to increase over the next several decades. Average annual precipitation is projected to increase in the region by 0-10 percent by the 2020s and 5-10 percent by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2013). Extreme precipitation has the potential to cause significant flooding and, in the winter, produce heavy snowfall.

Future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Because dam overtopping is often caused by excessive rainfall, it is appropriate to relate the future vulnerability of dams directly with the potential for increased rainfall in the Lehigh Valley.

Dams are designed partly based on assumptions about a river's flow behavior, expressed as hydrographs. Changes in weather patterns can have significant effects on the hydrograph used for the design of a dam. If the hygrograph changes, it is conceivable that the dam can lose some or all its designed margin of safety, also known as freeboard. Loss of designed margin of safety may cause floodwaters more readily to overtop the dam or create unintended loads. Such situations could lead to a dam failure.

Climate change may increase the probability of dam failures, as indicated above. Changes in climate may lead to higher intensity rainfall events. As a result, the failure probability of low, significant, and under-designed high-hazard dams may increase.

4.3.2 Drought

This section describes the location and extent, range of magnitude, past occurrence, future occurrence, and vulnerability assessment for the drought hazard in Armstrong County.

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

Drought can be defined or grouped into four categories:

- Meteorological drought is a measure of departure of precipitation from normal, defined solely by reference to relative degree of dryness. Because of climatic differences, dryness considered a drought at one location of the country may not be considered drought at another location.
- Agricultural drought links various characteristics of meteorological (or hydrological) drought to agricultural impacts, focusing on precipitation shortages, differences between actual and potential evapotranspiration, soil water deficits, reduced groundwater or reservoir levels, and other parameters. Agricultural drought occurs when not enough water is available for a particular crop to grow at a particular time. Agricultural drought is defined in terms of soil moisture deficiencies relative to water demands of plant life, primarily crops.
- Hydrological drought is associated with below-normal surface or subsurface water supply resulting from periods of precipitation shortfalls (including snowfall). Hydrological drought is related to effects of precipitation shortfalls on stream flows and water levels in reservoirs, lakes, and groundwater.
- Socioeconomic drought is associated with supply and demand of an economic good, with elements of meteorological, hydrological, and agricultural drought categories. This differs from the aforementioned types of drought because its occurrence depends on supply and demand to identify or classify droughts. Supplies of many economic goods such as water, silage, food grains, fish, and hydroelectric power depend on weather. Socioeconomic drought occurs when demand for an economic good exceeds supply as a result of a weather-related shortfall in water supply (National Drought Mitigation Center 2012).

Drought can affect many sectors of an economy and can reach beyond an area undergoing physical drought. Because water is essential for producing goods and providing services, drought can reduce crop yield, increase fire hazard, lower water levels, and damage wildlife and fish habitats. Further consequences include: reductions in crop yields, rangeland, and forest productivity that may lower incomes of farmers and agribusinesses; increase in prices of food and timber; increase in unemployment; reduction of tax revenues as expenditures decline; increase in crime, foreclosures, and migration; and depletion of disaster relief funds. The many impacts of drought can be categorized as economic, environmental, or social.

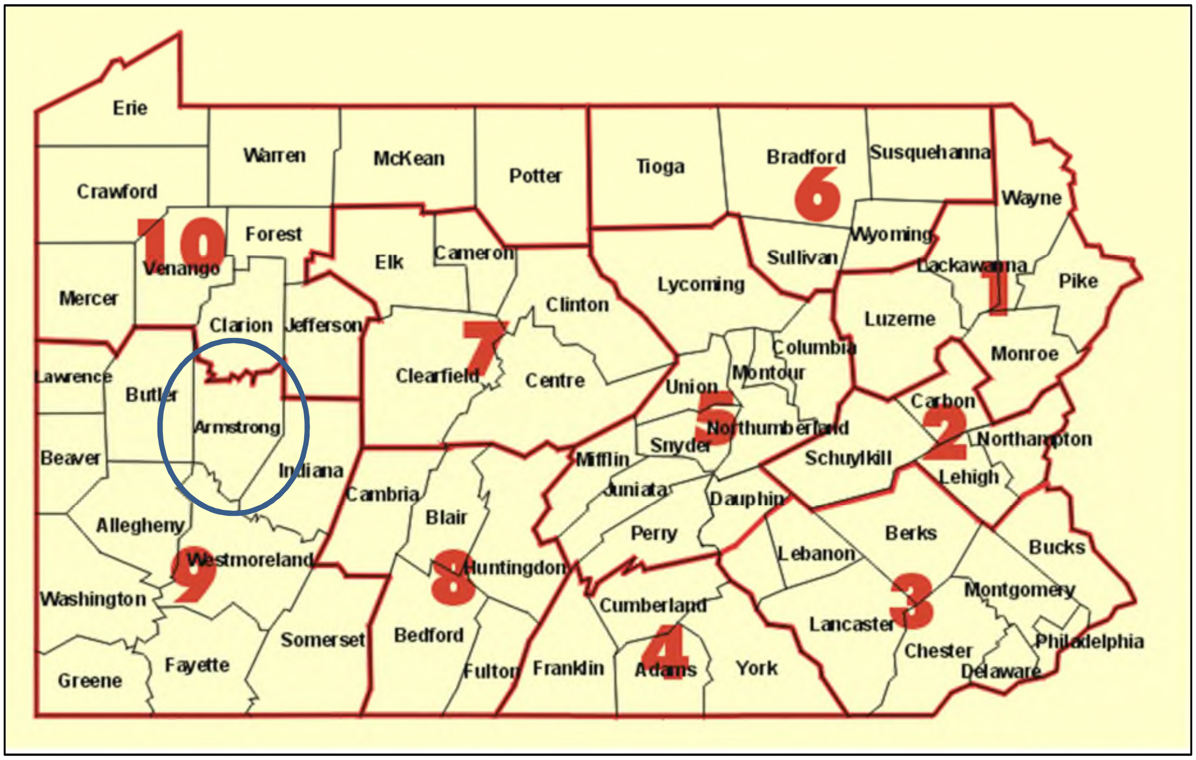
4.3.2.1 Location and Extent

Droughts are regional in scope and may affect the entirety of Armstrong County rather than only individual municipalities within the County. Droughts may also concurrently affect counties near Armstrong County, or even the entire Commonwealth. Generally, areas along waterways will reveal drought conditions later than areas away from waterways.

Climate divisions are regions within a state that are climatically homogenous. The National Oceanic and Atmospheric Administration (NOAA) has divided the United States into 359 climate divisions. The boundaries of these divisions typically coincide with County boundaries, except in the western United States, where they are based largely on drainage basins (CPC 2005).

According to NOAA, Pennsylvania includes 10 climate divisions: Pocono Mountains, East Central Mountains, Southeastern Piedmont, Lower Susquehanna, Middle Susquehanna, Upper Susquehanna, Central Mountains, South Central Mountains, Southwest Plateau, and Northwest Plateau Climate Division (CPC 2005). Figure 4.3.2-1 shows the climate divisions of Pennsylvania. Armstrong County is within the Southwest Plateau climate division.

Figure 4.3.2-1. Climate Divisions of Pennsylvania



Source: CPC 2005
Note: Highlight added.
The climate divisions for Pennsylvania are:
1 = Pocono Mountains; 2 = East Central Mountains; 3 = Southeastern Piedmont; 4 = Lower Susquehanna; 5 = Middle Susquehanna; 6 = Upper Susquehanna; 7 = Central Mountains; 8 = South Central Mountains; 9 = Southwest Plateau; 10 = Northwest Plateau

Particularly at locations where citizens rely on wells for drinking water, water supplies are vulnerable to effects of drought and thus can impact the severity of a drought. Residents depending on well water can more easily handle short-term droughts without major inconveniences than can populations that rely on surface water. However, longer-term droughts inhibit groundwater aquifers from recharging and can thus extend the problems of well owners for an indeterminate amount of time. Armstrong County residents who depend on private domestic wells have this greater “hidden vulnerability” to droughts. According to the United States Geological Survey (USGS) National Water Information System, the average daily domestic self-supplied groundwater withdrawals of fresh water in Armstrong County was 1.52 million gallons (Mgal) per day in 2010, serving roughly 25,381 residents for a total of roughly 60 gallons per person (dependent on well water) per day (USGS 2018).

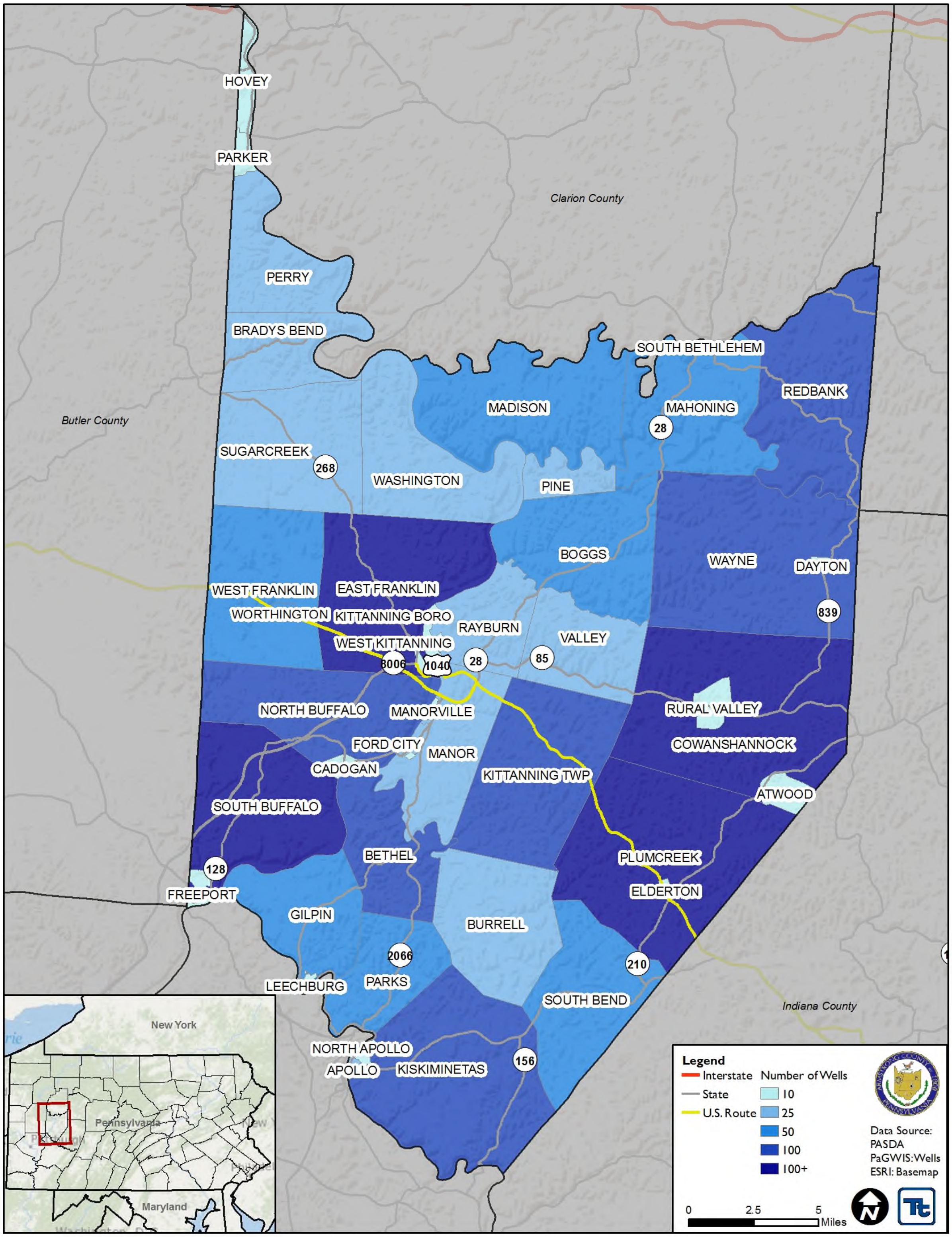
Table 4.3.2-1 lists the number of reported domestic wells within each municipality of Armstrong County. The well data were obtained from the Pennsylvania Groundwater Information System (PaGWIS). PaGWIS is maintained by Pennsylvania Department of Conservation and Natural Resources (PA DCNR) and relies on voluntary submissions of well record data by well drillers; as a result, it is not a complete database of all domestic wells in the County. It is, however, the most complete dataset of domestic wells available. Figure 4.3.2-2 shows well counts by municipality within Armstrong County.

Table 4.3.2-1. Domestic Wells in Armstrong County

Municipality	Number of Reported Domestic Wells	Municipality	Number of Reported Domestic Wells
Apollo Borough	26	Manor Township	43
Applewold Borough	0	Manorville Borough	0
Atwood Borough	2	North Apollo Borough	1
Bethel Township	74	North Buffalo Township	84
Boggs Township	58	Parker City	3
Bradys Bend Township	32	Parks Township	47
Burrell Township	25	Perry Township	34
Cadogan Township	0	Pine Township	29
Cowanshannock Township	129	Plumcreek Township	143
Dayton Borough	2	Rayburn Township	41
East Franklin Township	120	Redbank Township	78
Elderton Borough	1	Rural Valley Borough	1
Ford City Borough	19	South Bend Township	60
Ford Cliff Borough	0	South Bethlehem Borough	1
Freeport Borough	2	South Buffalo Township	106
Gilpin Township	62	Sugarcreek Township	37
Hovey Township	13	Valley Township	23
Kiskiminetas Township	100	Washington Township	33
Kittanning Borough	6	Wayne Township	78
Kittanning Township	93	West Franklin Township	56
Leechburg Borough	1	West Kittanning Borough	15
Madison Township	67	Worthington Borough	66
Mahoning Township	53	Armstrong County	1,864

Source: PaGWIS 2018

Figure 4.3.2-2 Armstrong County Domestic Well Counts by Municipality



Source: PaGWIS 2018

In addition to domestic wells in the County, residents may also receive their water from municipal water providers. According to the 2005 Armstrong County Comprehensive Plan, there are 30 municipal or joint municipal authorities that provide public water and sewerage in Armstrong County (Armstrong County Comprehensive Plan 2005).

Jurisdictions that are designated for agricultural use are particularly vulnerable to drought. Armstrong County has 783 farms covering a total of over 129,000 acres (USDA 2012), with over 21% of the County's total land being classified as agricultural land. Areas designated for agricultural use are illustrated in Figure 2-5 in Section 2.

4.3.2.2 Range of Magnitude

Effects of droughts vary depending on their severity, timing, duration, and location. Some droughts may exert their greatest impact on agriculture, while others may have stronger effects on water supply or recreational activities. Droughts can adversely affect the following significantly:

- 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
- Water for forests and for fighting forest fires
- Water for navigation and recreation.

Pennsylvania Department of Environmental Protection (PADEP) and Pennsylvania Emergency Management Agency (PEMA) manage water supply droughts according to the following four conditions of drought, as defined in the Commonwealth of Pennsylvania 2013 Standard Hazard Mitigation Plan (PEMA 2013):

- <u>Drought Watch</u>: A period to alert government agencies, public water suppliers, water users, and the public regarding potential for future drought-related problems. The focus is on increased monitoring, awareness, and preparation for response in the event that conditions worsen. A request for voluntary water conservation is issued. The objective of voluntary water conservation measures during a drought watch is to reduce water use by 5 percent within the affected areas. Because of varying conditions, individual water suppliers or municipalities may propose more stringent conservation actions.
- <u>Drought Warning</u>: This is a drought stage involving 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 use by 10 to 15 percent within the affected areas. Because of varying conditions, individual water suppliers or municipalities may propose more stringent conservation actions.
- <u>Drought Emergency</u>: During this drought stage, water management entities assemble all available resources to respond to actual emergency conditions, avoid depletion of water sources, ensure at least minimum water supplies to protect public health and safety, support essential and high-priority water uses, and avoid unnecessary economic upsets. If deemed necessary and if ordered by the Governor during this stage, imposition of mandatory restrictions on nonessential water usage could occur as provided for in 4 *Pa. Code* Chapter 119. Objectives of water use restrictions (mandatory or voluntary) and other conservation measures during a drought emergency are to reduce consumptive water use within the affected areas by 15 percent, and to reduce total use to the extent necessary to preserve public water system supplies, avoid or mitigate local or area shortages, and ensure equitable sharing of limited supplies.

- Local Water Rationing: This fourth condition of drought is not defined as a drought stage. Local municipalities may, with the approval of the PEMA Council, implement local water rationing to share a rapidly dwindling or severely depleted water supply within designated water supply service areas. These individual water rationing plans, authorized through provisions of 4 *Pa. Code* Chapter 120, 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 practices, procedures are specified for granting variances in consideration of individual hardships and economic dislocations (PEMA 2013).

Pennsylvania uses five parameters to assess drought conditions: precipitation deficits, stream flows, reservoir storage levels, groundwater levels, and a measure of soil moisture. These are described in detail below.

- Precipitation Deficits: As rainfall provides the basis for both groundwater and surface water resources, precipitation deficits are the earliest indicators of a potential drought. The National Weather Service (NWS) records "normal" monthly precipitation data for each County in Pennsylvania. These figures are generated from long-term monthly and decennial averages of precipitation and are updated at the end of each decade based on the most recent 30 years. Monthly totals with less than normal values represent precipitation deficits, which are then converted to percentages of the normal values. Table 4.3.2-2 lists the drought conditions (defined in the PA HMP and noted above) that are indicated by various precipitation deficit percentages (PEMA 2013).

Table 4.3.2-2. Precipitation Deficit Drought Indicators for Pennsylvania

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

Source: PEMA 2013

Table 4.3.2-3 lists normal monthly and annual precipitation from 1981 to 2010 at the Schenley Lock 5 NOAA weather station in Armstrong County. Data from the NOAA weather stations are available through the National Climatic Data Center (NCDC), which compiles monthly and annual normal total precipitation (inches) data retrieved from both NWS Cooperative Network (COOP) and Principal Observation (First-Order) locations throughout the United States.

Table 4.3.2-3. Normal Monthly and Annual Precipitation (total in inches) from 1981 to 2010 in Armstrong County

Weather Station	January	February	March	April	May	June	July	August	September	October	November	December	ANNUAL
Schenley Lock 5	2.62	1.96	2.90	3.54	4.09	4.47	4.34	3.63	3.64	2.60	3.41	2.92	40.12

Source: NCDC 2018

- Stream Flows: Stream flows, which typically lag up to 2 months behind normal precipitation amounts in signaling a drought, offer the second earliest indication of drought conditions. PADEP uses 73 U.S. Geological Survey (USGS)-maintained stream gauges throughout the State as its drought monitoring network, computing 30-day average stream flow values for each stream gauge based on the entire period of record for each gauge. For example, the Allegheny River gauge at Kittanning has data records as far back as August 1904 from which the long-term, 30-day average, or normal, flows are now determined. Drought status is determined from stream flows based on exceedances rather than percentages. The various stages of drought watch, warning, and emergency conditions are indicated, respectively, by 75-, 90-, and 95-percent exceedances of 30-day average flows (PEMA 2013). Detailed descriptions of these data collection methods appear in the PA HMP.
- Reservoir Storage Levels: Water levels in several large public water supply reservoirs are another indicator that PADEP uses for drought monitoring. Depending on total quantity of storage and length of the refill period for the various reservoirs, PADEP uses varying percentages of storage drawdown to indicate the three drought stages for each reservoir (PEMA 2013).
- Groundwater Levels: Groundwater levels can be an indicator of a developing drought, although low readings may lag up to 3 months behind drought-indicative precipitation readings. This lag occurs because storage of nearly 80 trillion gallons of groundwater throughout the Commonwealth disguises precipitation deficits for many months before significant lack of groundwater recharge becomes noticeable (PEMA 2013).

USGS also maintains groundwater monitoring wells in each County throughout the Commonwealth. Groundwater measurements taken from these wells at exceedances of 75, 90, and 95 percent are used to indicate drought watch, warning, and emergency statuses, respectively. Within the USGS well network, the 30-day average depth-to-groundwater readings are analyzed in relation to long-term, 30-day averages based on the period of record for each County well (PEMA 2013).

- Soil Moisture: NOAA's Palmer Drought Severity Index (PDSI) provides soil moisture information for evaluating the scope, severity, and frequency of prolonged periods of abnormally dry or wet weather. The index tool is frequently used to indicate availability of irrigation water supplies, reservoir levels, range conditions, amount of stock water, and forest fire potential. Although notably ineffective for monitoring short-term drought, the PDSI is effective for determining long-term droughts, and as such is most frequently used to delineate disaster areas (CPC 2015).

Table 4.3.2-4 lists PDSI classifications. The PDSI uses 0 to reflect normal status, and negative numbers indicate droughts. For example, 0 is no drought, -2 is moderate drought, and -4 is extreme drought. Positive numbers signify excess precipitation (PEMA 2013).

Table 4.3.2-4. Palmer Drought Severity Index (PDSI) Classifications

Severity Category	PDSI Value	Drought Status
Extremely wet	4.0 or more	None
Very wet	3.0 to 3.99	None
Moderately wet	2.0 to 2.99	None
Slightly wet	1.0 to 1.99	None
Incipient wet spell	0.5 to 0.99	None
Near normal	0.49 to -0.49	None
Incipient dry spell	-0.5 to -0.99	None
Mild drought	-1.0 to -1.99	None
Moderate drought	-2.0 to -2.99	Watch
Severe drought	-3.0 to -3.99	Warning
Extreme drought	-4.0 or less	Emergency

Source: PEMA 2013

Availability and management of water supply are discussed in the 2009 Pennsylvania State Water Plan, a joint effort by the Statewide Water Resources Committee and PADEP. In 2009, the PADEP Secretary approved an updated State Water Plan to guide management of Pennsylvania's water resources over a 15-year planning horizon. As a functional planning tool for all Pennsylvania municipalities, counties, and regional planning partnerships, the State Water Plan profiles drought and resource constraints and encourages implementation of new technology and use policies to facilitate reduced water uses and resource demands at critical peak times. The plan provides inventories of water availability, as well as an assessment of current and future water use demands and trends. It also offers strategies for improving management of water resources and waterway corridors that aim to reduce damages from extreme drought and flooding conditions (PADEP 2009).

4.3.2.3 Past Occurrence

Historical information has been drawn from many sources regarding previous occurrences and losses associated with drought events throughout Pennsylvania and Armstrong County. Because so many sources were reviewed for the purpose of developing this plan, loss and impact information pertaining to many events could vary depending on the source. Therefore, accuracy of cited monetary values is based only on the available information identified during research for this plan.

Between November 1980 and May 2017, Armstrong County was included in 23 drought watches, 11 drought warnings, and 4 drought emergencies (PEMA 2018). According to the Federal Emergency Management Agency (FEMA), between 1954 and 2017, Pennsylvania underwent one drought-related disaster (DR) or emergency (EM) classified as one or a combination of the following disaster types: drought or water shortage. Because these disaster types generally cover a wide region of the Commonwealth, this single disaster may have impacted many counties. However, not all counties were included in the disaster declaration. FEMA, PEMA, and other sources indicate that Armstrong County was included in any disaster declarations as a result of drought events (FEMA 2018).

While Armstrong County was not included in any FEMA declarations, the County was included in a USDA declaration. The USDA Secretary of Agriculture is authorized to designate counties as disaster areas to make emergency loans available to producers suffering losses in those counties and in counties that are contiguous to a designated County. The USDA included Armstrong County in one declaration as a result of drought conditions. This event occurred between May and December 2016 due to drought conditions (USDA declaration S4165) (USDA 2018).

Multiple sources provided historical information regarding previous occurrences and losses associated with drought events throughout the State of Pennsylvania and Armstrong County. Based on all sources researched, drought events between 1988 and 2018 that have affected Armstrong County are identified in Table 4.3.2-5.

It should be noted that loss and impact information for many events could vary depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP. Additionally, due to the extent of drought documentation for the State of Pennsylvania, it is possible that not all sources have been identified or researched. Therefore, Table 4.3.2-5 may not include all events that have occurred in Armstrong County.

Table 4.3.2-5. Past Occurrences of Drought Events from 1988 to 2018

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
July 7 – August 24, 1988	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
August 24 – December 12, 1988	Drought Warning	N/A	N/A	No information on losses or impacts were identified.
March 3 – May 15, 1989	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
June 28 – July 24, 1991	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
July 24 – August 16, 1991	Drought Warning	N/A	N/A	No information on losses or impacts were identified.
August 16, 1991 – April 20, 1992	Drought Emergency	N/A	N/A	No information on losses or impacts were identified.
April 20 – June 23, 1992	Drought Warning	N/A	N/A	No information on losses or impacts were identified.
September 1 – December 18, 1995	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
December 3-8, 1998	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
December 8, 1999 – March 15, 1999	Drought Warning	N/A	N/A	No information on losses or impacts were identified.
March 15 – June 18, 1999	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
June 18, 1999 – February 25, 2000	Drought Warning	N/A	N/A	Reports from farmers across Western Pennsylvania indicate crop losses ranging anywhere between 25% to 100% depending on the crop and location. Area dairy farmers estimated a 15% reduction in milk production due to a combination of heat and drought.
February 25 – May 5, 2000	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
August 24, 2001 – May 13, 2002	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
April 11 – June 30, 2006	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
August 6 – September 5, 2007	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
October 5, 2007 – January 11, 2008	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
November 7, 2008– January 26, 2009	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
September 16 – December 17, 2010	Drought Watch	N/A	N/A	No information on losses or impacts were identified.
August 5 – September 2, 2011	Drought Watch	N/A	N/A	No information on losses or impacts were identified.

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 10 – October 26, 2016	Drought Watch	N/A	N/A	Armstrong County was included in a USDA disaster declaration as a result of drought conditions. As a result of this event, farmers filed insurance claims for damages, totaling over $588,000 and impacting over 6,100 acres of land.

Sources: NRCC 2012, PEMA 2013, NCDC 2018, PADEP 2018, USDA 2018
Notes:
FEMA Federal Emergency Management Agency
N/A Not applicable
NCDC National Climatic Data Center
NRCC Northeast Regional Climate Center
PADEP Pennsylvania Department of Environmental Protection
PDSI Palmer Drought Severity Index
PEMA Pennsylvania Emergency Management Agency
USDA U.S. Department of Agriculture

Table 4.3.2-6 lists the crop loss insurance payments on claims from Armstrong County caused by drought events since 2009.

Table 4.3.2-6. Crop Loss Insurance Claims Due to Drought, 2009 to 2017

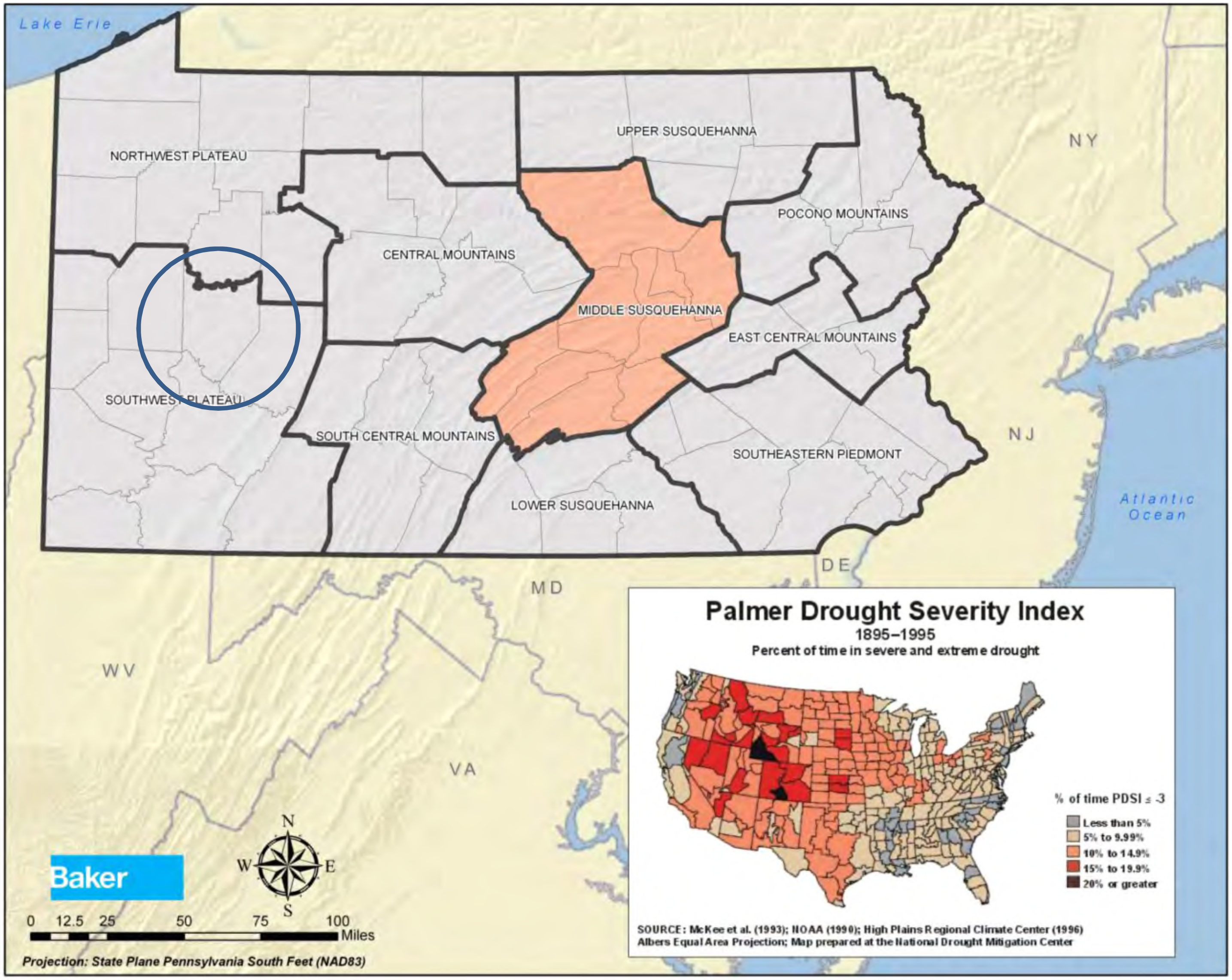
Crop Year	Total Claims
2009	None Reported
2010	$38,366.90
2011	$469,636.80
2012	$100,914.75
2013	None Reported
2014	None Reported
2015	$148,268.90
2016	$588,448.30
2017	$18,903.70

Source: U.S. Department of Agriculture (USDA) 2018

4.3.2.4 Future Occurrence

Frequency of droughts is difficult to forecast. Based on national annual data from 1895 to 1995, Armstrong County underwent severe or extreme drought conditions less than 5 percent of the time (illustrated on Figure 4.3.2-3). Based on national annual data from 1895 to July 2013, the Southwest Plateau (climate division 9), in which Armstrong County is located, had its lowest PDSI when it reached -7.13 in January 1931. This climate division has been in severe or extreme drought during approximately 7.7 percent of the 119 years on record (NRCC 2013).

Figure 4.3.2-3. Palmer Drought Severity Index for Pennsylvania (1895 to 1995)



Source: PEMA 2013 (highlight added)

For the 2019 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of drought events, of all magnitudes, for Armstrong County. Information from NOAA-National Centers for Environmental Information (NCEI) storm events database, the Drought Impact Report, and the Northeast Regional Climate Center (NRCC) were used to identify the number of drought events that occurred between 1950 and 2017. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Table 4.3.2-7 presents the probability of future occurrence of drought events in Armstrong County.

Table 4.3.2-7. Probability of Future Drought Events in Armstrong County

Hazard Type	Number of Occurrences Between 1950 and 2017	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in Any Given Year	Percent Chance of Occurrence in Any Given Year
Drought	24	0.36	2.83	0.35	35.29

Sources: NOAA-NCEI 2018; NRCC 2018

In Section 4.4, the identified hazards of concern for Armstrong County were ranked for relative risk. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records, the probability of occurrence for drought events in Armstrong County is considered possible. Please refer to Section 4.4 for further information on PEMA's risk factor methodology and the risk factors used to determine each hazard's risk rank.

4.3.2.5 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed and vulnerable within the identified hazard area. For the drought hazard, all of Armstrong County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities, and lifelines) described in the County Profile (Section 2) are potentially vulnerable to a drought. This section evaluates and estimates potential impacts of the drought hazard on Armstrong County in the following subsections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) economy; and (5) future growth and development
- Effects of climate change on vulnerability
- Further data collections that will assist in understanding this hazard over time

Overview of Vulnerability

Armstrong County is vulnerable to drought. Assets at particular risk include any open land or structures along the wildland/urban interface (WUI) that could become vulnerable to the wildfire hazard caused by extended periods of low rain and high heat, usually associated with drought. In addition, water supply resources could be impacted by extended periods of low rain. Finally, vulnerable populations could be particularly susceptible to the drought hazard and cascading impacts because of age, health conditions, and limited ability to mobilize to shelter, cooling, and medical resources.

Data and Methodology

At the time this plan was updated, insufficient data were available to model long-term potential impacts of a drought on Armstrong County. Over time, additional data will be collected to allow better analysis of this hazard. Preliminary assessments based on available data are provided below.

Impact on Life, Health, and Safety

Drought conditions can cause a shortage of water available for human consumption and can reduce local firefighting capabilities. Social impacts of a drought include mental and physical stress, public safety threats (increased threat from forest/grass fires), health threats, conflicts among water users, reduced quality of life, and inequities in distribution of impacts and disaster relief. The infirm, young, and elderly are particularly susceptible to drought and extreme temperatures, sometimes associated with drought conditions, due to their age, health conditions, and limited ability to mobilize to shelters, cooling, and medical resources. Impacts on the economy and environment may have social implications as well (New York State Disaster Preparedness Commission [NYSDPC] 2011). For the purposes of this plan, the entire population of the County is considered vulnerable to drought events.

Impact on General Building Stock and Critical Facilities

A drought is not expected to directly affect any structures, and all are expected to be operational during a drought event. However, droughts contribute to conditions conducive to wildfires. Risk to life and property is greatest in regions where forested areas adjoin urbanized areas (high-density residential, commercial, and industrial), also known as the WUI. Therefore, all assets in and adjacent to the WUI zone, including population, structures, critical facilities, lifelines, and businesses, are considered vulnerable to wildfire. Section 4.3.16 of this HMP addresses the wildfire hazard in Armstrong County.

Impact on the Economy

A prolonged drought can exert serious direct and indirect economic impacts on a community or across the County. A summary of impacts on the economy is presented in Table 4.3.2-8.

Table 4.3.2-8. Impacts on the Economy

Losses to Agricultural Producers	• Annual and perennial crop losses • Damage to crop quality • Income loss for farmers due to reduced crop yields • Reduced productivity of cropland (wind erosion, long-term loss of organic matter, etc.) • Insect infestation • Plant disease • Wildlife damage to crops • Increased irrigation costs • Cost of new or supplemental water resource development (wells, dams, pipelines)
Losses of Fishery Production	• Damage to fish habitat • Loss of fish and other aquatic organisms due to decreased flows
Losses to Recreation and Tourism Industry	• Loss to manufacturers and sellers of recreational equipment • Losses related to curtailed activities: hunting and fishing, bird watching, boating, etc.

Losses to Livestock Producers	• Reduced productivity of rangeland • Reduced milk production • Forced reduction of foundation stock • High cost/unavailability of water for livestock • Cost of new or supplemental water resource development (wells, dams, pipelines) • High cost/unavailability of feed for livestock • Increased feed transportation costs • High livestock mortality rates • Disruption of reproduction cycles (delayed breeding, more miscarriages) • Decreased stock weights • Increased predation • Grass fires
Energy-Related Effects	• Increased energy demand and reduced supply because of drought-related power curtailments • Costs to energy industry and consumers associated with substituting more expensive • fuels (oil) for hydroelectric power
Losses of Timber Production	• Wildland fires • Tree disease • Insect infestation • Impaired productivity of forest land • Direct loss of trees, especially young ones
Losses to Transportation Industry	• Loss from impaired navigability of streams, rivers, and canals
Decline in Food Production/Disrupted Food Supply	• Increase in food prices • Increased importation of food (higher costs)
Losses to Water Suppliers	• Revenue shortfalls and/or windfall profits • Cost of water transport or transfer • Cost of new or supplemental water resource development

Loss estimates are based on lost agricultural revenues statewide. Table 4.3.2-9 below enumerates the County's farmland acreage exposure to the drought hazard, as well as the annual market value of all agricultural products sold, as documented in the 2012 USDA Census of Agriculture. If the County would lose its agricultural yield due to drought, total losses could amount to nearly $36 million. Table 4.3.2-10 details the potential losses associated with County livestock by providing livestock totals for the County and their associated market value. Livestock, poultry, and associated products have a potential loss value of more than $15.6 million (USDA 2012).

Table 4.3.2-9. Estimated County Losses Relating to Agricultural Production

Impacted Farmland Acreage	Market Value of All Agricultural Products
129,090	$35,861,000

Source: USDA 2012

Table 4.3.2-10. Estimated County Losses Relating to Agricultural Production

Livestock and Poultry	Inventory	Market Value of All Livestock, Poultry, and Their Products
Layers	2,538	
Cattle and Calves	14,506	
Horse and Ponies	1,191	**$15,676,000**
Sheep and Lambs	758	
Total	**18,993**	

Source: USDA 2012
Note: Market value of livestock and poultry is only provided by total value and not available by category.

Impact on the Environment

As summarized in the PA HMP (2013), environmental impacts of drought include:

- Hydrologic effects – lower water levels in reservoirs, lakes, and ponds; reduced streamflow; loss of wetlands; estuarine impacts; groundwater depletion and land subsidence; effects on water quality such as increases in salt concentration and water temperature
- Damage to animal species – lack of feed and drinking water; disease; loss of biodiversity; migration or concentration; and reduction and degradation of fish and wildlife habitat
- Damage to plant communities – loss of biodiversity; loss of trees from urban landscapes and wooded conservation areas
- Increased number and severity of fires
- Reduced soil quality
- Air quality effects, such as dust and pollutants
- Loss of quality in landscape through loss in plants and plant diversity
- Increase in nitrate levels, which can negatively affect health of pregnant women and children.

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 to 10 years have been identified across the County (further discussed in Section 4.4 of this HMP). Exposure of any new development and new residents to the drought hazard is anticipated.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change can alter prevalence and severity of weather extremes such as droughts. While predicting changes in drought events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating effects of future climate change on human health, society, and the environment (U.S. Environmental Protection Agency 2016).

PADEP was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of potential impacts of global climate change on the Commonwealth. The June 2009 Pennsylvania Climate Impact Assessment's main findings indicated that Pennsylvania is very likely to undergo increased temperatures in the 21st century. Increases in temperature will likely lead to increased evapotranspiration, and thus an increase in soil-moisture-related droughts throughout late spring and early fall. Pennsylvania's precipitation climate is projected to become more extreme in the future, with longer dry periods and greater intensity of precipitation. Most models project an increase in the maximum number of consecutive dry days in a year, a drought indicator (Shortle et al. 2009).

Future improvements in modeling smaller-scale climatic processes can be expected and will lead to improved understanding of how the changing climate will alter temperature, precipitation, storm frequency, and intensity in Pennsylvania. Understanding this information can help provide better indications of future drought events (Shortle et al. 2009).

4.3.3 Earthquake

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

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

According to the U.S. Geological Survey (USGS) Earthquake Hazards Program, an earthquake hazard is any disruption associated with an earthquake that may affect normal activities of populations around the earthquake epicenter. This category includes surface faulting, ground motion (shaking), landslides, liquefaction, tectonic deformation, tsunamis, and seiches. Each of these terms is defined below:

- Surface faulting: Displacement that reaches the earth's surface during a slip along a fault. This commonly occurs with shallow earthquakes, which include those with an epicenter of less than 20 kilometers.
- Ground motion (shaking): The movement of the earth's surface from earthquakes or explosions. Ground motion or shaking is produced by waves that are generated by a sudden slip on a fault or sudden pressure at the explosive source and that travel through the Earth and along its surface.
- Landslide: A movement of surface material down a slope.
- Liquefaction: A process by which water-saturated sediment temporarily loses strength and acts as a fluid, such as the wet sand near the water at the beach. Earthquake shaking can cause this effect.
- Tectonic Deformation: A change in the original shape of the earth's material caused by stress and strain.
- Tsunami: A sea wave of local or distant origin that results from large-scale seafloor displacements associated with large earthquakes, major sub-marine slides, or exploding volcanic islands.
- Seiche: The sloshing of a closed body of water, such as a lake or bay, from earthquake shaking (USGS 2012).

Ground shaking is the primary cause of earthquake damage to manmade structures. Damage can be increased when soft soils amplify ground shaking. Soils influence damage in different ways. One way is that soft soils amplify the motion of earthquake waves, producing greater ground shaking and increasing the stresses on built structures on the land surface. An earthquake can also cause damage to soil that is loose, wet, or sandy. These soils may lose strength and flow as a fluid when shaken, causing foundations and underground structures to shift and break (Stanford 2003).

The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications defined by their shear-wave velocity that alters the severity of an earthquake. The soil classification system categories soil ranging from A to E; each class is presented in Table 4.3.3-1. Class A soils represent hard rock that reduces ground motion from an earthquake, and Class E soils represent soft soils that amplify and magnify ground shaking and increase building damage and losses.

Table 4.3.3-1. NEHRP Soil Classifications

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

Source: FEMA 2013

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 to 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 damage 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 (PEMA 2018).

Earthquake events in Pennsylvania typically do not impact areas greater than 100 kilometer (km) from the epicenter. Pennsylvania’s strongest earthquakes with in-state epicenters have persistently occurred in an area near Lancaster. 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. 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. Armstrong County is shown as being in one of the lowest seismic hazard areas in the state.

Figure 4.3.3-1. Relative Earthquake Hazard Zones of Pennsylvania

Source: PEMA 2018
Note: Armstrong County is outlined in red. The figure shows the County is in one of the lowest seismic zones in the state.

Data on 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 unusually small areas, suggesting that these events were relatively shallow (PEMA 2018).

4.3.3.2 Range of Magnitude

Earthquakes are measured by a seismographic network. Each seismic station measures the movement of the ground at the site. The slip of one block of rock over another in an earthquake releases energy that moves the ground vibrate. The vibration pushes the adjoining piece of ground and causes it to vibrate; with the energy traveling out from the earthquake in a wave (USGS 2018a).

Different ways are used to measure different aspects of an earthquake. While the Richter Scale was one of the most common instruments used to measure an earthquake, it is no longer used. Instead, magnitude and intensity are used to measure the different characteristics of an earthquake. Magnitude measures the energy released at the source of the earthquake. Magnitude is determined from measurements on seismographs. Intensity measures the strength of shaking produced by the earthquake at a certain location. Intensity is determined from effects on people, human structures, and the natural environment (USGS 2018a).

The moment magnitude scale is the preferred method of measuring the magnitude of an earthquake today because it works over a wider range of earthquake sizes. It is based on the total moment release of an earthquake. Moment is a product of the distance a fault moved, and the force required to move it. It is derived from modeling recordings of the earthquake at multiple stations (UPSeis 2014). Table 4.3.3-2 shows the moment magnitude scale and the estimated number of earthquakes that occur each year at that magnitude.

Table 4.3.3-2. Moment Magnitude Scale

Magnitude	Earthquake Effects	Estimated Number Each Year
2.5 or less	Usually not felt but can be recorded by seismograph.	900,000
2.5 to 5.4	Often felt, but only causes minor damage.	30,000
5.5 to 6.0	Causes slight damage to buildings and other structures.	500
6.1 to 6.9	May cause a lot of damage in very populated areas.	100
7.0 to 7.9	Major earthquake. Causes serious damage.	20
8.0 or greater	Great earthquake. May totally destroy communities near the epicenter.	Once every 5 to 10 years

Source: UPSeis 2005

The Modified Mercalli Intensity (MMI) scale expresses the intensity of an earthquake and is a subjective measure that describes the strength of a shock felt at a particular location. The MMI scale expresses the intensity of an earthquake's effects in a given locality in values ranging from I to XII. A detailed description of the MMI scale is shown in Table 4.3.3-3. The earthquakes that occur in Pennsylvania originate deep within the earth's crust, and not on an active fault. No injury or severe damage from earthquake events has been reported in Armstrong County.

Table 4.3.3-3. Modified Mercalli Intensity Scale with Associated Impacts

Intensity	Shaking	Description/Damage	Magnitude
I	Not felt	Not felt except by a very few under especially favorable conditions.	1.0-3.0
II	Weak	Felt only by a few persons at rest, especially on upper floors of buildings.	3.0-3.9
III	Weak	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck. Duration estimated.	3.0-3.9
IV	Light	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors disturbed; walls make cracking sound. Sensation similar to heavy truck striking building. Standing motor cars rocked noticeably.	4.0-4.9
V	Moderate	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.	4.0-4.9
VI	Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.	5.0-5.9
VII	Very Strong	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken.	5.0-5.9
VIII	Severe	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned.	6.0-6.9
IX	Violent	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations.	6.0-6.9
X	Extreme	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.	7.0 and higher

Source: USGS 2018b

Seismic hazards are often expressed in terms of peak ground acceleration (PGA). PGA is expressed as a percent acceleration force of gravity (%g). For example, 1.0%g PGA in an earthquake (an extremely strong ground motion) means that objects accelerate sideways at the same rate as if they had been dropped from the ceiling. 10%g PGA means that the ground acceleration is 10 percent that of gravity (NJOEM 2011). Damage levels experienced in an earthquake vary with the intensity of ground shaking and with the seismic capacity of structures, as noted in Table 4.3.3-4.

Table 4.3.3-4. PGA and Damage Levels Experienced in Earthquakes

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

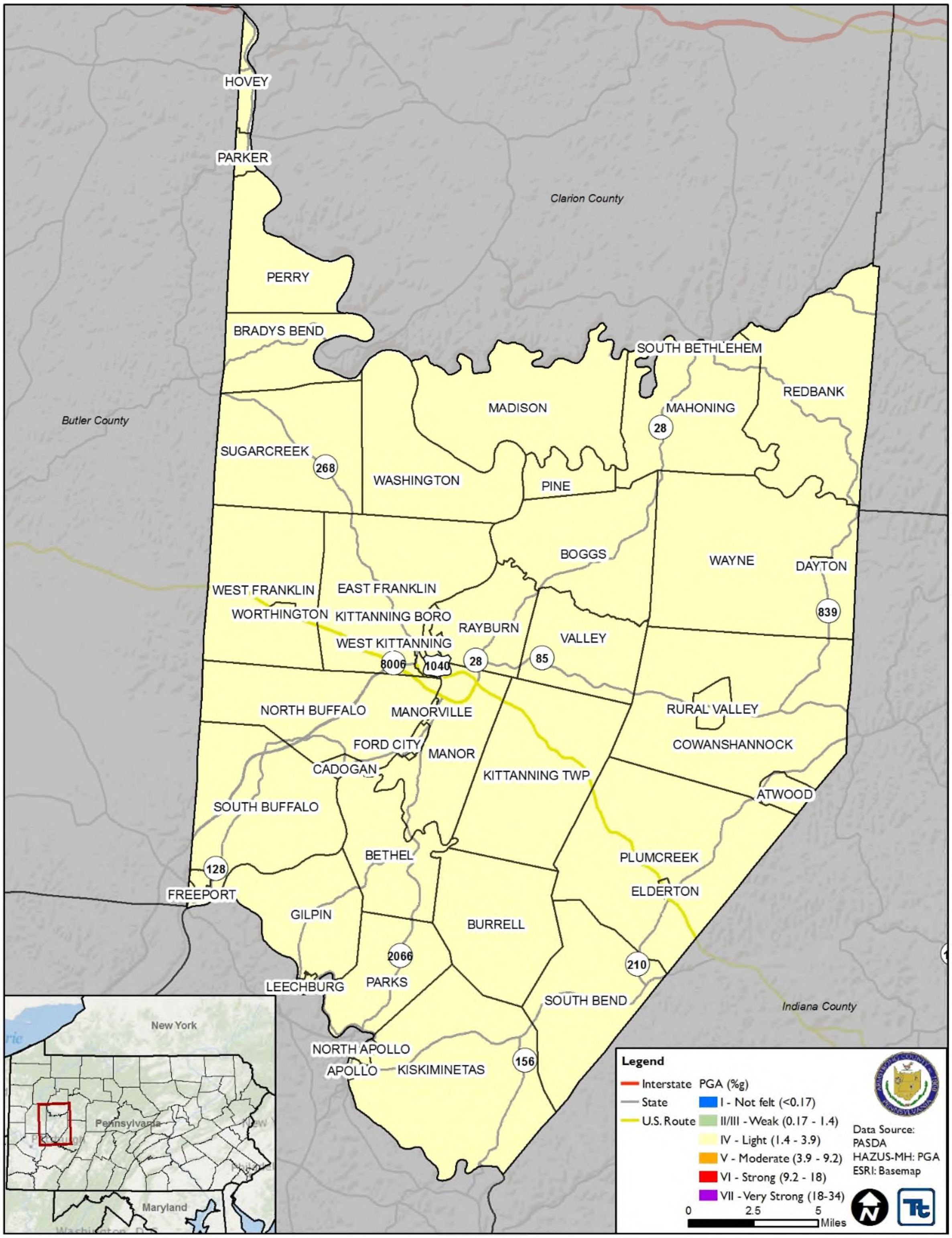
Source: NJOEM 2011
Note: %g Peak ground acceleration

National maps of earthquake shaking hazards have been produced since 1948. They provide information essential to creating and updating the seismic design requirements for building codes, insurance rate structures, earthquake loss studies, retrofit priorities and land use planning used in the United States. Scientists frequently revise these maps to reflect new information and knowledge. Buildings, bridges, highways and utilities built to meet modern seismic design requirements are typically able to withstand earthquakes better, with less damage and disruption. After thorough review of the studies, professional organizations of engineers update the seismic-risk maps and seismic design requirements contained in building codes (Brown et al. 2001).

The USGS updated the National Seismic Hazard Maps in 2014, which superseded the 2008 maps. New seismic, geologic, and geodetic information on earthquake rates and associated ground shaking were incorporated into these revised maps. The 2014 map represents the best available data as determined by the USGS. According to the data, Armstrong County has a PGA between 1%g and 2%g (USGS 2014). The 2014 PGA map can be found at: https://earthquake.usgs.gov/static/lfs/nshm/conterminous/2014/2014pga10pct.pdf.

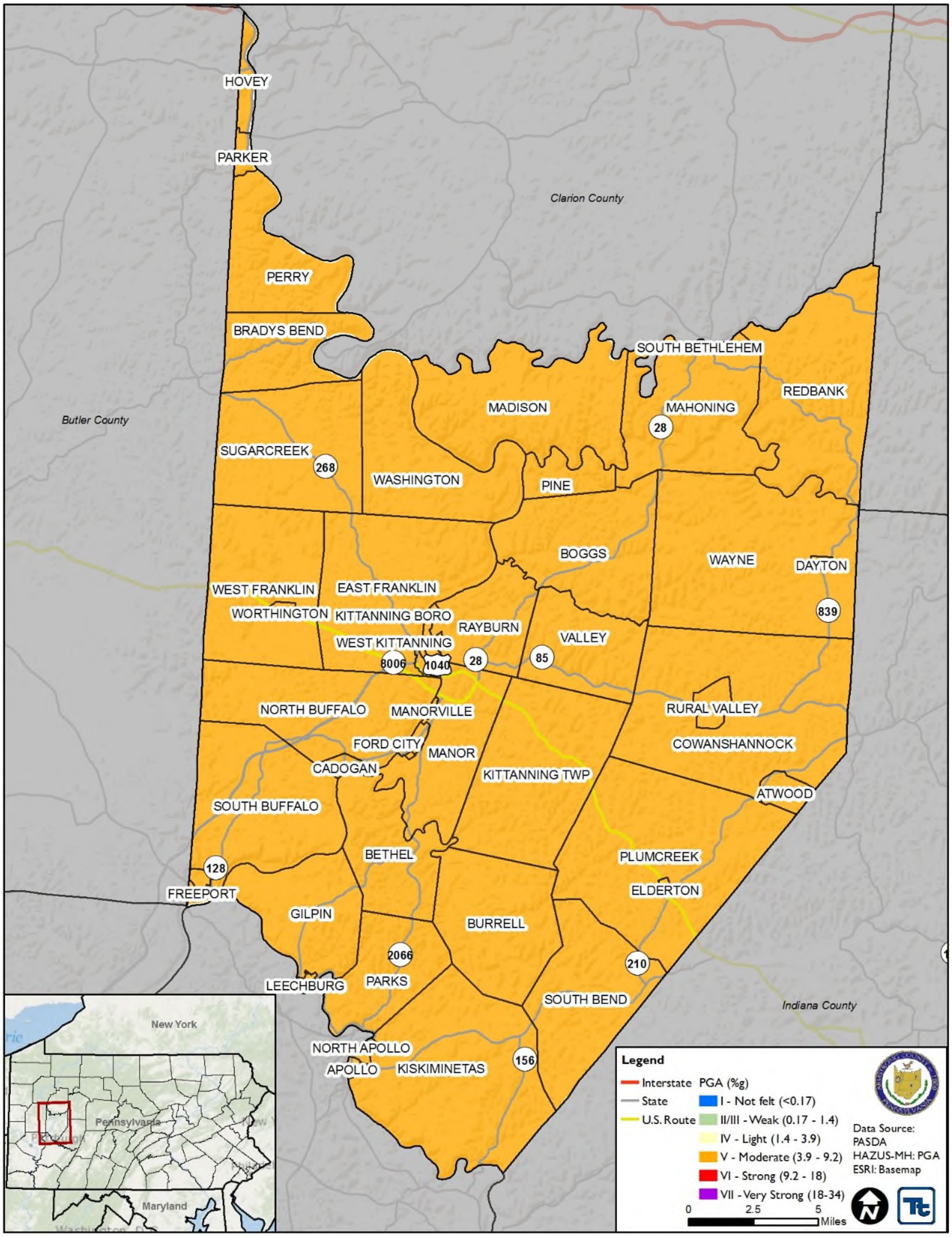
A probabilistic assessment was conducted for the 500- and 2,500-year mean return periods (MRP) in HAZUS-MH V4.2 to analyze the earthquake hazard for Armstrong County. The HAZUS analysis evaluates the statistical likelihood that a specific event will occur and what consequences will occur. Figure 4.3.3-2 and Figure 4.3.3-3 illustrates the geographic distribution of PGA (g) across the County or 500- and 2,500-year MRP events by Census-tract.

Figure 4.3.3-2. Peak Ground Acceleration Modified Mercalli Scale in Armstrong County for a 500-Year MRP Earthquake Event



Source: HAZUS-MH V4.2
Note: The peak ground acceleration for the 500-year MRP is 2.70%g-2.81%g.

Figure 4.3.3-3. Peak Ground Acceleration Modified Mercalli Scale in Armstrong County for a 2,500-Year MRP Earthquake Event



Source: HAZUS-MH V4.2

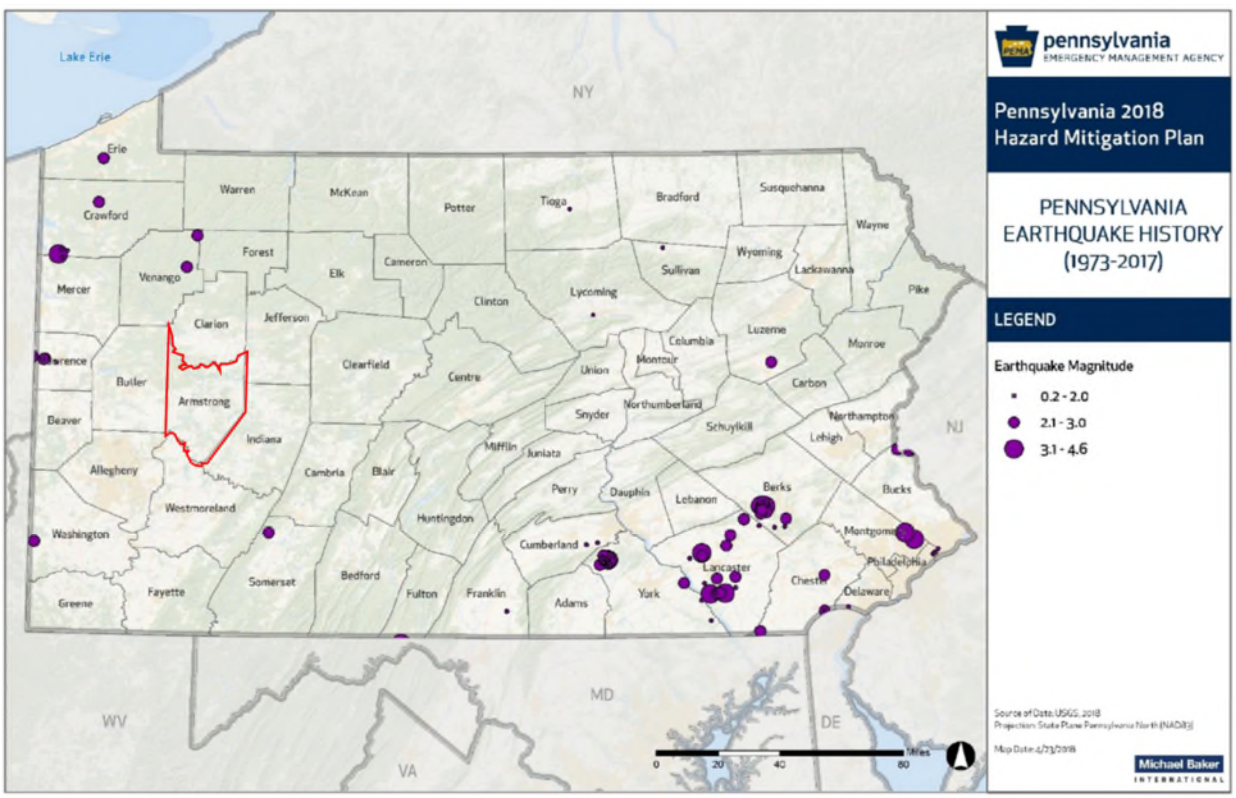
Note: The peak ground acceleration for the 2,500-year MRP is 6.73%*g-7.14%g*.

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 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 and 1812, 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 (PEMA 2018).

Figure 4.3.3-4 displays the location and magnitude of earthquakes with epicenters throughout Pennsylvania, as recorded in the USGS Earthquake Catalog. This catalog includes all detectable earthquakes recorded in the Commonwealth from 1973 to 2018. This figure shows that Armstrong County has not had any earthquake epicenters since 1973. According to the USGS's latest earthquakes database, there have been no recorded earthquake epicenters in Armstrong County between 1950 and 2018. However, epicenters were recorded in Somerset, Venango, and Lawrence Counties (USGS 2018c). Between 1954 and 2018, the Commonwealth of Pennsylvania was not included in any FEMA major disaster (DR) or emergency (EM) declarations (FEMA 2018).

Figure 4.3.3-4. Earthquake Epicenters in Pennsylvania



Source: PEMA 2018

Note: Armstrong County is outlined in red. The figure shows that the County has not had any earthquake epicenters.

4.3.3.4 Future Occurrence

The Pennsylvania Bureau of Topographic and Geologic Survey indicates that an earthquake is a relatively low-level hazard in Pennsylvania based on a probabilistic analysis considering the threat from earthquakes both outside and inside Pennsylvania (DCNR 2007).

An earthquake's severity can be expressed by considering the rate in change of motion of the earth's surface during a seismic event as a percent of the normal rate of acceleration caused by gravity (*g*), which is called the peak horizontal ground acceleration (PHGA). In general, ground acceleration must exceed 15 percent of *g* for significant damage to occur, although soil conditions at local sites are extremely important in controlling how much damage will occur because of a given amount of ground acceleration. According to PEMA, the highest seismic hazard is in southeastern Pennsylvania, where PHGA values range from 10 to 14 percent and there is a 90-percent probability that maximum horizontal acceleration in rock of 10 percent of gravity will not be exceeded in a 50-year period (PEMA 2013).

For the 2019 HMP update, the most up-to-date data was collected to calculate the probability of future occurrence of earthquake events (magnitudes that could be felt) for Armstrong County. Information from USGS databases and the 2013 Armstrong County HMP were used to identify earthquake events that occurred between 1950 and 2018. Using these sources ensures the most accurate probability estimates possible. Based on all research, the County has not experienced an earthquake epicenter, giving it an estimated zero-percent chance of an earthquake occurring with its epicenter in Armstrong County. However, the County may experience impacts from earthquakes that occur outside of the County's boundaries.

In Section 4.4, the identified hazards of concern for Armstrong County were ranked for relative risk. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and reference to the Pennsylvania State Hazard Mitigation Plan, the probability of occurrence for earthquake events in Armstrong County is considered *unlikely*. Please refer to Section 4.4 for further information on PEMA's risk factor methodology and the risk factors used to determine each hazard's risk rank.

4.3.3.5 Vulnerability Assessment

To understand risk, a community must evaluate which assets are exposed or vulnerable in the identified hazard area. The entire County is exposed to the earthquake hazard. Therefore, all assets in Armstrong County (population, structures, critical facilities, and lifelines) described in the County Profile (Section 2), are potentially vulnerable. The following section provides an evaluation and estimation of the potential impact of the earthquake hazard on Armstrong County, including the following:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, safety, and health of residents; (2) general building stock; (3) critical facilities; (4) economy; (5) environment; and (6) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

Earthquakes usually occur without warning and can impact areas a great distance from their point of origin. The extent of damage depends on the density of population and building and infrastructure construction in the area shaken by the quake. Some areas may be more vulnerable than others based on soil type, the age of the buildings, and building codes in place. Pennsylvania adopted the Uniform Construction Code in 1999 (amended in 2004), which references the construction guidelines set forth by the International Code Council. The International

Codes, similar to the west coast's reliance on the more seismically focused Uniform Building Code, encourage structures to be earthquake resistant and resilient in design and construction. Newer buildings may be more protected from severe damage as the result of an earthquake as compared to buildings constructed before these newer building codes were adopted.

The entire population and general building stock inventory of the County are at risk of being damaged or experiencing losses because of impacts of an earthquake. Potential losses associated with earth shaking were calculated for Armstrong County for the 500-year and 2,500-year MRP. A summary of the data and methodology used for this assessment is presented below, followed by the impacts on population, existing structures, critical facilities, and the economy within Armstrong County.

Data and Methodology

A probabilistic assessment was conducted for the 500-year and 2,500-year MRP in HAZUS-MH v4.2 to analyze the earthquake hazard. The probabilistic method uses information from historic earthquakes and inferred faults, locations and magnitudes, and computes the probable ground shaking levels that may be experienced during a recurrence period by Census Tract. It should be noted that, in some cases, there were more than one municipality per Census Tract; however, the results are reported at the municipality level as detailed in Section 4.4 Hazard Vulnerability Summary.

Ground shaking is the primary cause of earthquake damage to man-made structures and soft soils amplify ground shaking. One contributor to the site amplification is the velocity at which the rock or soil transmits shear waves (S-waves). The National Earthquake Hazard Reduction Program (NEHRP) developed five soil classifications defined by their shear-wave velocity that impact the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake, and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. NEHRP soil classifications were not available for Armstrong County at the time of this analysis. Soils were classified as NEHRP soil type D across the County as a conservative approach to this risk assessment. Groundwater was set at a depth of 5 feet (default setting). Damage and losses due to liquefaction, landslide, or surface fault rupture were not included in this analysis. The default assumption is a magnitude 7 earthquake for all return periods.

In addition to the probabilistic scenarios mentioned, an annualized loss run was conducted in HAZUS v4.2 to estimate the annualized general building stock dollar losses for Armstrong County. The annualized loss methodology combines the estimated losses associated with ground shaking for eight return periods, which are based on values from the USGS seismic probabilistic curves. Annualized losses are useful for mitigation planning because they provide a baseline that can be used to compare (1) the risk of one hazard across multiple jurisdictions, and (2) the degree of risk of all hazards for each participating jurisdiction.

Impact on Life, Health, and Safety

The entire population of Armstrong County (67,512) is potentially exposed to the direct and indirect impacts from earthquakes (U.S. Census Bureau, 2012-2016 American Community Survey 5-Year Estimates). The degree of exposure is dependent on many factors, including the age and construction type of buildings and the soil type on which buildings are constructed. The impact of earthquakes on life, health, and safety is dependent upon the severity of the event. Risk to public safety and loss of life from an earthquake in Armstrong County is minimal, with higher risks occurring in buildings because of damage to the structure, or people walking below building ornamentation and chimneys that may be shaken loose and fall because of the quake. Business interruption may prevent people from working, road closures could isolate populations, and loss of utilities could impact populations that may not have suffered direct damage from the event itself.

Populations considered most vulnerable include the elderly (persons over the age of 65) and individuals living below the Census poverty threshold. These socially vulnerable populations are most susceptible based on several factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing.

Residents may be displaced or require temporary to long-term sheltering because of the event. The number of people requiring shelter is generally less than the number displaced, as some displaced persons use hotels or stay with family or friends after a disaster event. HAZUS-MH v4.2 does not estimate any displaced persons or population that may require short-term sheltering because of the 500-year and 2,500-year events.

Table 4.3.3-5. Summary of Estimated Sheltering Needs for Armstrong County

Scenario	Displaced Households	Persons Seeking Short-Term Shelter
500-Year Earthquake	2	1
2,500- Year Earthquake	16	9

Source: HAZUS-MH v4.2

According to the 1999-2003 New York City Area Consortium for Earthquake Loss Mitigation (NYCEM) Summary Report (Earthquake Risks and Mitigation in the New York / New Jersey / Connecticut Region), there is a strong correlation between structural building damage and the number of injuries and casualties from an earthquake event. HAZUS-MH v4.2 estimates the number of people that may potentially be injured and/or killed by an earthquake depending upon the time of day the event occurs. These estimates are provided for three times of day (2:00 AM, 2:00 PM, and 5:00 PM), representing the periods of the day that different sectors of the community are at their peak. The 2:00 AM estimate considers the residential occupancy at its maximum, the 2:00 PM estimate considers the educational, commercial and industrial sector at their maximum, and the 5:00 PM estimate represents peak commuter time.

Table 4.3.3-6. Estimated Number of Injuries and Casualties from the 500 and 2,500-Year MRP Earthquake Event

Level of Severity	Time of Day		
	2:00 AM	2:00 PM	5:00 PM
500-year			
Injuries	2	1	1
Hospitalization	0	0	0
Casualties	0	0	0
2,500-Year			
Injuries	11	9	7
Hospitalization	1	1	1
Casualties	0	0	0

Source: HAZUS-MH v4.2.

Impact on General Building Stock

The entire County's general building stock is considered at risk and exposed to this hazard. The HAZUS-MH v4.2 model estimates the value of the exposed building stock and the loss (in terms of damage to the exposed stock). Refer to the Community Profile (Section 2) for general building stock data replacement value statistics (structure and contents).

There is a strong correlation between PGA and damage a building might undergo (NYCEM 2003). The HAZUS-MH v4.2 model is based on best available earthquake science and aligns with these statements. The HAZUS-MH v4.2 probabilistic model was applied to analyze effects from the earthquake hazard on general building stock in Armstrong County. See Figure 4.3.3-2 and Figure 4.3.3-3 earlier in this profile that illustrate the geographic distribution of PGA (%g) across the County for 500- and 2,500-year MRP events.

A building's construction determines how well it can withstand the force of an earthquake. The NYCEM report indicates that un-reinforced masonry buildings are most at risk during an earthquake because the walls are prone to collapse outward, whereas steel and wood buildings absorb more of the earthquake's energy. Additional attributes that contribute to a building's capability to withstand an earthquake's force include its age, number of stories, and quality of construction. HAZUS-MH v4.2 considers building construction and the age of buildings as part of the analysis. The default building ages and building types already incorporated into the inventory were used because the default general building stock was used for this HAZUS-MH analysis.

Potential building damage was evaluated by HAZUS-MH v4.2 across the following damage categories: none, slight, moderate, extensive, and complete. Table 4.3.3-7 provides definitions of these categories of damage for a light wood-framed building; definitions for other building types are included in the HAZUS-MH technical manual documentation. General building stock damage for these categories by occupancy class and building type across Armstrong County is summarized for the 500- and 2,500-year events in Table 4.3.3-8.

Table 4.3.3-7 Example of Structural Damage State Definitions for a Light Wood-Framed Building

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

Source: FEMA 2012

The value of general building stock exposed to and damaged by the 500- and 2,500-year MRP earthquake events were evaluated and annualized losses were calculated via HAZUS-MH v4.2. Table 4.3.3-8 below lists estimated numbers of buildings damaged (within general occupancy categories) during 500- and 2,500-year MRP earthquake events. Damage loss estimates include structural and non-structural damage to the building and loss of contents. Table 4.3.3-9 lists estimated replacement cost values (RCV) of buildings and contents damaged by 500- and 2,500-year MRP earthquake events. Table 4.3.3-10 below lists values of residential and commercial buildings and contents in Armstrong County damaged by the 500- and 2,500-year MRP earthquake events (total RCVs are same as in Table 4.3.3-9). The total cost of all damage estimates for both mean return periods is less than 1% of total replacement cost value for each municipality.

Table 4.3.3-8 Estimated Buildings Damaged by General Occupancy for 500-year and 2,500-year MRP Earthquake Events

Category	Expected Building Damage by Occupancy									
	500-Year MRP					2,500-Year MRP				
	None	Slight	Moderate	Extensive	Complete	None	Slight	Moderate	Extensive	Complete
Residential	29,579.99 (93.85%)	390.09 (93.45%)	111.39 (93.68%)	9.93 (92.64%)	0.59 (95.07%)	27,886.58 (93.9%)	1,562.6 (93.27%)	563.92 (92.87%)	71.69 (92.25%)	7.21 (94.04%)
Commercial	1213.88 (3.85%)	17.7 (4.24%)	4.88 (4.1%)	0.52 (4.81%)	0.02 (3.21%)	1,132.53 (3.81%)	72.37 (4.32%)	27.87 (4.59%)	3.93 (5.06%)	0.3 (3.85%)
Industrial	315.6 (1%)	4.18 (1%)	1.11 (0.93%)	0.11 (1.01%)	0.00 (0.55%)	295.32 (0.99%)	17.79 (1.06%)	6.95 (1.14%)	0.87 (1.12%)	0.06 (0.81%)
Education, Government, Religious and Agricultural	407.83 (1.3%)	5.46 (1.32%)	1.52 (1.28%)	0.17 (1.54%)	0.00 (1.17)	382.68 (1.28%)	22.54 (1.35%)	8.46 (1.39%)	1.2 (1.57%)	0.11 (1.31%)

Source: HAZUS-MH v4.2

Table 4.3.3-9 Estimated Building Value (Building and Contents) Damaged by the 500-Year and 2,500 Year MRP Earthquake Event

Municipality	Total Replacement Cost Value (Structure and Contents)	Estimated Total Damage		
		Annualized Loss	500-Year	2,500-Year
Apollo Borough	$251,670,000	$581.55	$66,983.39	$544,626.25
Applewood Borough	$74,252,000	$167.64	$17,549.56	$159,110.93
Atwood Borough	$10,050,000	$23.48	$2,663.92	$22,068.97
Bethel Township	$128,949,000	$324.22	$39,243.94	$295,802.68
Boggs Township	$76,331,000	$185.95	$22,155.17	$172,835.74
Bradys Bend Township	$131,764,000	$349.44	$40,598.74	$323,770.88
Burrell Township	$73,172,000	$183.98	$22,268.94	$167,852.98
Cadogan Township	$65,238,000	$156.84	$18,298.65	$145,348.84
Cowanshannock Township	$303,507,000	$709.16	$80,449.48	$666,476.32
Dayton Borough	$84,832,000	$201.85	$22,497.47	$190,254.08
East Franklin Township	$1,027,803,000	$2,320.42	$242,922.65	$2,202,428.04
Elderton Borough	$75,474,000	$189.66	$22,582.73	$172,721.16
Ford City Borough	$538,129,000	$1,242.27	$136,929.43	$1,179,436.62
Ford Cliff Borough	$42,367,000	$103.82	$12,154.20	$95,880.51
Freeport Borough	$314,661,000	$734.20	$84,389.40	$691,167.60
Gilpin Township	$375,439,000	$898.10	$109,270.81	$824,508.31
Hovey Township	$25,518,000	$67.67	$7,862.53	$62,702.90
Kiskiminetas Township	$529,524,000	$1,322.08	$158,223.28	$1,197,992.99
Kittanning Borough	$933,567,000	$2,190.61	$231,716.85	$2,085,578.25
Kittanning Township	$224,824,000	$565.28	$68,422.24	$515,735.22
Leechburg Borough	$490,357,000	$1,079.00	$118,135.59	$1,023,436.89
Madison Township	$176,372,000	$440.53	$50,086.80	$412,006.00
Mahoning Township	$155,073,000	$368.98	$41,125.40	$347,784.70

Municipality	Total Replacement Cost Value (Structure and Contents)	Estimated Total Damage		
		Annualized Loss	500-Year	2,500-Year
Manor Township	$578,870,000	$1,418.53	$166,065.64	$1,310,037.25
Manorville Borough	$40,861,000	$100.13	$11,722.16	$92,472.29
North Apollo Borough	$163,435,000	$377.74	$43,513.48	$353,724.55
North Buffalo Township	$364,294,000	$875.80	$102,175.22	$811,623.29
Parker City	$83,797,000	$222.23	$25,819.29	$205,906.23
Parks Township	$502,517,000	$1,144.22	$129,303.38	$1,069,331.12
Perry Township	$72,571,000	$192.46	$22,360.36	$178,321.67
Pine Township	$51,655,000	$129.04	$14,672.91	$120,684.89
Plumcreek Township	$219,089,000	$550.51	$65,546.38	$501,361.19
Rayburn Township	$225,689,000	$547.86	$64,596.73	$510,370.26
Redbank Township	$211,247,000	$502.63	$56,022.75	$473,767.03
Rural Valley Borough	$154,259,000	$360.43	$40,888.86	$338,740.03
South Bend Township	$116,754,000	$293.38	$34,933.77	$267,162.45
South Bethlehem Borough	$132,137,000	$314.40	$35,042.76	$296,345.76
South Buffalo Township	$454,112,000	$1,091.77	$127,374.19	$1,011,751.60
Sugarcreek Township	$190,498,000	$505.20	$58,695.68	$468,092.23
Valley Township	$88,371,000	$215.28	$25,649.80	$200,097.82
Washington Township	$111,171,000	$277.73	$31,578.79	$259,735.94
Wayne Township	$108,168,000	$257.38	$28,691.82	$242,594.96
West Franklin Township	$347,597,000	$797.12	$88,462.04	$750,079.21
West Kittanning Borough	$412,394,000	$931.04	$97,469.89	$883,698.64
Worthington Borough	$144,717,000	$331.87	$36,829.90	$312,284.67
Armstrong County (Total)	**$10,883,076,000**	**$25,843.50**	**$2,923,947.00**	**$24,157,709.90**

Source: HAZUS-MH v4.2

Table 4.3.3-10. Estimated Values of Residential and Commercial Buildings and Contents Damaged by the 500- and 2,500-Year MRP Earthquake Events

Municipality	Total Replacement Cost Value (Building and Contents)	Estimated Residential Damage		Estimated Commercial Damage	
		500-Year	2,500-Year	500-Year	2,500-Year
Apollo Borough	$251,670,000	$50,410	$382,376	$11,050	$106,302
Applewood Borough	$74,252,000	$9,476	$74,159	$5,942	$62,283
Atwood Borough	$10,050,000	$2,230	$17,432	$250	$2,519
Bethel Township	$128,949,000	$37,336	$275,394	$1,116	$10,492
Boggs Township	$76,331,000	$20,876	$159,328	$813	$8,154
Bradys Bend Township	$131,764,000	$38,100	$298,415	$1,499	$14,939
Burrell Township	$73,172,000	$21,186	$156,272	$633	$5,953
Cadogan Township	$65,238,000	$15,629	$116,934	$1,504	$14,997
Cowanshannock Township	$303,507,000	$67,334	$526,455	$7,545	$76,085
Dayton Borough	$84,832,000	$17,566	$138,184	$3,276	$33,874
East Franklin Township	$1,027,803,000	$131,174	$1,026,521	$82,256	$862,124

Municipality	Total Replacement Cost Value (Building and Contents)	Estimated Residential Damage		Estimated Commercial Damage	
		500-Year	2,500-Year	500-Year	2,500-Year
Elderton Borough	$75,474,000	$19,075	$137,277	$1,650	$16,209
Ford City Borough	$538,129,000	$96,967	$763,745	$22,134	$217,300
Ford Cliff Borough	$42,367,000	$10,264	$76,710	$974	$9,368
Freeport Borough	$314,661,000	$63,758	$490,783	$12,191	$116,740
Gilpin Township	$375,439,000	$103,547	$762,817	$3,125	$29,081
Hovey Township	$25,518,000	$7,379	$57,792	$290	$2,893
Kiskiminetas Township	$529,524,000	$131,585	$936,173	$14,663	$140,975
Kittanning Borough	$933,567,000	$133,485	$1,097,352	$67,889	$669,299
Kittanning Township	$224,824,000	$65,095	$480,152	$1,945	$18,292
Leechburg Borough	$490,357,000	$74,915	$576,537	$23,380	$230,267
Madison Township	$176,372,000	$41,063	$311,177	$3,129	$31,579
Mahoning Township	$155,073,000	$32,111	$252,601	$5,989	$61,921
Manor Township	$578,870,000	$140,234	$1,048,106	$13,303	$128,000
Manorville Borough	$40,861,000	$9,899	$73,983	$939	$9,035
North Apollo Borough	$163,435,000	$32,758	$248,425	$7,168	$68,964
North Buffalo Township	$364,294,000	$87,258	$652,842	$8,396	$83,739
Parker City	$83,797,000	$24,230	$189,781	$954	$9,501
Parks Township	$502,517,000	$95,711	$703,491	$11,600	$111,711
Perry Township	$72,571,000	$20,984	$164,357	$826	$8,228
Pine Township	$51,655,000	$12,032	$91,163	$912	$9,205
Plumcreek Township	$219,089,000	$55,363	$398,474	$4,791	$47,059
Rayburn Township	$225,689,000	$58,901	$451,357	$3,746	$37,310
Redbank Township	$211,247,000	$43,743	$344,104	$8,158	$84,351
Rural Valley Borough	$154,259,000	$34,223	$267,574	$3,835	$38,671
South Bend Township	$116,754,000	$29,503	$212,306	$2,559	$25,128
South Bethlehem Borough	$132,137,000	$27,361	$215,240	$5,103	$52,762
South Buffalo Township	$454,112,000	$108,793	$813,957	$10,467	$104,390
Sugarcreek Township	$190,498,000	$55,083	$431,434	$2,168	$21,599
Valley Township	$88,371,000	$24,169	$184,460	$941	$9,440
Washington Township	$111,171,000	$25,894	$196,200	$1,963	$19,811
Wayne Township	$108,168,000	$22,413	$176,300	$4,171	$43,126
West Franklin Township	$347,597,000	$56,638	$431,927	$7,540	$74,149
West Kittanning Borough	$412,394,000	$52,632	$411,880	$33,004	$345,917
Worthington Borough	$144,717,000	$23,580	$179,827	$3,139	$30,871
Armstrong County (Total)	**$10,883,076,000**	**$2,231,961**	**$17,001,774**	**$408,924**	**$4,104,614**

Source: HAZUS-MH v4.2.

HAZUS-MH v4.2 estimated approximately $2.9 million in building damage as a result of a 500-year earthquake event. This includes structural damage, non-structural damage, and loss of contents representing less than one (1) percent of total RCV of general building stock in Armstrong County. From a 2,500-year MRP earthquake event, HAZUS-MH estimates approximately $24.2 million in building damage, which is less than 1 percent of total general building stock RCV. Residential and commercial buildings account for greatest damage as a result of these earthquake events.

Impact on Critical Facilities

All critical facilities (essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities, and user-defined facilities) in Armstrong County are considered exposed and potentially vulnerable to the earthquake hazard. The Critical Facilities subsection in Section 2 of the County Profile includes a complete inventory of critical facilities in Armstrong County.

The HAZUS-MH v4.2 model was used to assign a probability of each damage state (described in Table 4.3.3-7) to every critical facility in the planning area, which was then averaged across the facility category. In addition, the model estimates the time to restore critical facilities to fully functional use. Results are presented as probability of being functional at specified time increments. For example, HAZUS may estimate that a facility has 5 percent chance of being fully functional at Day 3, and a 95-percent chance of being fully functional at Day 90. Results for the 500- and 2,500-year events are summarized in Table 4.3.3-11. For percent probability of sustaining damage, the minimum and maximum damage estimated value for that facility type is presented. During and following the 500-year MRP event, HAZUS-MH v4.2 estimates that utilities identified by Armstrong County as critical would be nearly 100 percent functional with negligible damage.

Table 4.3.3-11. Estimated Damage and Loss of Functionality for Critical Facilities and Utilities in Armstrong County for the 500- and 2,500-Year MRP Earthquake Events

Name	Percent Probability of Sustaining Damage					Percent Functionality			
	None	Slight	Moderate	Extensive	Complete	Day 1	Day 7	Day 30	Day 90
500-Year MRP									
Critical Facilities									
Medical	95	3	1	<1	0	95	99	100	100
Police	95-96	3	1	<1	0	95-96	99	100	100
Fire	95-96	3	1	<1	0	95-96	99	100	100
EOC	95-96	3	1	<1	0	95-96	99	100	100
School	95-96	3	1	<1	0	95-96	99	100	100
2,500-Year MRP									
Critical Facilities									
Medical	84	10	5	1	<1	84	94	99	99
Police	84	10	5	1	<1	84	94	99	99
Fire	83-84	10	5	1	<1	83-84	94	99	99
EOC	84	10	5	1	<1	84	94	99	99
School	84	10	5	1	<1	84	94	99	99
Utilities									
Potable Water	96-97	3	<1	0	0	98	100	100	100
Wastewater	90-97	3-10	<1	0	0	93-97	100	100	100
Oil	96-97	3	<1	0	0	98	100	100	100
Natural Gas	96-97	3	<1	0	0	98	100	100	100
Electric Power	96-97	3	<1	0	0	99	100	100	100
Communication	90-97	3-9	<1	0	0	100	100	100	100

EOC – Emergency operations center

Source: HAZUS-MH v4.2

Impact on Economy

Earthquakes also impact the economy, including loss of business function, damage to inventory (buildings, transportation and utility systems), relocation costs, wage loss, and rental loss due to repair and replacement of buildings. HAZUS-MH estimates building-related economic losses, including income losses (wage, rental, relocation, and capital-related losses) and capital stock losses (structural, non-structural, content, and inventory losses). Economic losses estimated by HAZUS-MH are summarized in Table 4.3.3-12 below; no economic losses were estimated for the 100-year MRP event.

Table 4.3.3-12. Building-Related Economic Losses from the 500 and 2,500-Year MRP Earthquake Event

Level of Severity	Mean Return Period	
	500-year	2,500-year
Income Losses		
Wages	$340,800	$2,101,200
Capital Related	$217,600	$1,366,600
Rental	$340,400	$1,996,100
Relocation	$633,300	$3,918,000
Subtotal	**$1,532,100**	**$9,381,900**
Capital Stock Losses		
Structural	$1,158,000	$6,865,600
Non-Structural	$2,024,700	$20,500,600
Content	$413,400	$7,599,300
Inventory	$7,200	$126,500
Subtotal	**$3,603,300**	**$35,092,000**

Source: HAZUS-MH v4.2.

Although the HAZUS-MH v4.2 analysis did not compute estimates of damage to roadway segments and railroad tracks, assumedly these features would undergo damage due to ground failure, resulting in interruptions of regional transportation and of distribution of materials. Losses to the community that would result from damage to lifelines could exceed costs of repair (FEMA 2012).

Earthquake events can significantly affect road bridges, many of which provide the only access to certain neighborhoods. Because softer soils generally follow floodplain boundaries, bridges that cross watercourses should be considered vulnerable. Another key factor in degree of vulnerability is age of facilities and infrastructure, which correlates with standards in place at times of construction of these. HAZUS-MH v4.2 estimated economic impacts on the County for 15 years after an earthquake event—in the category of transportation infrastructure, $5.6 million for repair of highway bridges damaged as a result of a 2,500-year event, less than $500,000 for that purpose as a result of a 500-year event, and no costs estimated for that as a result of a 100-year event.

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

HAZUS-MH v4.2 estimates greater than 2,000 tons of debris will be generated for the 500-year MRP event. Table 4.3.3-13 summarizes the estimated debris generated by the 500-year MRP and 2,500-year MRP earthquake events.

Table 4.3.3-13. Estimated Debris Generated by the 500-year and 2,500-Year MRP Earthquake Event

Municipality	500-Year		2,500-Year	
	Brick/Wood (tons)	Concrete/Steel (tons)	Brick/Wood (tons)	Concrete/Steel (tons)
Apollo Borough	61.6	12.0	285.2	80.98
Applewood Borough	13.2	3.2	62.9	23.19
Atwood Borough	2.5	0.5	12.2	3.24
Bethel Township	36.5	6.5	172.5	43.26
Boggs Township	19.5	3.3	94.2	22.75
Bradys Bend Township	34.0	6.3	165.5	44.17
Burrell Township	20.7	3.7	97.9	24.55
Cadogan Township	15.0	2.7	70.6	18.95
Cowanshannock Township	75.7	13.8	368.9	97.87
Dayton Borough	19.6	3.7	96.5	26.50
East Franklin Township	182.1	44.5	870.3	321.03
Elderton Borough	19.7	3.7	93.8	24.58
Ford City Borough	123.6	25.9	582.6	180.06
Ford Cliff Borough	10.7	2.0	50.5	13.42
Freeport Borough	71.1	15.0	330.3	98.63
Gilpin Township	90.2	14.8	419.1	98.06
Hovey Township	6.6	1.2	32.1	8.55
Kiskiminetas Township	139.7	25.9	650.8	172.01
Kittanning Borough	179.2	44.8	855.6	320.90
Kittanning Township	63.6	11.3	300.8	75.42
Leechburg Borough	94.3	20.7	437.9	142.31
Madison Township	44.6	8.4	217.5	59.61
Mahoning Township	35.9	6.8	176.5	48.45
Manor Township	145.6	27.0	689.7	183.39
Manorville Borough	10.3	1.9	48.7	12.94
North Apollo Borough	40.0	7.8	185.3	52.59
North Buffalo Township	83.7	15.4	394.0	105.81
Parker City	21.6	4.0	105.3	28.09
Parks Township	106.7	21.8	496.5	148.24
Perry Township	18.7	3.4	91.2	24.33
Pine Township	13.1	2.5	63.7	17.46
Plumcreek Township	57.3	10.6	272.4	71.35
Rayburn Township	56.2	9.8	271.7	68.25
Redbank Township	48.9	9.2	240.4	66.00
Rural Valley Borough	38.5	7.0	187.5	49.74
South Bend Township	30.5	5.7	145.1	38.02

Municipality	500-Year		2,500-Year	
	Brick/Wood (tons)	Concrete/Steel (tons)	Brick/Wood (tons)	Concrete/Steel (tons)
South Bethlehem Borough	30.6	5.8	150.4	41.28
South Buffalo Township	104.3	19.1	491.2	131.88
Sugarcreek Township	49.1	9.0	239.3	63.86
Valley Township	22.5	3.8	109.1	26.34
Washington Township	28.1	5.3	137.1	37.58
Wayne Township	25.0	4.7	123.1	33.79
West Franklin Township	68.7	16.3	327.2	115.68
West Kittanning Borough	73.1	17.8	349.2	128.81
Worthington Borough	28.6	6.8	136.2	48.16
Armstrong County (Total)	**2,460.3**	**495.1**	**11,698.5**	**3,442.08**

Source: HAZUS-MH v4.2

Impact on the Environment

Earthquakes can lead to numerous, widespread, and devastating environmental impacts. These impacts may include but are not limited to:

- Induced flooding or landslides
- Poor water quality
- Damage to vegetation
- Breakage in sewers or toxic material containments

Secondary impacts can include train derailments, roadway damage, spillage of hazardous materials, and utility interruption.

Future Growth and Development

As discussed in Section 2.4 of this HMP, areas targeted for future growth and development have been identified across Armstrong County. It is anticipated that the human exposure and vulnerability to earthquake impacts in newly developed areas will be similar to those that currently exist within the County. Current building codes require seismic provisions that should render new construction less vulnerable to seismic impacts than older, existing construction that may have been built using lower construction standards.

Effect of Climate Change on Vulnerability

The impacts of global climate change on earthquake probability are unknown. Some scientists say that melting glaciers could induce tectonic activity. As ice melts and water runs off, tremendous amounts of weight are shifted on the earth's crust. As newly freed crust returns to its original, pre-glacier shape, it could cause seismic plates to slip and stimulate volcanic activity according to research into prehistoric earthquakes and volcanic activity. National Aeronautics and Space Administration (NASA) and USGS scientists found that retreating glaciers in southern Alaska might be opening the way for future earthquakes (NASA 2004).

Secondary impacts of earthquakes could also be magnified by climate change. Soils saturated by repetitive storms could experience liquefaction during seismic activity as a result of the increased saturation. Dams storing increased volumes of water, as a result of changes in the hydrograph, could fail during seismic events. Currently, no models are available to estimate these impacts.

Additional Data and Next Steps

Ground shaking is the primary cause of earthquake damage to manmade structures, and soft soils amplify ground shaking. One contributor to the site amplification is the velocity the rock or soil transmits, shear waves (S-waves). The National Earthquake Hazards Reduction Program (NEHRP) developed five soil classifications defined by their shear-wave velocity that alter the severity of an earthquake. The soil classification system ranges from A to E, where A represents hard rock that reduces ground motions from an earthquake and E represents soft soils that amplify and magnify ground shaking and increase building damage and losses. When this soil information becomes available, it may be incorporated into HAZUS-MH to further refine the County's vulnerability assessment.

Additional data to further refine the County's vulnerability assessment include (1) updated demographic data to replace the default data in HAZUS-MH; and (2) updated building data to update the replace data in HAZUS-MH. The County can identify non-reinforced masonry critical facilities and privately-owned buildings (residences) using local knowledge and pictometry and orthophotos. These buildings may not withstand earthquakes of certain magnitudes and plans to provide emergency response/recovery efforts for these properties can be proactively set in place. Further mitigation actions include training of County and municipal personnel to provide post-hazard-event rapid visual damage assessments, increasing County and local debris management and logistic capabilities, and revising regulations to prevent additional construction of non-reinforced masonry buildings.

4.3.4 Environmental Hazard

This section provides a profile and vulnerability assessment of the environmental hazard profile for Armstrong County. Hazards in this profile include releases of hazardous materials either at fixed sites or in transit.

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 (PEMA 2018).

Product release into the local environment can be generated from a fixed facility or at any location along a route of travel and may be the result of carelessness, technical failure, external incidents, or an intentional act against the facility or container. Volatility of products stored or transported, along with potential impact on a local community, may increase the risk of intentional acts against a facility or transport vehicle. Release of certain products considered hazardous materials can immediately and adversely impact the general population, ranging from inconvenience of evacuations to personal injury and even death. Moreover, any release can compromise the local environment through contamination of soil, groundwater, or local flora and fauna.

4.3.4.1 Location and Extent

Facilities that use, manufacture, or store hazardous materials in Pennsylvania must comply with both Title III of the Federal Superfund Amendments and Reauthorization Act (SARA), also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Commonwealth's reporting requirements under the Hazardous Materials Emergency Planning and Response Act (1990-165), as amended. The community right-to-know reporting requirements keep communities abreast of the presence and release of chemicals at individual facilities. EPCRA was designed to ensure that state and local communities are prepared to respond to potential chemical accidents through Local Emergency Planning Committees (LEPCs). LEPCs are charged with developing emergency response plans for SARA Title III facilities; these plans cover the location and extent of hazardous materials; establish evacuation plans, response procedures, and methods to reduce the magnitude of a materials release; and establish methods and schedules for training and exercises.

In addition to SARA Title III facilities, facilities that use toxic chemicals are also a concern to Armstrong County. These facilities are known as Toxic Release Inventory (TRI) sites and are included on the TRI because they use at least one of the 650 toxic chemicals that the U.S. Environmental Protection Agency (EPA) identified as a threat to human health and the environment. TRI sites are required to report on releases of toxic chemicals into the air, water, and land. In addition, they need to report off-site transfers or disposal at a separate facility. A list of TRI facilities and other facilities that store, use, and produce toxic chemicals and waste can be found on the EPA website: https://www3.epa.gov/enviro/.

There are 327 EPA-regulated facilities located throughout Armstrong County. Several of these facilities are located in close proximity to population centers that could be affected should a major accident or spill occur (EPA 2018). Figure 4.3.4-1 shows the location of these facilities. In addition to the EPA-regulated facilities, there are several gas transmission lines (Columbia Gas Transmission, EQT Midstream, Dominion Energy Transmission, and Peoples Natural Gas Company) that cross Armstrong County and pose a threat of hazardous material release (PHMSA 2018). Figure 4.3.4-2 illustrates the location of gas transmission lines in Armstrong County.

Figure 4.3.4-1. Armstrong County Hazardous Materials Facilities

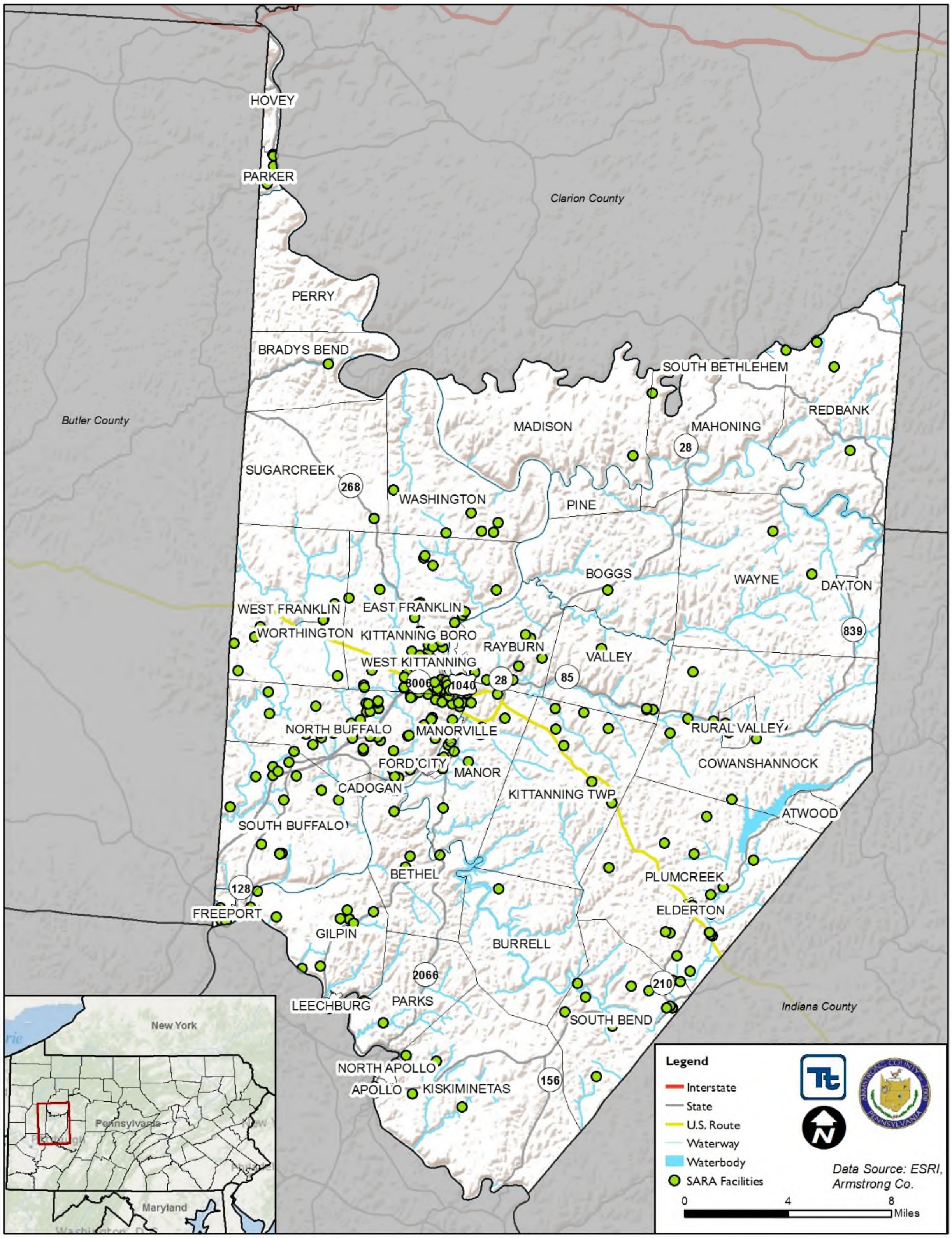
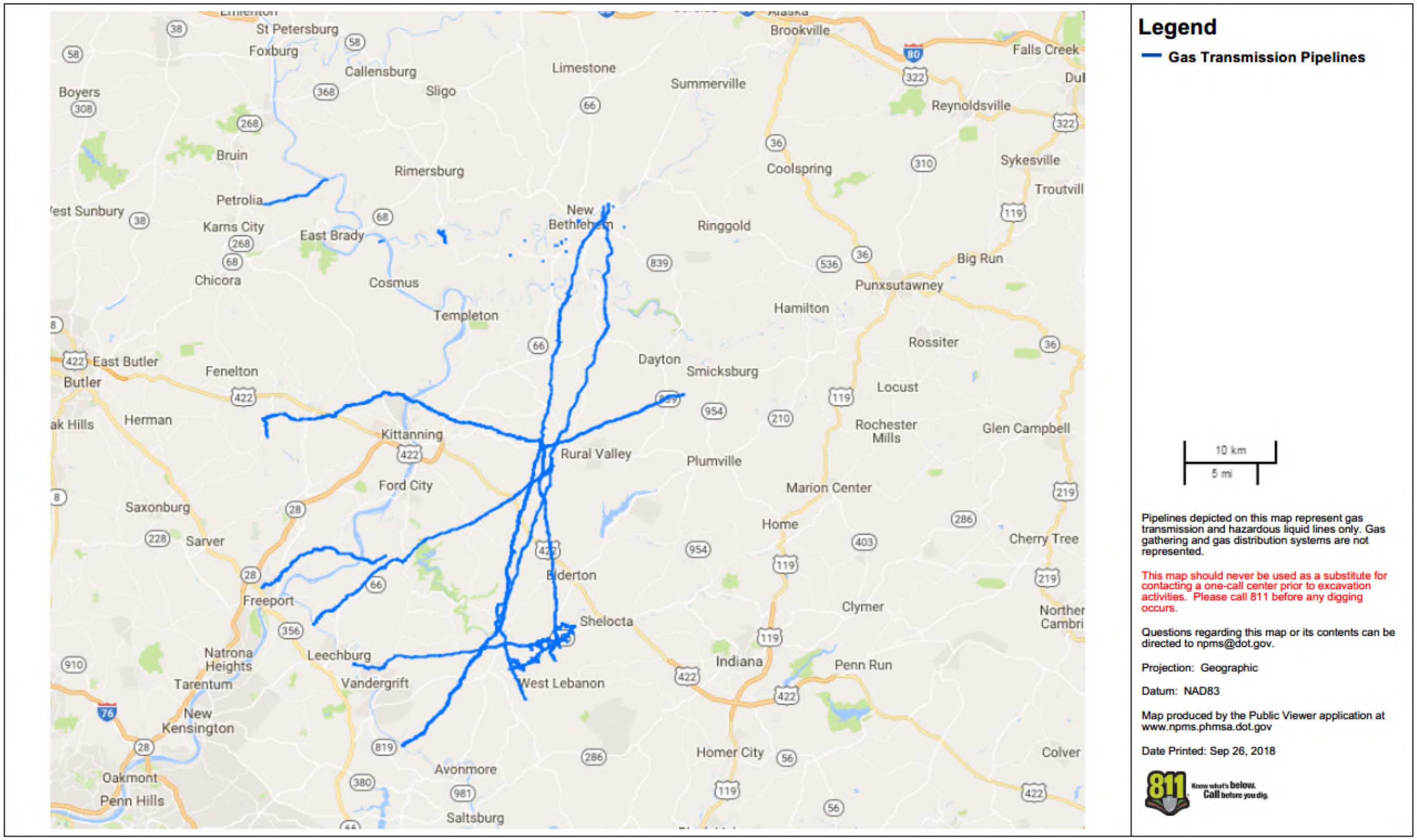


Figure 4.3.4-2. Gas Transmission Pipelines in Armstrong County



Source: PHSMA 2018

The U.S. Department of Transportation (DOT) categorizes hazardous materials into the following nine classes based on chemical characteristics producing the risk:

- Class 1: Explosives
- Class 2: Gases
- Class 3: Flammable liquids
- Class 4: Flammable solids
- Class 5: Oxidizers and organic pesticides
- Class 6: Poisons and etiologic materials
- Class 7: Radioactive materials
- Class 8: Corrosives
- Class 9: Miscellaneous

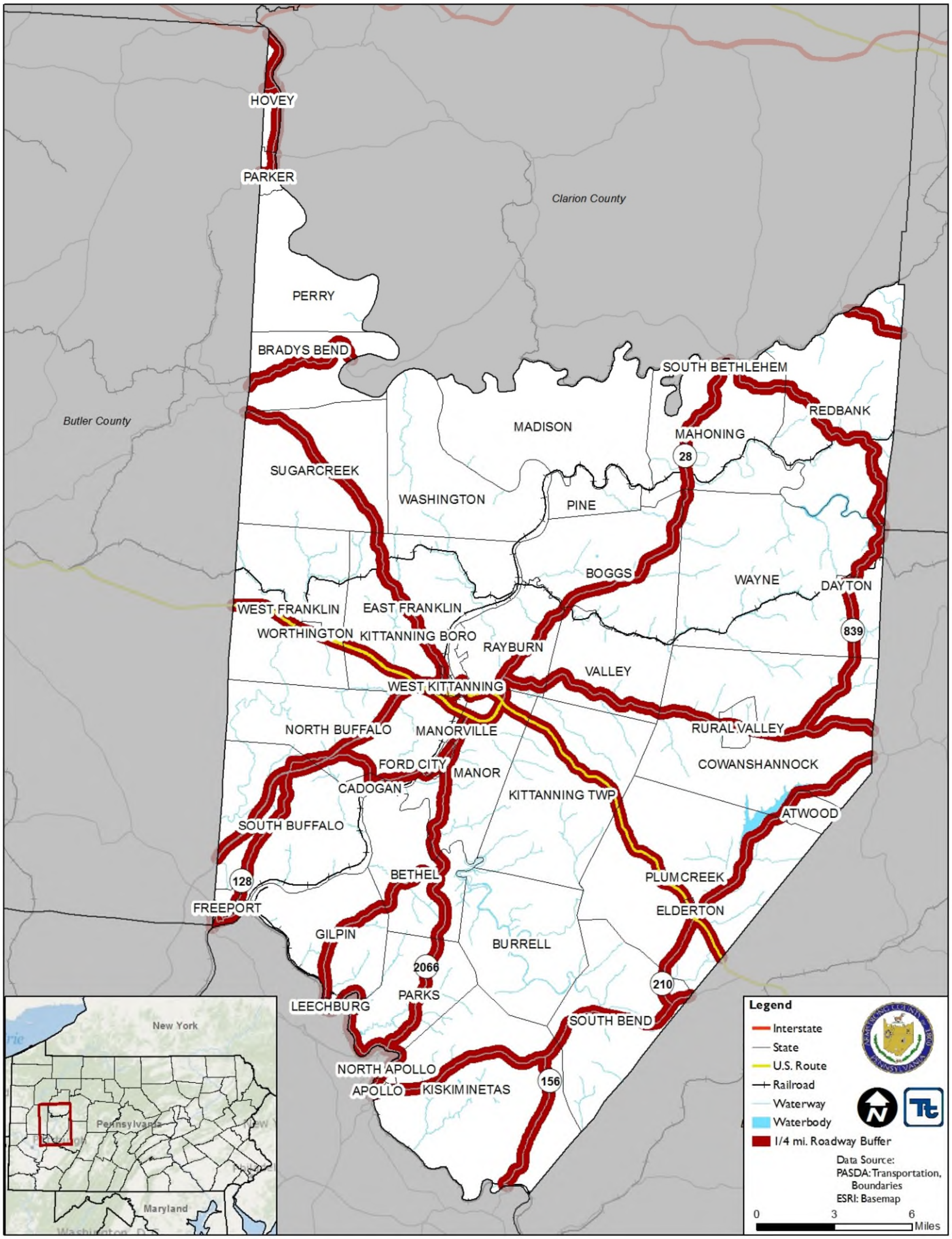
Armstrong County is home to 1,628.8 miles of roadways, including 42 miles of U.S. highways, 192.1 miles of state highways, and over 1,300 miles of local roads. With nearly 1,700 miles of roadways linking more-populated areas with rural communities, the grid work of roadways facilitates free movement of hazardous materials throughout the region. In addition, 89.2 miles of railway traverse the county. The County's mountainous terrain increases its vulnerability to hazardous materials accidents.

While permitted, identified hazardous substance travel routes are not maintained by the County or regional planning entities. The primary roadways in Armstrong County are listed as follows (and shown in red on Figure 4.3.4-3):

- U.S. Route 422
- Pennsylvania Route 12
- Pennsylvania Route 28
- Pennsylvania Route 56
- Pennsylvania Route 58
- Pennsylvania Route 66
- Pennsylvania Route 68
- Pennsylvania Route 85
- Pennsylvania Route 156
- Pennsylvania Route 210
- Pennsylvania Route 268
- Pennsylvania Route 356
- Pennsylvania Route 368
- Pennsylvania Route 536
- Pennsylvania Route 839

Based on past occurrences, hazardous material releases within Armstrong County have been accidental and have not been considered terrorist or criminal acts. While past occurrences have not been deemed intentional, an intentional release of any of these products in large quantity would pose a threat to the local population, economy, and environment, resulting in lost revenue, injuries, and deaths.

Figure 4.3.4-3. Major Roadways Used to Transport Hazardous Materials in Armstrong County



Source: Pennsylvania Spatial Data Access (PASDA)

4.3.4.2 Range of Magnitude

Environmental hazard incidents within Armstrong County could range from minor petroleum spills to large, facility-based incidents that could lead to loss of life and damage to property, environment, and economy. Additionally, the range of explosion-related incidents within the County could vary from a small incident that affects a residential structure or smaller commercial building to a catastrophic failure leading to loss of life, significant property damage, and negative impacts on the economy. Severity of an incident varies with type of material released, and distance and related response time for emergency response teams. Areas within closest proximity to the releases are generally at greatest risk, yet depending on the agent, a release can travel great distances or persist over a long time (e.g., nuclear radiation), resulting in far-reaching effects on people and the environment.

A hazardous materials release, whether accidental or intentional, can be exacerbated or mitigated by specific circumstances surrounding the event. Exacerbating conditions are characteristics that can enhance or magnify effects of a hazard. Mitigating conditions, on the other hand, are characteristics of the target and its physical environment that can reduce effects of a hazard. These conditions include:

- Weather conditions – affect how the hazard develops.
- Micro-meteorological effects of buildings and terrain – alter dispersion of materials.
- Shielding in the form of sheltering-in-place – protects people and property from harmful effects.
- Non-compliance with applicable codes (e.g., fire and building codes) and maintenance failures (e.g., fire protection and containment features) – can substantially increase damage to a facility and to surrounding buildings.
- Geographic location of hazardous materials site – if occurring within a Special Flood Hazard Area (SFHA), there could be larger-scale water contamination during a flood incident, should the flood compromise the production or storage of hazardous materials. This type of situation could move toxic chemicals throughout a water supply quickly and across great distances.

The severity of a given incident is dependent not only on the circumstances described above, but also on the type of materials 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.

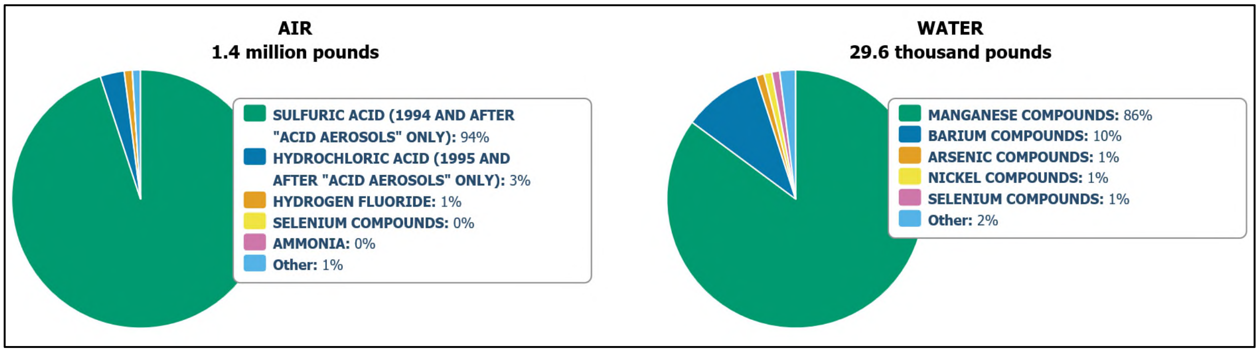
The worst-case scenario would be a large, uncontrolled release of a toxic gas within a major urban area. In Armstrong County, this could take the form of an accident and major rupture of a tanker hauling a toxic gas in or near the Borough of Kittanning. While little physical property damage is likely from this type of event, potential for injury and death to residents and visitors up to 0.25 mile from the scene is significant. This event would likely overwhelm the medical care capacity within the County and possibly the region. The population vulnerable to such a release includes the 4,044 people in the Borough of Kittanning alone. In addition, an event such as this would likely close County offices, causing a major disruption to government operations. The most likely scenario would be a transportation accident resulting in a rupture of a truck's fuel tank, spilling a small quantity of diesel fuel onto the roadway.

4.3.4.3 Past Occurrence

With some exceptions, the majority of hazardous material release incidents over the years has involved petroleum product spills along the highways or has involved the railroad. Most of these are the result of collisions or derailments and have a limited impact on people and the environment. The number and quantity of hazardous materials being produced, stored, and transported continue to increase each year in Pennsylvania. Reporting requirements from the State changed in 2007, allowing State agencies to categorize incidents as something other than "Hazardous Materials." For instance, a vehicle collision resulting in a spill of petroleum products (e.g., gasoline, motor oil) may be reported as a vehicle accident instead of a hazardous materials release. In the case of an explosion, the explosive event may not be the primary incident. Rather, the incident may be based on events that led up to an explosion.

According to the U.S. Department of Transportation (USDOT) Pipeline and Hazardous Materials Safety Administration (PHMSA), which provides an incident report database for information on incidents throughout the United States, there have been 17 incidents (all highway) between 1990 and 2018 (PHMSA 2018). In 2016, Armstrong County reported to the EPA a total of 2.4 million pounds of on-site and off-site disposals or other chemical releases. Sulfuric acid was the leading chemical released to air (1,316,000 pounds, 94% of air releases) and manganese compounds were the leading chemical released to water (25,456 pounds, 86% of water releases) (EPA 2016).

Figure 4.3.4-4. Top Five Chemicals Released to Air and Water, Armstrong County, PA, 2016



Source: EPA 2016

Table 4.3.4-1 provides a description of hazardous material events that occurred in Armstrong County from 1990 to 2018. Nearly all of these incidents occurred during transit.

Table 4.3.4-1. Previous Hazardous Materials Incidents in Armstrong County

Date	Location	Material Involved	Type of Incident/Details
January 17, 1990	Madison Township	Hydrochloric Acid Solution	Waste hydrochloric acid was being transported from Ohio to Yukon, PA. The driver noticed a dark stream near the top/rear of the tank truck and pulled off I-70 at the Madison, PA exit. The driver discovered a cracked rupture disk at the top/rear of the vehicle and a small amount of acid had been released through the crack. The driver called emergency personnel. The rupture disk was replaced, and the truck was cleaned. Approximately one pint of acid was released onto the ground; 1.5 cubic feet of dirt was removed from the scene. There were no injuries or fatalities associated with this incident.
March 26, 1990	Manor Township	Potassium Hydroxide Solution	A driver hit an overhead wire that caused a spark and the trailer caught on fire and burned. The trailer contained Potassium Hydroxide Solution. Total damages were estimated at $36,000. There were no injuries or fatalities associated with this incident.

Date	Location	Material Involved	Type of Incident/Details
October 31, 1994	Sugarcreek Township	Fuel Oil No. 1, 2, 4, 5 or 6	A driver discovered fuel coming out of a gravity pipe on his truck. Driver notified dispatch and received instructions per hazardous regulations. Emergency response was contacted and a cleanup crew was sent to the scene. Approximately $4,588 in damages. There were no injuries or fatalities associated with this incident.
October 21, 1999	Madison Township	Corrosive Liquids Toxic Not Otherwise Specified (N.O.S.)	A trailer was found leaking in route. A certified hazardous materials response team was called to the scene to recover spillage and recoup pail. The recovered pail was returned in a dot approved salvage drum to the shipper for claims credit. Approximately $1,805 in damages. There were no injuries or fatalities associated with this incident.
September 6, 2000	Madison Township	Paint Related Material Including Paint Thinning Drying Removing or Reducing Compound	While at a truck stop in Madison, PA, a drive noticed free product leaking from the rear of his trailer. HAZMAT One was contacted to perform the cleanup. There was one damaged 55-gallon steel drum in the nose of the trailer. Approximately 28 gallons of free product was released. Approximately $2,280 in damages. There were no injuries or fatalities associated with this incident.
August 1, 2005	Bethel Township	Resin Solution Flammable	A driver noticed a leak from the trailer; a contractor was called to handle the spill. There were no injuries or fatalities associated with this incident.
January 13, 2009	Boggs Township	Polymeric Beads	A truck was headed eastbound on I-80 in Boggs Township when the brakes overheated and caught fire. The truck was carrying 40,000 pounds of polymeric beads which were very flammable.
April 3, 2009	Wayne Township	organic Peroxide Type E Liquid	Freight was double stacked, crushing hazardous materials located at the bottom of the stack. This caused a spill. Approximately $3,000 in damages. There were no injuries or fatalities associated with this incident.
June 28, 2011	Rayburn Township	Diesel Fuel	A truck involved in an accident on Route 66 in Rayburn Township leaked diesel fuel and forced one lane of the highway to close.
July 29, 2011	Burrell Township	Brine	A fracking truck carrying brine overturned at the intersection of Routes 119 and 22 in Burrell Township.
April 21, 2014	Washington Township	Fuel Oil (No. 1, 2, 4, 5 or 6)	Details of this incident were not identified; however, total damages reported were over $163,000. There were no injuries or fatalities associated with this incident.
August 11, 2014	Manor Township	Diesel Fuel	An overturned truck in Manor Township led to a diesel fuel spill on the roadway. Manor and Ford Cliff fire departments performed the cleanup as crews used pulleys to pull the truck upright.
May 12, 2015	Kittanning Township	Fuel and Milk	Diesel fuel and ruptured cartons of milk coated Route 422 after a tractor trailer hit a garbage truck near Pine Tree Road in Kittanning Township.
October 5, 2016	Washington Township	Hydrochloric Acid	A leaking package was discovered in a trailer at the UPS facility. The package had strong odor. Production was stopped in the trailer until package could be removed outside away from employees. There were no injuries or fatalities associated with this incident.
March 18, 2018	Spring Church	Natural Gas	Natural gas release due to equipment failure via pipeline owned by Dominion Energy Transmission.

Sources: PHSMA 2018; NPMS 2018; North American Hazmat Situations and Deployments Map 2018

4.3.4.4 Future Occurrence

While hazardous materials incidents have occurred in the past, they are generally considered difficult to predict; however, the continuing trend of accidents involving hazardous materials in Armstrong County is expected to remain constant. Smaller incidents such as fuel spills will continue to occur multiple times a year, most likely along major roadways or during refilling of home heating oil tanks. Although the County does not anticipate severe releases on any regular basis, possibility of this should not be discounted. Based on Risk Factor Methodology Probability Criteria (further defined in Section 4.4), the likelihood of future environmental hazard incidents occurring within Armstrong County remains at *likely*.

4.3.4.5 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed or vulnerable within the identified hazard area. To assess effects of and risk from environmental hazards, locations of SARA Title III facilities and major transportation networks are examined. The following sections evaluate and estimate potential impacts in Armstrong County, presenting specifically:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on (1) life, health, and safety; (2) general building stock, critical facilities, and the economy; and (3) future growth and development

Overview of Vulnerability

Facilities that produce, use, or ship hazardous materials within the Commonwealth of Pennsylvania are required to comply with regulations set forth within the federal SARA and the EPCRA, and the Commonwealth of Pennsylvania reporting requirements under the Hazardous Materials Emergency Planning and Response Act (Act 165). The County has 288 SARA Title III facilities.

As stated above, the major roadways in the County include one U.S. route and 14 state routes (listed in the Location and Extent section above). Accidents on these roadways or railways can result in hazardous materials spills that can contaminate and impact surrounding populations and environment.

Data and Methodology

To determine potential impact on the County, a 0.25-mile buffer was placed around the identified major roadways and rail lines, and the designated vulnerability radius of each SARA Title III planning facility was used to define the hazard area. Populations and features of the built environment within these areas may be directly or indirectly affected by a potential environmental hazard. The hazard area was overlaid upon the 2010 U.S. Census population data in Geographic Information System (GIS) (U.S. Census 2010). Census blocks do not coincide with these boundaries; blocks with centroids in the hazard area were determined to be affected.

The vulnerability radius for each hazard facility is determined by the County Local Emergency Planning Committee, and each radius is shown in Appendix I.

Impact on Life, Health, and Safety

Environmental hazards exert the greatest impact on the residential population in Armstrong County (Table 4.3.4-2 below). Several incidents reported in the County are related to petroleum spills, which may have resulted from motor vehicle incidents.

Table 4.3.4-2. Estimated Armstrong County Population Vulnerable to Environmental Hazards

Municipality	Total Population	Population within ¼ mile of railroads	% Population	Population within ¼ mile of major roadways	% Population	Population within vulnerability radii of SARA Facility	% Population
Apollo Borough	1,647	0	0.0%	1,577	95.7%	209	12.7%
Applewold Borough	310	310	100.0%	310	100.0%	0	0.0%
Atwood Borough	107	0	0.0%	3	2.8%	0	0.0%
Bethel Township	1,183	0	0.0%	398	33.6%	0	0.0%
Boggs Township	941	38	4.0%	196	20.8%	0	0.0%
Bradys Bend Township	783	23	2.9%	177	22.6%	0	0.0%
Burrell Township	684	0	0.0%	0	0.0%	0	0.0%
Cadogan Township	344	245	71.2%	316	91.9%	0	0.0%
Cowanshannock Township	2,893	0	0.0%	811	28.0%	0	0.0%
Dayton Borough	559	353	63.1%	489	87.5%	0	0.0%
East Franklin Township	4,089	779	19.1%	1,561	38.2%	293	7.2%
Elderton Borough	355	0	0.0%	355	100.0%	272	76.6%
Ford City Borough	3,035	0	0.0%	3,035	100.0%	2,370	78.1%
Ford Cliff Borough	371	0	0.0%	229	61.7%	**0**	0.0%
Freeport Borough	1,813	1,282	70.7%	1,684	92.9%	**0**	0.0%
Gilpin Township	2,500	260	10.4%	566	22.6%	55	2.2%
Hovey Township	97	0	0.0%	89	91.8%	0	0.0%
Kiskiminetas Township	4,776	4	0.1%	1,120	23.5%	0	0.0%
Kittanning Borough	4,044	222	5.5%	951	23.5%	2,072	51.2%
Kittanning Township	2,265	0	0.0%	612	27.0%	0	0.0%
Leechburg Borough	2,152	279	13.0%	1,891	87.9%	0	0.0%
Madison Township	824	7	0.8%	0	0.0%	0	0.0%
Mahoning Township	1,420	63	4.4%	227	16.0%	0	0.0%
Manor Township	4,183	10	0.2%	2,188	52.3%	1,121	26.8%
Manorville Borough	410	0	0.0%	410	100.0%	410	100.0%
North Apollo Borough	1302	0	0.0%	973	74.7%	0	0.0%
North Buffalo Township	3,015	154	5.1%	537	17.8%	76	2.5%
Parker City	840	0	0.0%	580	69.0%	0	0.0%
Parks Township	2,749	0	0.0%	1,257	45.7%	108	3.9%
Perry Township	352	0	0.0%	0	0.0%	0	0.0%
Pine Township	413	120	29.1%	0	0.0%	0	0.0%
Plumcreek Township	2,382	0	0.0%	493	20.7%	470	19.7%
Rayburn Township	1907	50	2.6%	748	39.2%	454	23.8%
Redbank Township	1063	47	4.4%	85	8.0%	0	0.0%
Rural Valley Borough	876	0	0.0%	566	64.6%	0	0.0%

Municipality	Total Population	Population within ¼ mile of railroads	% Population	Population within ¼ mile of major roadways	% Population	Population within vulnerability radii of SARA Facility	% Population
South Bend Township	1,186	0	0.0%	165	13.9%	17	1.4%
South Bethlehem Borough	481	0	0.0%	481	100.0%	0	0.0%
South Buffalo Township	2,636	103	3.9%	857	32.5%	0	0.0%
Sugarcreek Township	1,529	0	0.0%	165	10.8%	0	0.0%
Valley Township	648	8	1.2%	92	14.2%	0	0.0%
Washington Township	923	5	0.5%	0	0.0%	0	0.0%
Wayne Township	1,198	73	6.1%	147	12.3%	0	0.0%
West Franklin Township	1,849	63	3.4%	233	12.6%	344	18.6%
West Kittanning Borough	1,168	702	60.1%	1,168	100.0%	0	0.0%
Worthington Borough	639	0	0.0%	460	72.0%	99	15.5%
Armstrong County (Total)	**68,941**	**5,200**	**7.5%**	**28,202**	**40.9%**	**8,370**	**12.1%**

Sources: U.S. Census 2010, Armstrong County 2018.

Notes:
% Percent
SARA Superfund Amendments and Reauthorization Act

Impact on General Building Stock, Critical Facilities, and Economy

While buildings and critical facilities may be present within the hazard area, estimating direct damage to these structures and facilities would be difficult. However, damages to the surrounding environment can result in indirect impacts, such as temporary loss of function due to hazard response or damage in the area. As for the population, an assessment occurred of exposure of critical facilities within the 0.25-mile buffer surrounding major roadways and railroads, and within specified vulnerability radii of SARA facilities (Table 4.3.4-3 below).

Economic loss from environmental hazards and explosion incidents ranges from non-recordable to losses exceeding millions of dollars. Impact on the local economy from a single incident is almost impossible to measure because of complexities of predicting losses of work, revenue, and future business.

Table 4.3.4-3. Critical Facilities Vulnerable to Environmental Hazards

Municipality	Armory	Bus	Bus Facility	Child Care	Communication Facility	Community Services	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
	Facility Types																											
Apollo (B)	0	0	0	2	1	0	0	1	0	0	0	2	1	0	1	0	0	0	0	1	0	1	0	0	0	1	0	0
Applewold (B)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atwood (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bethel (T)	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	2	0	0
Boggs (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	0	0
Bradys Bend (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0
Burrell (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cadogan (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Cowanshannock (T)	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	1	3	3	0	0	2	0	0
Dayton (B)	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	0	1	0
East Franklin (T)	0	0	1	1	0	0	0	1	1	0	0	1	1	3	0	3	1	24	1	0	2	1	0	1	0	36	1	0
Elderton (B)	0	0	1	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	1	1	1	0	0	0	1	1	0
Ford City (B)	0	0	0	4	0	0	0	1	0	1	0	1	2	0	1	0	1	0	0	1	0	4	0	1	0	4	2	0
Ford Cliff (B)	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Freeport (B)	0	0	0	1	0	0	0	1	0	1	0	1	0	0	1	0	1	0	0	1	0	2	0	1	0	4	0	1
Gilpin (T)	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	1	3	0	1	1	1	1	1	0	8	0	0
Hovey (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Kiskiminetas (T)	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	1	0	2	1	0	0	2	3	0
Kittanning (B)	0	0	1	2	1	0	0	1	0	1	0	1	3	1	1	2	1	0	1	5	1	3	1	0	1	3	0	0

Municipality	Armory	Bus	Bus Facility	Child Care	Communication Facility	Community Services	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
	Facility Types																											
Kittanning (T)	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	1	1	0	0	1	0	0	0	3	0	0
Leechburg (B)	0	0	0	1	1	0	0	2	0	1	0	2	0	0	1	0	1	0	0	1	0	2	1	0	0	1	3	0
Madison (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mahoning (T)	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	1	0	0	1	0	0	0	0	0	0
Manor (T)	1	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	1	1	0	1	1	2	1	0	0	5	3	1
Manorville (B)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0
North Apollo (B)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
North Apollo (T)	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
North Buffalo (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	20	0	1	0	1	0	0	0	23	0	1
Parker (C)	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	2	1	1	0	4	0	1
Parks (T)	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	0	2	0	1	0	2	0	0
Perry (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pine (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
Plumcreek (T)	0	0	0	0	0	0	3	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	8	0	0
Rayburn (T)	0	0	1	1	0	1	0	1	0	0	3	2	0	0	0	1	1	1	0	0	1	1	0	2	1	5	0	0
Redbank (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rural Valley (B)	0	0	0	2	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	1	1	1	0	1	1	0
South Bend (T)	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	5	0	0
South Bethlehem (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
South Buffalo (T)	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	1	1	3	0	1	0	2	0	0	0	6	2	0

Municipality	Facility Types																											
	Armory	Bus	Bus Facility	Child Care	Communication Facility	Community Services	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
Sugarcreek (T)	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	1	0	0	0	0	1	0	0	0	1	1	0
Valley (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	3	0	0
Washington (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wayne (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
West Franklin (T)	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	2	0	6	0	0
West Kittanning (B)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0
West Kittanning (T)	0	0	0	4	0	0	0	0	0	0	0	1	1	0	0	0	0	4	0	1	0	0	0	1	0	5	1	0
Worthington (B)	0	0	0	1	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	1	1	1	1	0	0	0	1	0
Armstrong County	**1**	**1**	**4**	**24**	**6**	**1**	**3**	**27**	**5**	**6**	**6**	**26**	**12**	**5**	**6**	**7**	**29**	**68**	**4**	**18**	**10**	**49**	**13**	**14**	**2**	**143**	**20**	**4**

Source: Armstrong County Planning 2018

Impact on the Environment

As discussed above, environmental hazards and explosion incidents can profoundly affect the surrounding environment. Contamination of soil, surface water, and groundwater can result in many direct impacts on surrounding populations and ecosystems. Local flora and fauna within hazard areas are also at risk.

Future Growth and Development

As discussed in Section 4.4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be impacted by environmental hazards if within identified hazard areas. The County intends to discourage development within vulnerable areas and to work with municipalities to enforce the prohibition of the storage of certain hazardous materials in the floodplain.

4.3.5 Flood, Flash Flood, Ice Jam

This section provides a profile and vulnerability assessment of the flood hazard for the Armstrong County Hazard Mitigation Plan (HMP).

Floods are one of the most common natural hazards in the United States and are the most prevalent type of natural disaster occurring in Pennsylvania. Over 94 percent of the State's municipalities have been designated as flood-prone areas. Both seasonal and flash floods have been causes of millions of dollars in annual property damages, loss of lives, and disruption of economic activities (Pennsylvania Emergency Management Agency [PEMA] 2013).

The Federal Emergency Management Agency's (FEMA) definition of flooding is "a general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two or more properties from the overflow of inland or tidal waters or the rapid accumulation of runoff of surface waters from any source" (FloodSmart.gov 2015).

Most floods fall into three categories: riverine, coastal, and shallow (FEMA 2015). Other types of floods may include ice-jam floods, flash floods, stormwater floods, alluvial fan floods, dam failure floods, and floods associated with local drainage or high groundwater (as indicated in the previous flood definition). For the purpose of this Plan and as deemed appropriate by the Steering Committee, riverine, flash, and ice-jam are the main flood types of concern for Armstrong County. These types of floods are further discussed below. Dam failures are discussed in Section 4.3.1.

Riverine Floods

Riverine floods are the most common flood type and occur along a channel. Channels are defined features on the ground that carry water through and out of a watershed. They may be called rivers, creeks, streams, or ditches. When a channel receives too much water, the excess water flows over its banks and inundates low-lying areas. These floods usually occur after heavy rains, heavy thunderstorms, or snowmelt, and can be slow or fast-rising, and generally develop over a period of hours to days (FEMA 2015; Illinois Association for Floodplain and Stormwater Management 2006).

Flash Floods

According to the National Weather Service (NWS), flash floods are a rapid and extreme flow of high water into a normally dry area, or a rapid water level rise in a stream or creek above a predetermined flood level, beginning within 6 hours of the causative event (e.g., intense rainfall, dam failure, or ice jam) (NWS 2015).

Flash floods can occur very quickly and with very little warning. This type of flood can be deadly because it produces rapid rises in water levels and has devastating flow velocities. Urban areas are more susceptible to flash floods because a high percentage of the surface area is impervious (PEMA 2013). Time elapsed before flash flooding occurs may vary in different parts of the country. Ongoing flooding can intensify to flash flooding where intense rainfall results in a rapid surge of rising flood waters (NWS 2015). A flash flood can have a dangerous wall of roaring water that carries rocks, mud, and other debris, and can sweep away most things in its path. Flash floods usually result from intense storms dropping large amounts of rain within a brief period with little or no warning, and can reach their peak within only a few minutes. They normally occur in the summer during the thunderstorm season. The most severe flooding conditions usually occur when direct rainfall is augmented by snowmelt. If the soil is saturated or frozen, stream flow may increase because of inability of the soil to absorb additional precipitation (FEMA 2008).

Ice-Jam Floods

An ice jam is an accumulation of ice that acts as a natural dam and restricts flow of a body of water. Ice jams occur when warm temperatures and heavy rains cause rapid snow melt. The melting snow, combined with the heavy rain, causes frozen rivers to swell. The rising water breaks the ice layers into large chunks, which float downstream and often pile up near narrow passages and obstructions (bridges and dams). Ice jams may build up to a thickness great enough to raise the water level and cause flooding (Northeast States Emergency Consortium [NESEC] Date Unknown; U.S. Army Corps of Engineers [USACE] 2002).

Ice jams are of two different types: freeze-up and breakup. Freeze-up jams occur in the early to mid-winter when floating ice may slow or stop due to a change in water slope as it reaches an obstruction to movement. Breakup jams occur during periods of thaw, generally in late winter and early spring. The ice cover breakup is usually associated with a rapid increase in runoff and corresponding river discharge caused by a heavy rainfall, snowmelt, or warmer temperatures (USACE 2002).

4.3.5.1 Location and Extent

Flooding in Pennsylvania is typically associated with abnormally high and intense rainfall amounts. It can also be caused by sudden snowmelt, landslides, or dam failures. In Pennsylvania, flooding usually occurs in the summer; however, flooding has occurred during the winter months as well. Ice jam flooding occurs during the winter months along rivers and creeks.

Most communities in Armstrong County are located along stream and creek valleys throughout the County, many of which are flood prone, as can be seen in Figure 4.3.5-1. According to the Armstrong County Department of Public Safety, the County is home to three lakes, two rivers, 25 streams and creeks, and 74 runs (Armstrong County Department of Public Safety 2013).

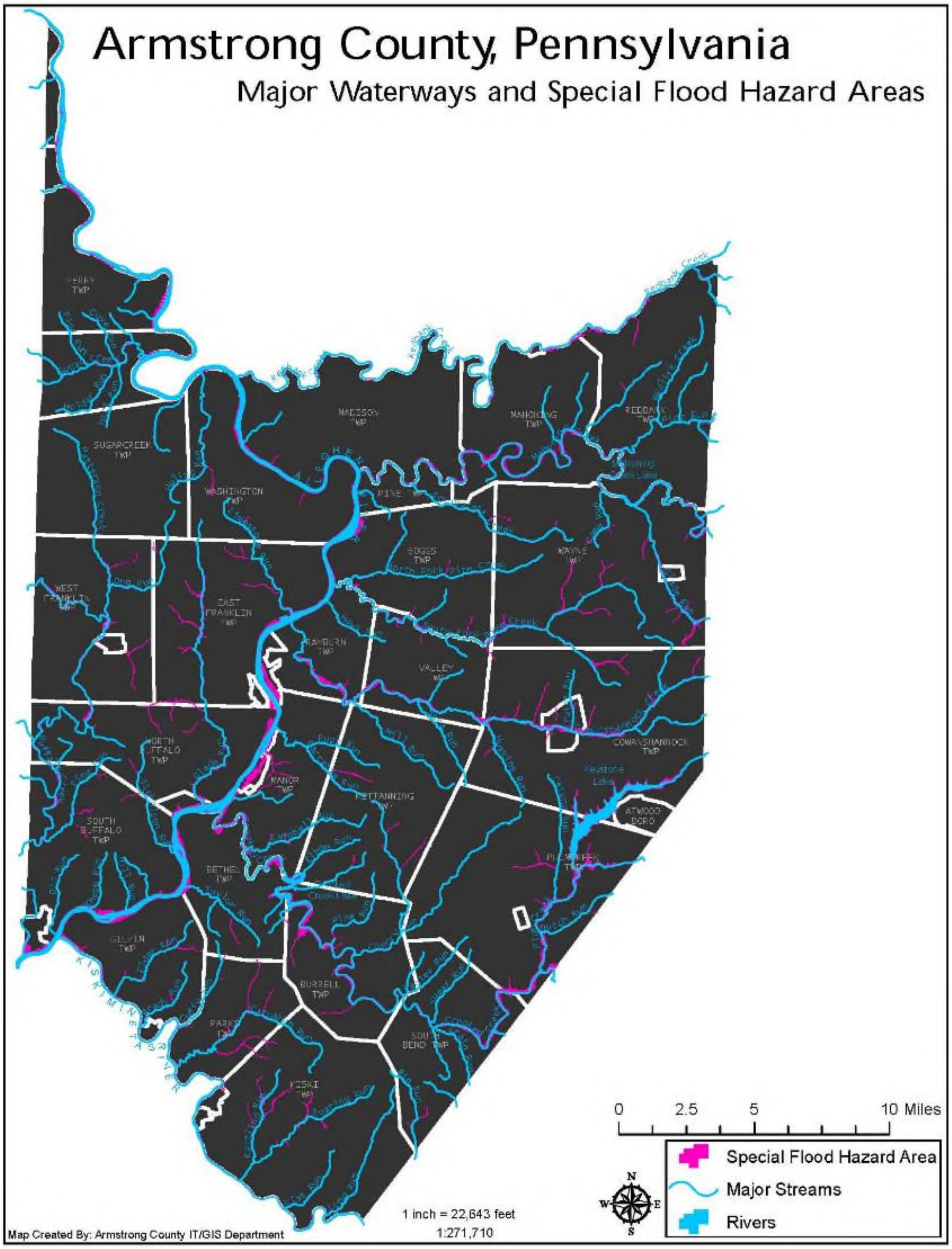
Armstrong County has five major natural waterways and lakes within its borders. These waterways include the Allegheny River, which bisects the County and runs north to south. Due to the mountainous nature of the region, excess water from snowmelt or rainfall accumulates and overflows onto stream banks and adjacent floodplains. Floodplains are lowlands adjacent to rivers, streams, and creeks that are subject to recurring floods. The size of the floodplain is described by the recurrence interval of a given flood. Flood recurrence intervals are explained later in this profile.

In accordance with the 1978 Pennsylvania Stormwater Management Act (Act 167), counties are required to prepare stormwater management plans on a watershed-by-watershed basis that provide for improved management of stormwater impacts associated with development of land. In July 2017, Armstrong County developed the Act 167 Scope of Study for Armstrong County Stormwater Management Plan (Armstrong County Planning Commission 2017). Figure 4.3.5-2 shows Pennsylvania Department of Environmental Protection (PADEP)-designated watersheds with critical facilities for Armstrong County. This Plan is the result of Phase 1 of the Act 167 Plan and includes:

- A summary of County watershed characteristics
- An inventory of relevant problems
- A proposed scope of study, schedule and budget for completion of the Phase 2 Plan project.

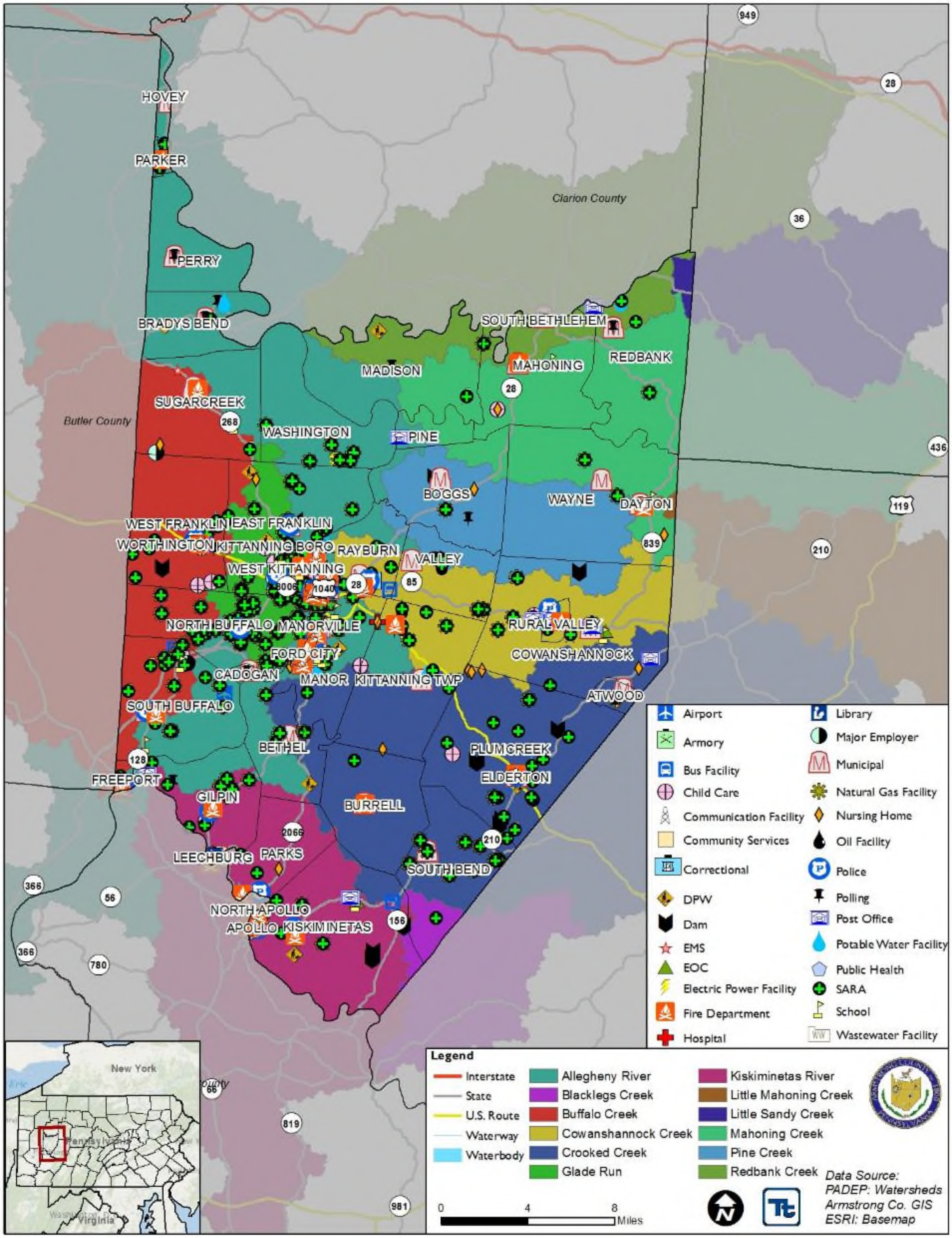
The 2016 FEMA Flood Insurance Study (FIS) for Armstrong County also documents flood-prone areas throughout the County. The main sources of flooding are from the Allegheny River, Buffalo Creek, and Redbank Creek. The Allegheny River has a history of flooding dating from the 1800s, with major flooding occurring in Buffalo Township. The main flood season is normally late winter to early spring, with most of the floods resulting from heavy rain and snowmelt. Buffalo Creek floods within the Borough of Freeport and is caused primarily by backwater from the Allegheny River (FEMA 2016).

Figure 4.3.5-1. Location of Watercourses and Flood Zones Throughout Armstrong County



Source: Armstrong County IT/GIS 2013

Figure 4.3.5-2. PADEP-Designated Watersheds with Critical Facilities

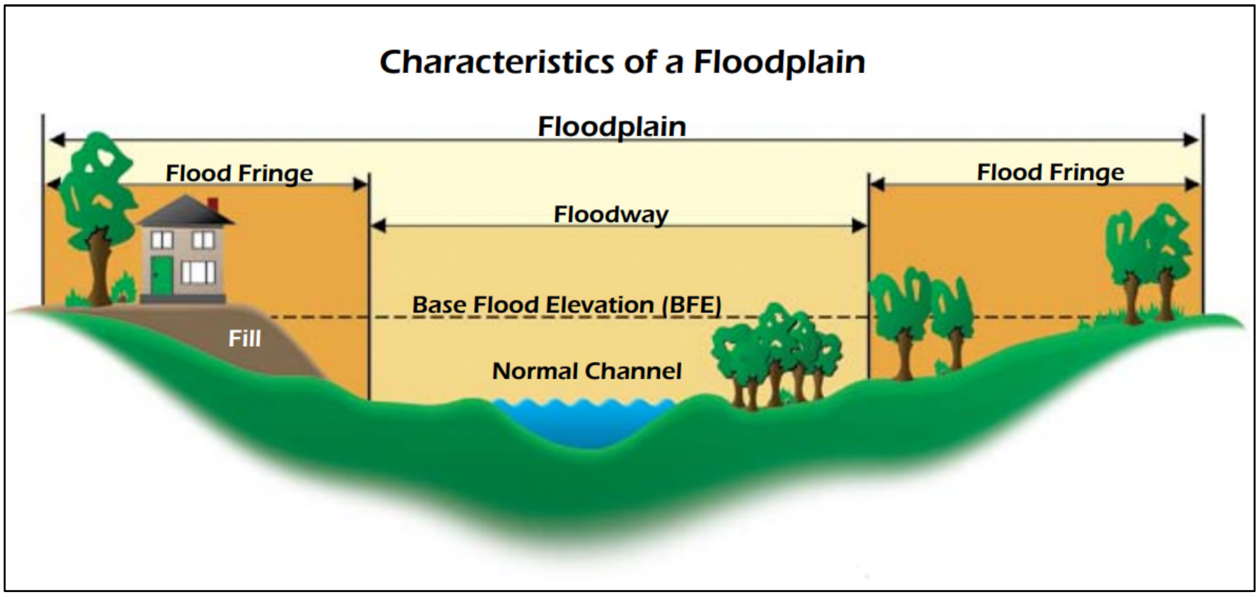


Source: PADEP 2018; Armstrong County GIS 2018

FEMA Regulatory Flood Zones

Floodplains are found in lowland areas adjacent to rivers, streams, creeks, lakes, or other bodies of water that become inundated during a flood. The size of a floodplain is described by the recurrence interval of a given flood. A 1-percent annual chance floodplain is smaller than the floodplain associated with a flood that has a 0.2-percent annual chance of occurring (PEMA 2013). 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-percent annual chance of occurring in a given year is smaller than the floodplain associated with a flood that has a 0.2-percent annual chance of occurring. The National Flood Insurance Program (NFIP), for which digital flood insurance rate maps (DFIRM) are published, identifies the 1-percent annual-chance flood, which is used to delineate the special flood hazard area (SFHA) and identify base flood elevations (BFE). Figure 4.3.5-3 illustrates these terms.

Figure 4.3.5-3. Floodplain Illustration

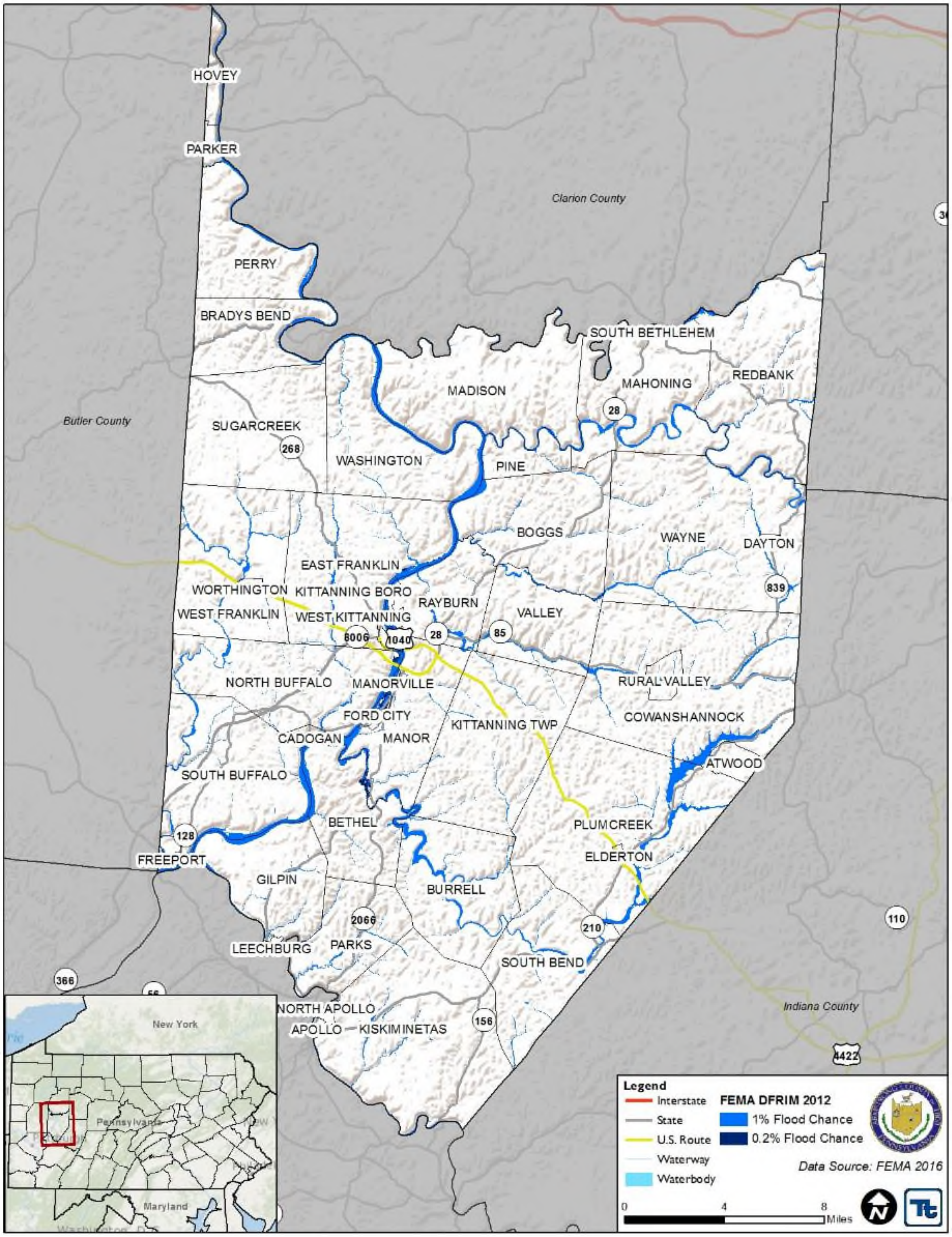


Source: NFIP Guidebook 2009

The SFHA serves as the primary regulatory boundary used by FEMA and Pennsylvania. DFIRMs, FIRMs, and other flood hazard information can be referenced to identify the expected spatial extent of flooding from a 1-percent annual chance event and 0.2-percent annual chance event.

At the time this Plan was updated, the February 2016 DFIRMs were considered the best available, and were used for the risk analysis. Figure 4.3.5-4 illustrates NFIP flood zones in Armstrong County. Maps of each municipality's flood zones are shown at the end of this profile.

Figure 4.3.5-4. NFIP Floodplains in Armstrong County



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 (PEMA 2018).

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 (PEMA 2018).

Rainfall in Pennsylvania is about average for the eastern United States. Amounts of precipitation can be divided into the following six categories:

- Very light rain – precipitation rate of <0.01 inch per hour
- Light rain – precipitation rate between 0.01 inch and 0.04 inch per hour
- Moderate rain – precipitation rate between 0.04 inch and 0.16 inch per hour
- Heavy rain – precipitation rate between 0.16 inch and 0.63 inch per hour
- Very heavy rain – precipitation rate between 0.63 inch and 2 inches per hour
- Extreme rain – precipitation rate greater than 2 inches per hour (PEMA 2018)

Severity of a flood depends not only on the amount of water that accumulates within a period of time, but also on the land's ability to manage this water. The size of rivers and streams in an area also affect flood severity; but an equally important factor is the land's absorbency. When it rains, soil acts as a sponge. When the land is saturated or frozen, infiltration into the ground slows, and any more water that accumulates must flow as runoff (Harris 2008).

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

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

One tool that Armstrong County utilizes to monitor rainfall and stream levels is the Integrated Flood Observing and Warning System (IFLOWS). It was initially put into service in 1992 and continues to provide critical data to the Armstrong Department of Public Safety, allowing much more precise and "real-time" monitoring of rainfall amounts and stream levels. These data are also transmitted to PEMA as well as the NWS in State College, Pennsylvania, so that these agencies can disseminate this information to the general public in a timelier manner.

4.3.5.3 Past Occurrence

With over 19,000 acres of land located in the 1-percent annual chance flood area, Armstrong County has a long history of flooding incidents. The largest floods on record in the County include: March 1936 along the Allegheny River in Buffalo Township that reached 34 feet; March 1936 along Redbank Creek; and October 1954 along Buffalo Creek in Freeport Borough (FEMA FIS 2016).

Armstrong County uses 18 gauges to monitor hydrologic conditions throughout the County. They are as follows:

- Allegheny River at Parker (PARP1)
- Allegheny River at Rimer Lock and Dam (RMRP1)
- Allegheny River at Clinton Lock and Dam (CLNP1)
- Allegheny River at Freeport Lock and Dam (FREP1)
- Allegheny River at Kittanning Lock and Dam (KTTP1)
- Kiskiminetas River at Vandergrift, PA (VGFP1)

Table 4.3.5-1 describes the different stages for the six gauges.

Table 4.3.5-1. Flood Categories in Armstrong County

Flood Category	Flood Category Definition	PARP1	RMRP1	CLNP1	FREP1	KTTP1	VGFP1
Major Flood Stage	Life-threatening and extensive inundation of structures and roads; significant evacuations are expected at this stage.	26	23	24	26	23	28
Moderate Flood Stage	Inundation of buildings usually begins at this stage; roads are likely to be closed and some areas cut off (evacuations may be necessary).	23	21	22	24	22	27
Flood Stage	Gage height above which a rise in water surface level begins to create a hazard to lives, property or commerce; issuance of flood warnings is linked to flood stage.	20	19	21	23	21	25
Action Stage	Level where the NWS needs to take some type of mitigation action in preparation for possible significant hydrologic activity	13.9	14	17	16	17	19.3

Source: NWS 2018

Many sources provided flooding information regarding previous occurrences and losses associated with flooding events throughout Pennsylvania and Armstrong County; therefore, the loss and impact information for many events could vary depending on the source. It is likely that additional flood occurrences have gone unreported before and during this recording period. In some instances, historical flood information shows flood activity across a multi-county forecast area for a particular event. Therefore, accuracy of monetary figures discussed is based only on available information identified during research for this HMP.

FEMA Major Disasters and Emergency Declarations

Between 1954 and 2018, FEMA included Armstrong County in six flood-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: floods, rains, severe storms, heavy rains, high winds, flash floods, tropical depression, tornado, and tropical storm (FEMA 2018). Table 4.3.5-2 lists FEMA DR and EM flood-related declarations that have been declared for Armstrong County.

Table 4.3.5-2. FEMA Declarations for Flood Events in Armstrong County, 1954 to 2018

FEMA Declaration Number	Date(s) of Event	Event Type
DR-629	August 19, 1980	Severe Storms and Flooding

FEMA Declaration Number	Date(s) of Event	Event Type
DR-721	August 27, 1984	Severe Storms and Flooding
DR-1093	January 19-February 1, 1996	Severe Storms and Flooding
DR-1130	July 19, 1996	Severe Storms, Flooding, and Tornadoes
DR-1555	September 8-9, 2004	Severe Storms and Flooding associated with Tropical Depression Frances
DR-1649	June 23-July 10, 2006	Severe Storms, Flooding, and Mudslides

Source: FEMA 2018

Ice Jam Events

The Ice Jam Database, maintained by the Ice Engineering Group at the USACE Cold Regions Research and Engineering Laboratory (CRREL) shows that Armstrong County underwent 51 historical ice jam events between 1917 and 2018. Ice jams have formed along Allegheny River, Buffalo Creek, Kiski River, Mahoning Creek, and Sugar Creek (USACE 2018).

Flood Events

Known flood events, including FEMA disaster declarations, that affected Armstrong County are listed in Table 4.3.5-3. Notably, not all events in Armstrong County are included because of the amount of documentation available and possibility that not all sources were identified or researched. Loss and impact information could vary depending on the source. Therefore, accuracy of monetary figures discussed is based only on available information identified during research for this HMP update.

Table 4.3.5-3. Major Flooding Events between 1972 and 2018 in Armstrong County

Dates of Event	Location	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 21, 1972	Countywide	Flooding – Severe Storm/Thunder Storm (Tropical Storm Agnes)	DR-340	Yes	$7.56 million
August 19, 1980	Countywide	Severe Storm/Flooding	DR-629	Yes	No losses and/or damages were reported for this event
September 11, 1984	Countywide	Severe Storm/Flooding	DR-721	Yes	$500,000
July 9, 1990	Countywide	Flooding	N/A	N/A	$50,000
June 25, 1995	Countywide	Flooding	N/A	N/A	$705,000
January 19, 1996	Countywide	Flood	DR-1093	Yes	$3.75 million
January 19, 1996	Kittanning	Flash Flood	N/A	N/A	$50,000
June 18, 1996	Ford City	Flash Flood	N/A	N/A	$20,000
July 19, 1996	Countywide	Flood	DR-1130	Yes	$10,000
July 19, 1996	South Bethlehem	Flash Flood	DR-1130	Yes	$200,000
September 9, 1996	Mosgrove	Flash Flood	N/A	N/A	$8,000
January 25, 1997	Countywide	Flood	N/A	N/A	$1,000
January 27, 1997	Countywide	Flood	N/A	N/A	No losses and/or damages were reported for this event
January 28, 1997	Countywide	Flood	N/A	N/A	No losses and/or damages were reported for this event

Dates of Event	Location	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
February 5, 1997	Oak Ridge	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
May 25, 1997	Iron Bridge	Flash Flood	N/A	N/A	$1,000
November 8, 1997	East Central Portion	Flash Flood	N/A	N/A	$5,000
May 5, 1998	Nu Mine	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
July 14, 2000	Apollo	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
March 26, 2002	Countywide	Flood	N/A	N/A	$5,000
June 12, 2003	Kittanning	Flash Flood	N/A	N/A	$25,000
August 25, 2003	West Kittanning	Flash Flood	N/A	N/A	$6,000
August 26, 2003	West Kittanning	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
November 19, 2003	Freeport	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
November 19, 2003	Rural Valley	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
November 19, 2003	Apollo	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
January 4, 2004	Countywide	Flood	N/A	N/A	No losses and/or damages were reported for this event
February 6, 2004	Countywide	Flood	N/A	N/A	No losses and/or damages were reported for this event
June 17, 2004	Countywide	Flood	N/A	N/A	No losses and/or damages were reported for this event
September 9, 2004	Countywide	Flood	N/A	N/A	No losses and/or damages were reported for this event
September 17, 2004	Countywide	Flood	N/A	N/A	$4 million
January 6, 2005	Countywide	Flood	N/A	N/A	No losses and/or damages were reported for this event
August 8, 2005	Kittanning	Flash Flood	N/A	N/A	$55,000
June 25, 2006	Kittanning	Flash Flood	DR-1649	Yes	$600,000
June 27, 2006	Goheenville	Flash Flood	DR-1649	Yes	$15,000
July 5, 2007	Maysville	Flash Flood	N/A	N/A	$5,000
March 13, 2010	Apollo	Flood	N/A	N/A	$5,000
February 28, 2011	Christy Manor	Flood	N/A	N/A	$10,000
March 11, 2011	Clinton	Flood	N/A	N/A	$5,000
June 29, 2013	Adrian	Flood	N/A	N/A	No losses and/or damages were reported for this event
June 29, 2013	Mosgrove	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
August 8, 2013	Cowansville	Flood	N/A	N/A	No losses and/or damages were reported for this event
August 28, 2013	Boggsville	Flood	N/A	N/A	No losses and/or damages were reported for this event

Dates of Event	Location	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 28, 2013	Apollo	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
January 12, 2014	Hillville	Flood	N/A	N/A	$1,000
February 21, 2014	Boggsville	Flood	N/A	N/A	$2,000
June 18, 2014	Sherrett	Flood	N/A	N/A	$10,000
June 14, 2015	Adrian	Flash Flood	N/A	N/A	$10,000
June 15, 2015	Craigsville	Flash Flood	N/A	N/A	$10,000
June 15, 2015	Leechburg Airport	Flash Flood	N/A	N/A	$30,000
August 11, 2016	Frogtown	Flash Flood	N/A	N/A	$5,000
May 5, 2017	Cadogan	Flood	N/A	N/A	$10,000
May 5, 2017	West Kittanning	Flash Flood	N/A	N/A	$20,000
May 5, 2017	Adrian	Flash Flood	N/A	N/A	$5,000
June 22, 2017	South Bend	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
July 28, 2017	Dock Hollow	Flash Flood	N/A	N/A	No losses and/or damages were reported for this event
January 12, 2018	Hillville	Ice Jam	N/A	N/A	Homes in the Seybertown area were being flooded
February 16, 2018	Craigsville	Flood	N/A	N/A	Nichola Road was flooded between Hindman Hill Road and Valley View Road from Buffalo Creek. Yellow Dog Road was closed between Craigsville Road and Airport Road.
June 13, 2018	Rural Valley	Flash Flood	N/A	N/A	Montgomery and Tarrtown Road near East Franklin Township were washed out. A section of Tarrtown Road in East Franklin Township was washed out.

Sources: NOAA-NCEI 2018; FEMA 2018
Notes:
Monetary figures within this table were U.S. Dollar (USD) figures calculated during or within the approximate time of the event. If such an event would occur in the present day, monetary losses would be considerably higher in USDs as a result of increased U.S. Inflation Rates.

DR Federal Disaster Declaration
EM Federal Emergency Declaration
FEMA Federal Emergency Management Agency
NCEI National Centers for Environmental Information
NOAA National Oceanic Atmospheric Administration
PEMA Pennsylvania Emergency Management Agency

4.3.5.4 Future Occurrence

Based on the historic and more recent flood events in Armstrong County, it is clear that the County has a high probability of flooding for the future. The fact that the elements required for flooding exist and that major flooding has occurred throughout the County in the past, whether major or minor, suggests that many people and properties are at risk from the flood hazard in the future.

For the 2019 HMP update, the most up-to-date information was collected to calculate the probability of future occurrence of flooding events for Armstrong County. Data from NOAA-NCEI storm events database, FEMA, the CRREL ice jam database, and the 2014 County HMP were used to identify the number of flood events that occurred between 1950 and 2018. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100-percent chance of flood event, of any type or magnitude, occurring in any given year in Armstrong County. Percent chance of future flooding events in Armstrong County are listed in Table 4.3.5-4.

Table 4.3.5-4. Probability of Future Flooding Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Percent Chance of Occurrence in Any Given Year
Flash Flood	30	0.43	2.3	43.48%
Flood	28	0.41	2.46	40.58%
Ice Jam	45	0.65	1.53	65.22%
Total	**103**	**1.49**	**0.67**	**100%**

Sources: NOAA-NCEI 2018; CRREL 2018

It is estimated that Armstrong County will continue to experience direct and indirect impacts of flooding events annually that may induce secondary hazards such as infrastructure deterioration or failure, utility failures, power outages, water quality and supply concerns, and transportation delays, accidents and inconveniences. Therefore, the future occurrence of floods in Armstrong County is considered *highly likely* (100-percent probability of occurrence). Section 4.4 includes further information on PEMA's risk factor methodology.

4.3.5.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets exposed or vulnerable within the identified hazard area. For the flood hazard, the 1-percent annual chance event (100-year flood) is examined. This section discusses the potential impact of the flooding hazard on Armstrong County in the following subsections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) the economy; (5) the environment; and (6) future growth and development
- Effects of climate change on vulnerability
- Further data collections that will assist in understanding this hazard over time

Overview of Vulnerability

Flood is a significant concern for Armstrong County. To assess vulnerability, potential losses were calculated for the County for the 1-percent annual chance (100-year) mean return period (MRP) flood event. The flood hazard exposure and loss estimate analysis is presented below.

Data and Methodology

The 1-percent annual chance flood event was examined to evaluate Armstrong County's risk from and vulnerability to the flood hazard. The polygons representing the 1-percent annual chance event from the FEMA Effective Digital Flood Insurance Rate Map (DFIRM) dated February 2016 were used to estimate exposure. The FEMA Risk MAP 1-percent annual chance flood depth grid, dated March 2014 was incorporated into HAZUS-MH v4.2 to estimate potential losses for the County. An approximately 520 ft. length of the Buffalo Creek in South Buffalo Township did not have depth associated with the boundaries. The 1-percent annual chance event boundary for that length was used with 1/9 arc-second Digital Elevation Map (DEM) model provided by the

U.S. Geological Survey (USGS). The depth grid was integrated into HAZUS-MH, and the model was run to estimate potential losses at the census block level using the HAZUS-MH v4.2 default building inventory for the 1-percent annual chance flood event.

HAZUS-MH v4.2 utilizes 2010 U.S. Census demographic data. The 2010 U.S. Census data were also used to estimate population exposure in order to provide the best available output. Figure 4.3.5-4 illustrates the flood boundaries used for this vulnerability assessment.

Impact on Life, Health, and Safety

Impacts of flooding on life, health, and safety depend on several factors including severity of the event and whether or not adequate warning time is provided to residents. The population living in or near floodplain areas would assumed to be exposed. However, exposure should not be limited only to those who reside within a defined hazard zone, but everyone who may be affected by the effects of a hazard event (e.g., people are at risk while traveling in flooded areas, or their access to emergency services is compromised during an event). The degree of that impact varies and is not strictly measurable.

Table 4.3.5-5 lists the estimated population located within the 1-percent annual chance flood zone by municipality. To estimate the population exposed to the 1-percent flood event, the FEMA DFIRM floodplain boundaries were overlaid upon the 2010 U.S. Census population data in Geographic Information Systems (GIS) (U.S. Census 2010). The U.S. Census blocks do not follow the boundaries of the floodplain. Utilizing the centroid or intersect of the U.S. Census block and the floodplain can grossly overestimate or underestimate the population exposed. The limitations of these analyses are recognized, and as such the results are used only to provide a general estimate.

The 2010 U.S. Census blocks, with their centroids within the flood boundaries, were used to calculate the estimated population exposed to this hazard. Use of this approach resulted in an estimate of 5,202 people within the 1-percent annual chance floodplain, or 7.5 percent of the total County population.

Table 4.3.5-5. Estimated Armstrong County Population Vulnerable to the 1-Percent Flood Hazard (2010 Census)

Municipality	Total Population	1-Percent Annual Chance Event	
		Population in SFHA	Percent Population in Boundary
Apollo Borough	1,647	0	0.0%
Applewold Borough	310	168	54.2%
Atwood Borough	107	3	2.8%
Bethel Township	1,183	21	1.8%
Boggs Township	941	34	3.6%
Bradys Bend Township	783	107	13.7%
Burrell Township	684	31	4.5%
Cadogan Township	344	0	0.0%
Cowanshannock Township	2,893	57	2.0%
Dayton Borough	559	19	3.4%
East Franklin Township	4,089	91	2.2%
Elderton Borough	355	0	0.0%
Ford City Borough	3,035	1,717	56.6%
Ford Cliff Borough	371	0	0.0%
Freeport Borough	1,813	475	26.2%
Gilpin Township	2,500	12	0.5%
Hovey Township	97	8	8.2%
Kiskiminetas Township	4,776	247	5.2%

Municipality	Total Population	1-Percent Annual Chance Event	
		Population in SFHA	Percent Population in Boundary
Kittanning Borough	4,044	918	22.7%
Kittanning Township	2,265	6	0.3%
Leechburg Borough	2,152	0	0.0%
Madison Township	824	5	0.6%
Mahoning Township	1,420	15	1.1%
Manor Township	4,183	176	4.2%
Manorville Borough	410	184	44.9%
North Apollo Borough	1,302	0	0.0%
North Buffalo Township	3,015	226	7.5%
Parker City	840	0	0.0%
Parks Township	2,749	29	1.1%
Perry Township	352	49	13.9%
Pine Township	413	25	6.1%
Plumcreek Township	2,382	23	1.0%
Rayburn Township	1,907	238	12.5%
Redbank Township	1,063	62	5.8%
Rural Valley Borough	876	27	3.1%
South Bend Township	1,186	12	1.0%
South Bethlehem Borough	481	5	1.0%
South Buffalo Township	2,636	26	1.0%
Sugarcreek Township	1,529	0	0.0%
Valley Township	648	80	12.3%
Washington Township	923	3	0.3%
Wayne Township	1,198	19	1.6%
West Franklin Township	1,849	56	3.0%
West Kittanning Borough	1,168	0	0.0%
Worthington Borough	639	28	4.4%
Armstrong County (Total)	**68,941**	**5,202**	**7.5%**

Sources: U.S. Census 2010, FEMA 2016
Note:
SFHA Special Flood Hazard Area

Of the population exposed, the most vulnerable include the economically disadvantaged and the population over the age of 65. Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions to evacuate based on the potential economic impact on their families. The population over the age of 65 is also more vulnerable because they are more likely to seek or need medical attention that may not be available because of isolation during a flood event, and they may have more difficulty evacuating. Within the 1-percent annual chance event, there are approximately 1,059 people over the age of 65 and 1,683 people below the poverty level (HAZUS-MH v4.2 demographic data based on U.S. Census 2010).

Using 2010 U.S. Census data, HAZUS-MH v4.2 estimates potential sheltering needs based on a 1-percent chance flood event. For the 1-percent flood event, HAZUS-MH v4.2 estimates 5,529 people will be displaced, and 247 people will seek short-term sheltering, representing less than 1 percent of the Armstrong County population seeking short-term shelter. These statistics, by municipality, are listed in Table 4.3.5-6. The estimated displaced population and number of persons seeking short-term sheltering differs from the number of persons exposed to the 1-percent annual chance flood (Table 4.3.5-5), because the displaced population numbers take into consideration that not all residents will be significantly impacted enough to be displaced or to require short-term sheltering during a flood event.

Table 4.3.5-6. Estimated Population Displaced or Seeking Short-Term Shelter from the 1-Percent Annual Chance Flood Event

Municipality	Total Population (2010 U.S. Census)	1-Percent Annual Chance Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
Apollo Borough	1,647	12	0
Applewold Borough	310	152	8
Atwood Borough	107	0	0
Bethel Township	1,183	67	0
Boggs Township	941	38	0
Bradys Bend Township	783	125	0
Burrell Township	684	6	0
Cadogan Township	344	4	0
Cowanshannock Township	2,893	103	0
Dayton Borough	559	16	0
East Franklin Township	4,089	80	0
Elderton Borough	355	0	0
Ford City Borough	3,035	1,699	103
Ford Cliff Borough	371	0	0
Freeport Borough	1,813	441	11
Gilpin Township	2,500	96	0
Hovey Township	97	3	0
Kiskiminetas Township	4,776	75	0
Kittanning Borough	4,044	1,176	104
Kittanning Township	2,265	25	0
Leechburg Borough	2,152	12	0
Madison Township	824	9	0
Mahoning Township	1,420	37	0
Manor Township	4,183	227	1
Manorville Borough	410	205	1
North Apollo Borough	1,302	5	0
North Buffalo Township	3,015	28	0
Parker City	840	5	0
Parks Township	2,749	96	0
Perry Township	352	37	0
Pine Township	413	9	0
Plumcreek Township	2,382	44	0
Rayburn Township	1,907	266	16
Redbank Township	1,063	82	1
Rural Valley Borough	876	65	0
South Bend Township	1,186	40	0
South Bethlehem Borough	481	25	0

Municipality	Total Population (2010 U.S. Census)	1-Percent Annual Chance Event	
		Displaced Population	Persons Seeking Short-Term Sheltering
South Buffalo Township	2,636	46	0
Sugarcreek Township	1,529	0	0
Valley Township	648	67	1
Washington Township	923	34	1
Wayne Township	1,198	17	0
West Franklin Township	1,849	51	0
West Kittanning Borough	1,168	0	0
Worthington Borough	639	4	0
Armstrong County (Total)	**68,941**	**5,529**	**247**

Source: HAZUS-MH v4.2

Generally, the total number of injuries and casualties resulting from riverine flooding is limited because of advanced weather forecasting, blockades, and warnings. Therefore, injuries and deaths are not anticipated if proper warning occurs and precautions are in place. Warning time for flash flooding is often limited. Flash flood events are frequently associated with other natural hazard events such as earthquakes, landslides, or severe weather, which limits their predictability and compounds the hazard. Populations without adequate warning of the event are highly vulnerable to this hazard. Ongoing mitigation efforts should help to avoid the most likely cause of injury, which is persons trying to cross flooded roadways or channels. Mitigation action items addressing this issue are included in Section 6 (Mitigation Strategies) of this Plan.

Impact on General Building Stock

Total land area within the 1-percent annual chance flood zones was calculated for each municipality, as listed in Table 4.3.5-7 below.

Table 4.3.5-7. Total Land Area within the 1-Percent Annual Chance Flood Zone (Acres)

Municipality	Total Area (acres)	1-Percent Flood Event Hazard Area	
		A-Zone Area Exposed (acres)	Percentage of Total Land in A-Zone
Apollo Borough	226.2	26.5	11.7%
Applewold Borough	29.6	14.1	47.6%
Atwood Borough	1,455.1	7.2	0.5%
Bethel Township	10,177.6	835.6	8.2%
Boggs Township	15,557.6	554.2	3.6%
Bradys Bend Township	8,431.2	494.9	5.9%
Burrell Township	14,145.0	1,006.6	7.1%
Cadogan Township	722.4	162.8	22.5%
Cowanshannock Township	29,173.9	1,484.4	5.1%
Dayton Borough	271.5	24.0	8.8%
East Franklin Township	20,310.9	1,051.3	5.2%
Elderton Borough	167.1	0.0	0.0%
Ford City Borough	487.9	235.7	48.3%
Ford Cliff Borough	46.3	0.0	0.0%

Municipality	Total Area (acres)	1-Percent Flood Event Hazard Area	
		A-Zone Area Exposed (acres)	Percentage of Total Land in A-Zone
Freeport Borough	740.5	134.7	18.2%
Gilpin Township	10,979.4	780.9	7.1%
Hovey Township	1,579.6	253.3	16.0%
Kiskiminetas Township	26,245.9	513.7	2.0%
Kittanning Borough	819.2	279.6	34.1%
Kittanning Township	19,751.3	334.6	1.7%
Leechburg Borough	304.7	32.9	10.8%
Madison Township	20,041.2	990.4	4.9%
Mahoning Township	16,429.1	960.9	5.8%
Manor Township	10,948.2	731.9	6.7%
Manorville Borough	113.3	81.9	72.3%
North Apollo Borough	382.0	39.4	10.3%
North Buffalo Township	16,368.5	775.7	4.7%
Parker City	704.4	104.3	14.8%
Parks Township	9,152.7	386.5	4.2%
Perry Township	10,015.5	563.6	5.6%
Pine Township	3,286.1	253.1	7.7%
Plumcreek Township	27,953.8	1,426.9	5.1%
Rayburn Township	7,741.9	545.7	7.0%
Redbank Township	20,788.7	831.9	4.0%
Rural Valley Borough	1,365.2	134.6	9.9%
South Bend Township	14,494.0	576.7	4.0%
South Bethlehem Borough	106.1	22.9	21.5%
South Buffalo Township	17,962.7	1,106.3	6.2%
Sugarcreek Township	17,059.4	9.2	0.1%
Valley Township	9,520.2	442.2	4.6%
Washington Township	15,196.8	1,088.8	7.2%
Wayne Township	29,101.3	966.8	3.3%
West Franklin Township	16,686.4	522.6	3.1%
West Kittanning Borough	246.4	0.0	0.0%
Worthington Borough	381.3	23.0	6.0%
Armstrong Count (Total)	**427,668.2**	**20,811.9**	**4.9%**

Source: FEMA 2016
Notes:
The area represented includes the area of inclusive water bodies.

Similar to the population, the building stock data are presented by U.S. Census block. To estimate the value of building stock exposed to the 1-percent flood event, the FEMA DFIRM floodplain boundaries were overlaid upon the HAZUS-MH v4.2 building stock data in GIS. Using the default general building stock, the replacement cost values of the Census blocks with their centroids in the floodplain were totaled. Approximately $1.1 billion worth of building/contents are exposed to the 1-percent annual chance flood in Armstrong County. This represents approximately 10.3 percent of the County's total general building stock replacement value inventory ($10.9 billion).

To estimate the number of structures exposed to the FEMA DFIRM floodplain boundary, the County's spatial layer of structures was overlaid by the 1-percent flood event boundary. In total, 2,502 structures, or 7.6% of the building stock, are located in this hazard area. The building stock exposure per municipality is presented in Table 4.3.5-8.

Potential damage estimated to the general building stock inventory associated with the 1-percent annual chance flood is nearly $400 million. Building stock potential loss estimates per municipality are listed in Table 4.3.5-9.

Table 4.3.5-8. Estimated General Building Stock Exposure to the 1-Percent Annual Chance Flood Event

Municipality	Total Number of Buildings	Total RCV	1-Percent Annual Chance Flood Boundary			
			Number of Buildings	% of Total	RCV	% of Total
Apollo Borough	734	$251,670,000	1	0.1%	$0.00	0.0%
Applewold Borough	139	$74,252,000	61	43.9%	$33,608,000	45.3%
Atwood Borough	51	$10,050,000	0	0.0%	$225,000	2.2%
Bethel Township	684	$128,949,000	74	10.8%	$5,697,000	4.4%
Boggs Township	458	$76,331,000	68	14.8%	$3,450,000	4.5%
Bradys Bend Township	610	$131,764,000	91	14.9%	$16,241,000	12.3%
Burrell Township	358	$73,172,000	0	0.0%	$597,000	0.8%
Cadogan Township	192	$65,238,000	2	1.0%	$0	0.0%
Cowanshannock Township	1,328	$303,507,000	16	1.2%	$4,199,000	1.4%
Dayton Borough	274	$84,832,000	1	<1%	$1,200,000	1.4%
East Franklin Township	1,804	$1,027,803,000	30	1.7%	$16,226,000	1.6%
Elderton Borough	174	$75,474,000	0	0.0%	$0	0.0%
Ford City Borough	1,353	$538,129,000	782	57.8%	$367,630,000	68.3%
Ford Cliff Borough	182	$42,367,000	0	0.0%	$0	0.0%
Freeport Borough	601	$314,661,000	158	26.3%	$53,193,000	16.9%
Gilpin Township	1,435	$375,439,000	216	15.1%	$2,228,000	<1%
Hovey Township	98	$25,518,000	8	8.2%	$225,000	<1%
Kiskiminetas Township	2,269	$529,524,000	8	<1%	$2,954,000	<1%
Kittanning Borough	1,610	$933,567,000	323	20.1%	$417,769,000	44.7%
Kittanning Township	969	$224,824,000	4	<1%	$0	0.0%
Leechburg Borough	1,026	$490,357,000	0	0.0%	$0	0.0%
Madison Township	584	$176,372,000	44	7.5%	$525,000	0.3%
Mahoning Township	703	$155,073,000	38	5.4%	$3,299,000	2.1%
Manor Township	2013	$578,870,000	134	6.7%	$76,244,000	13.2%
Manorville Borough	166	$40,861,000	79	47.6%	$21,582,000	52.8%
North Apollo Borough	652	$163,435,000	2	<1%	$0	0.0%
North Buffalo Township	1,333	$364,294,000	45	3.4%	$954,000	0.3%

Municipality	Total Number of Buildings	Total RCV	1-Percent Annual Chance Flood Boundary			
			Number of Buildings	% of Total	RCV	% of Total
Parker City	375	$83,797,000	2	0.5%	$0	0.0%
Parks Township	1,249	$502,517,000	23	1.8%	$5,767,000	1.1%
Perry Township	280	$72,571,000	51	18.2%	$17,869,000	24.6%
Pine Township	282	$51,655,000	10	3.5%	$5,339,000	10.3%
Plumcreek Township	994	$219,089,000	7	<1%	$1,828,000	<1%
Rayburn Township	800	$225,689,000	51	6.4%	$15,991,000	7.1%
Redbank Township	536	$211,247,000	11	2.1%	$17,419,000	8.2%
Rural Valley Borough	409	$154,259,000	2	<1%	$3,060,000	2.0%
South Bend Township	522	$116,754,000	10	1.9%	$1,052,000	<1%
South Bethlehem Borough	213	$132,137,000	3	1.4%	$0	0.0%
South Buffalo Township	1,264	$454,112,000	58	4.6%	$11,532,000	2.5%
Sugarcreek Township	617	$190,498,000	0	0.0%	$0	0.0%
Valley Township	322	$88,371,000	14	4.3%	$10,514,000	11.9%
Washington Township	729	$111,171,000	45	6.2%	$0	0.0%
Wayne Township	537	$108,168,000	4	<1%	$4,994,000	4.6%
West Franklin Township	878	$347,597,000	21	2.4%	$0	0.0%
West Kittanning Borough	593	$412,394,000	0	0.0%	$0	0.0%
Worthington Borough	314	$144,717,000	5	1.6%	$1,649,000	1.1%
Armstrong County (Total)	**32,714**	**$10,883,076,000**	**2,502**	**7.6%**	**$1,125,060,000**	**10.3%**

Source: HAZUS-MH v4.2; Armstrong County 2018; FEMA 2016
Notes:
RCV Replacement cost value (structure and contents)

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

Municipality	Total Replacement Cost Value	1-Percent Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	Percent of Total	Estimated Loss	Percent of Total	Estimated Loss	Percent of Total	Estimated Loss	Percent of Total
Apollo Borough	$251,670,000	$1,554,000	< 1%	$986,000	< 1%	$450,000	< 1%	$118,000	< 1%
Applewold Borough	$74,252,000	$7,106,000	9.6%	$3,238,000	4.4%	$2,794,000	3.8%	$1,074,000	1.4%
Atwood Borough	$10,050,000	$3,000	< 1%	$3,000	< 1%	$0	0.0%	$0	0.0%
Bethel Township	$128,949,000	$2,399,000	1.9%	$2,399,000	1.9%	$0	0.0%	$0	0.0%
Boggs Township	$76,331,000	$778,000	1.0%	$772,000	1.0%	$6,000	< 1%	$0	0.0%
Bradys Bend Township	$131,764,000	$4,765,000	3.6%	$4,765,000	3.6%	$0	0.0%	$0	0.0%
Burrell Township	$73,172,000	$76,000	< 1%	$66,000	< 1%	$0	0.0%	$10,000	< 1%
Cadogan Township	$65,238,000	$474,000	< 1%	$173,000	< 1%	$288,000	< 1%	$13,000	< 1%
Cowanshannock Township	$303,507,000	$1,664,000	< 1%	$1,336,000	< 1%	$234,000	< 1%	$94,000	< 1%
Dayton Borough	$84,832,000	$164,000	< 1%	$164,000	< 1%	$0	0.0%	$0	0.0%
East Franklin Township	$1,027,803,000	$4,015,000	< 1%	$2,719,000	< 1%	$1,296,000	< 1%	$0	0.0%
Elderton Borough	$75,474,000	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Ford City Borough	$538,129,000	$126,810,000	23.6%	$37,472,000	7.0%	$48,866,000	9.1%	$40,472,000	7.5%
Ford Cliff Borough	$42,367,000	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Freeport Borough	$314,661,000	$16,376,000	5.2%	$8,391,000	2.7%	$3,746,000	1.2%	$4,239,000	1.3%
Gilpin Township	$375,439,000	$2,325,000	< 1%	$1,972,000	< 1%	$140,000	< 1%	$213,000	0.1%
Hovey Township	$25,518,000	$480,000	1.9%	$480,000	1.9%	$0	0.0%	$0	0.0%
Kiskiminetas Township	$529,524,000	$3,175,000	< 1%	$714,000	< 1%	$568,000	< 1%	$1,893,000	< 1%
Kittanning Borough	$933,567,000	$156,411,000	16.8%	$27,219,000	2.9%	$95,958,000	10.3%	$33,234,000	3.6%
Kittanning Township	$224,824,000	$171,000	< 1%	$171,000	< 1%	$0	0.0%	$0	0.0%
Leechburg Borough	$490,357,000	$8,113,000	1.7%	$197,000	< 1%	$7,388,000	1.5%	$528,000	< 1%
Madison Township	$176,372,000	$1,823,000	1.0%	$1,823,000	1.0%	$0	0.0%	$0	0.0%
Mahoning Township	$155,073,000	$1,553,000	1.0%	$1,531,000	1.0%	$22,000	< 1%	$0	0.0%
Manor Township	$578,870,000	$8,281,000	1.4%	$6,675,000	1.2%	$407,000	< 1%	$1,199,000	< 1%

Municipality	Total Replacement Cost Value	1-Percent Annual Chance Event							
		All Occupancies		Residential		Commercial		Industrial, Religious, Education and Government	
		Estimated Loss	Percent of Total	Estimated Loss	Percent of Total	Estimated Loss	Percent of Total	Estimated Loss	Percent of Total
Manorville Borough	$40,861,000	$3,145,000	7.7%	$1,795,000	4.4%	$586,000	1.4%	$764,000	1.9%
North Apollo Borough	$163,435,000	$131,000	< 1%	$106,000	< 1%	$25,000	< 1%	$0	0.0%
North Buffalo Township	$364,294,000	$581,000	< 1%	$460,000	< 1%	$88,000	< 1%	$33,000	< 1%
Parker City	$83,797,000	$127,000	< 1%	$127,000	< 1%	$0	0.0%	$0	0.0%
Parks Township	$502,517,000	$7,236,000	1.4%	$1,644,000	< 1%	$1,236,000	< 1%	$4,356,000	< 1%
Perry Township	$72,571,000	$2,805,000	3.9%	$2,805,000	3.9%	$0	0.0%	$0	0.0%
Pine Township	$51,655,000	$2,088,000	4.0%	$1,410,000	2.7%	$133,000	< 1%	$545,000	1.1%
Plumcreek Township	$219,089,000	$1,170,000	< 1%	$657,000	< 1%	$291,000	< 1%	$222,000	< 1%
Rayburn Township	$225,689,000	$8,282,000	3.7%	$8,033,000	3.6%	$190,000	< 1%	$59,000	< 1%
Redbank Township	$211,247,000	$1,919,000	< 1%	$1,853,000	< 1%	$66,000	< 1%	$0	0.0%
Rural Valley Borough	$154,259,000	$1,859,000	1.2%	$1,015,000	< 1%	$493,000	< 1%	$351,000	< 1%
South Bend Township	$116,754,000	$1,771,000	1.5%	$620,000	< 1%	$705,000	< 1%	$446,000	< 1%
South Bethlehem Borough	$132,137,000	$6,025,000	4.6%	$176,000	< 1%	$5,830,000	4.4%	$19,000	< 1%
South Buffalo Township	$454,112,000	$2,977,000	< 1%	$2,307,000	< 1%	$325,000	< 1%	$345,000	< 1%
Sugarcreek Township	$190,498,000	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Valley Township	$88,371,000	$5,637,000	6.4%	$1,487,000	1.7%	$581,000	< 1%	$3,569,000	4.0%
Washington Township	$111,171,000	$3,576,000	3.2%	$3,575,000	3.2%	$1,000	< 1%	$0	0.0%
Wayne Township	$108,168,000	$275,000	< 1%	$193,000	< 1%	$10,000	< 1%	$72,000	< 1%
West Franklin Township	$347,597,000	$1,727,000	< 1%	$1,308,000	< 1%	$68,000	< 1%	$351,000	< 1%
West Kittanning Borough	$412,394,000	$0	0.0%	$0	0.0%	$0	0.0%	$0	0.0%
Worthington Borough	$144,717,000	$140,000	< 1%	$111,000	< 1%	$29,000	< 1%	$0	0.0%
Armstrong County (Total)	**$10,883,076,000**	**$399,987,000**	**3.7%**	**$132,948,000**	**1.2%**	**$172,820,000**	**1.6%**	**$94,219,000**	**< 1%**

Source: HAZUS-MH v4.2
Notes:
% Percent
RCV Replacement cost value

To further enhance the risk assessment, FEMA Region III provided data on the total exposure in the floodplain (TEIF) for Armstrong County. This information utilizes best-available data including the 2010 Census geography and 2012 RS Means valuations. These data are used in lieu of the average annualized loss study, and indicate that the total exposure in the floodplain for Armstrong County is $755 million.

NFIP Statistics

Individual data available regarding flood policies, claims, repetitive loss (RL) properties, and severe repetitive loss (SRL) properties were analyzed. A RL property is defined by the NFIP as an NFIP-insured structure that incurred flood-related damage on two occasions, and for which the cost of repair equaled or exceeded $1,000 at the time of each flood. FEMA's Flood Mitigation Assistance program refers to an NFIP-insured structure that incurred flood-related damage on two occasions, and for which the cost of repair equaled or exceeded 25 percent of the market value of the structure at the time of each such flood. An SRL property is defined as a residential property covered by an NFIP flood insurance policy, and can claim at least one of the following (S ection 1361A of the National Flood Insurance, 42 *United States Code* (U.S.C.) 4102a):

- Has at least four NFIP claim payments (including building and contents) over $5,000 each, and the cumulative amount of such claims payments exceeds $20,000.
- For which at least two separate claims 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 either of the above, at least two of the referenced claims must have occurred within any 10-year period and must have occurred more than 10 days apart.

Table 4.3.5-10 summarizes the NFIP policies and claims for Armstrong County. Armstrong County has 44 RL properties (whether residential or commercial/industrial), and 3 SRL properties, per FEMA documentation (FEMA 2018).

Table 4.3.5-10. NFIP Policies, Claims, and Repetitive Loss Statistics

Municipality	# Policies (1)	# Claims (Losses) (1)	# Repetitive Loss Properties (1)	# Severe Repetitive Loss Properties (1)	Total Loss Payments (2)
Apollo Borough	4	4	-	-	$16,448
Applewold Borough	16	0	-	-	$0
Atwood Borough	0	0	-	-	$0
Bethel Township	20	38	7	1	$678,284
Boggs Township	5	15	-	-	$69,096
Bradys Bend Township	19	26	2	-	$176,960
Burrell Township	0	0	-	-	$0
Cadogan Township	0	4	1	-	$28,253
Cowanshannock Township	3	1	-	-	$1,430
Dayton Borough	0	0	-	-	$0
East Franklin Township	3	11	3	-	$84,236
Elderton Borough	0	0	-	-	$0
Ford City Borough	176	21	2	-	$111,300
Ford Cliff Borough	0	0	-	-	$0
Freeport Borough	65	50	3	-	$294,730

Municipality	# Policies (1)	# Claims (Losses) (1)	# Repetitive Loss Properties (1)	# Severe Repetitive Loss Properties (1)	Total Loss Payments (2)
Gilpin Township	22	55	9	-	$809,756
Hovey Township	1	2	-	-	$1,418
Kiskiminetas Township	2	3	-	-	$1,989
Kittanning Borough	89	57	2	-	$230,030
Kittanning Township	1	1	-	-	$801
Leechburg Borough	4	8	-	-	$41,112
Madison Township	7	43	3	--	$275,298
Mahoning Township	9	0	-	-	$0
Manor Township	23	15	-	-	$81,383
Manorville Borough	28	11	1	-	$17,004
North Apollo Borough	5	1	-	-	$0
North Buffalo Township	3	5	-	-	$28,056
Parker City	4	12	-	-	$18,649
Parks Township	6	11	-	-	$81,847
Perry Township	9	10	-	-	$42,152
Pine Township	1	0	-	-	$0
Plumcreek Township	8	2	-	-	$21,297
Rayburn Township	2	3	-	-	$51,437
Redbank Township	3	4	1	-	$86,157
Rural Valley Borough	2	3	-	-	$6,274
South Bend Township	4	2	-	-	$224,722
South Bethlehem Borough	2	0	-	-	$0
South Buffalo Township	19	43	9	2	$1,362,710
Sugarcreek Township	0	2	-	-	$8,458
Valley Township	2	0	-	-	$0
Washington Township	3	5	-	-	$40,729
Wayne Township	1	0	-	-	$0
West Franklin Township	7	7	-	-	$253,665
West Kittanning Borough	0	0	-	-	$0
Worthington Borough	2	1	1	-	$35,419
Armstrong County (Total)	**580**	**476**	**44**	**3**	**$5,181,100**

Source: FEMA 2018

Notes:

(1) Policies, claims, repetitive loss, and severe repetitive loss statistics provided by FEMA and PEMA and are current as of 2/27/18. Total number of repetitive loss properties includes the severe repetitive loss properties. The number of claims represents claims closed by 2/27/18.

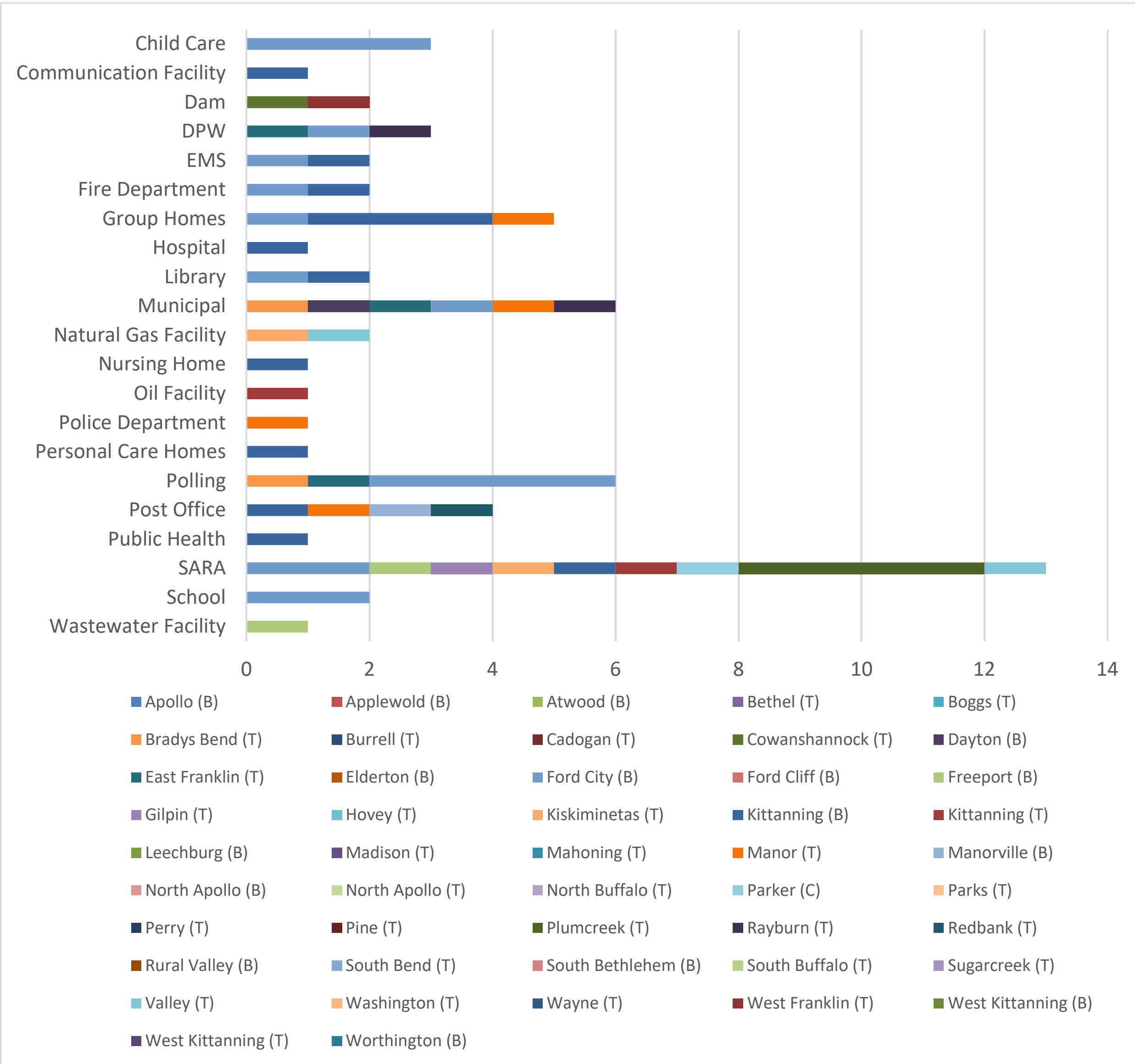
(2) Total building and content loss information was collected from the claims file provided by FEMA.

Impact on Critical Facilities

HAZUS-MH v4.2 was used to estimate the flood loss potential to critical facilities exposed to the flood risk. Using depth/damage function curves, HAZUS-MH v4.2 estimates the percent of damage to the building and contents of critical facilities. Figure 4.3.5-5 shows the number of critical facilities and utilities within the FEMA flood zones, for those municipalities with critical facilities in the flood zones.

In cases where short-term functionality is impacted by a hazard, other facilities of neighboring municipalities may need to increase support response functions during a disaster event. Mitigation planning should consider means to reduce impacts on critical facilities and ensure that sufficient emergency and school services remain functional when a significant event occurs.

Figure 4.3.5-5. Critical Facilities Within the 1-Percent Annual Chance Flood Boundary



Sources: FEMA 2016; Armstrong County 2018

Impact on the Economy

Losses include but are not limited to general building stock damage, agricultural losses, business interruption, and tax base of Armstrong County. Damage to general building stock can be quantified by use of HAZUS-MH v4.2 as discussed above. Other economic components such as loss of facility use, functional downtime, and social economic factors are less susceptible to measurement with a high degree of certainty. The previous subsection discusses direct impacts to buildings in the County.

Flooding can cause extensive damage to public utilities and disruptions to delivery of services. Loss of power and communications may occur and drinking water and wastewater treatment facilities may be temporarily out of operation. Flooded streets and road blocks make it difficult for emergency vehicles to respond to calls for service. Floodwaters can wash out sections of roadway and bridges.

HAZUS-MH v4.2 estimates the amount of debris generated from a 1-percent flood event. The model breaks down debris into three categories because of the different types of equipment needed to handle debris: (1) finishes (dry wall, insulation, etc.), (2) structural (wood, brick, etc.), and (3) foundations (concrete slab and block, rebar, etc.). Table 4.3.5-11 summarizes the debris HAZUS-MH v4.2 estimates to result from a 1-percent flood event.

Table 4.3.5-11. Estimated Debris Generated from the 1-Percent Flood Event

	1-Percent Flood Event			
Municipality	Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Apollo Borough	146.4	74.2	42.5	29.7
Applewold Borough	61.3	55.8	1.6	3.9
Atwood Borough	0.8	0.3	0.3	0.2
Bethel Township	244.5	150.4	53.6	40.5
Boggs Township	141.6	51.0	43.2	47.4
Bradys Bend Township	523.2	231.7	138.3	153.2
Burrell Township	15.6	6.1	4.6	4.9
Cadogan Township	19.3	11.1	4.5	3.7
Cowanshannock Township	145.9	77.7	33.9	34.4
Dayton Borough	12.4	7.5	1.7	3.2
East Franklin Township	267.8	136.4	71.9	59.5
Elderton Borough	0.0	0.0	0.0	0.0
Ford City Borough	2,401.7	2,251.9	86.6	63.2
Ford Cliff Borough	0.0	0.0	0.0	0.0
Freeport Borough	784.4	592.9	109.1	82.4
Gilpin Township	140.2	87.0	27.2	25.9
Hovey Township	98.0	32.6	36.6	28.8
Kiskiminetas Township	89.5	35.3	27.5	26.6
Kittanning Borough	1,414.8	1,082.9	154.7	177.1
Kittanning Township	18.5	10.5	2.7	5.3
Leechburg Borough	175.5	47.5	70.7	57.3
Madison Township	425.0	124.3	162.6	138.1
Mahoning Township	278.4	100.0	98.5	80.0
Manor Township	978.1	345.0	333.7	299.3
Manorville Borough	87.0	49.5	14.9	22.6
North Apollo Borough	19.3	8.0	6.4	4.8
North Buffalo Township	42.4	27.8	7.0	7.6
Parker City	29.8	10.0	11.2	8.7
Parks Township	166.5	78.0	49.5	39.1
Perry Township	306.7	121.7	91.5	93.5
Pine Township	376.5	94.1	154.0	128.4
Plumcreek Township	111.1	48.8	28.9	33.4
Rayburn Township	1,096.7	422.8	362.5	311.4

Municipality	1-Percent Flood Event Total (tons)	Finish (tons)	Structure (tons)	Foundation (tons)
Redbank Township	192.0	97.7	50.0	44.3
Rural Valley Borough	73.2	50.0	12.3	10.8
South Bend Township	155.2	51.7	49.8	53.7
South Bethlehem Borough	45.2	30.8	7.8	6.6
South Buffalo Township	340.2	107.7	128.6	103.9
Sugarcreek Township	0.0	0.0	0.0	0.0
Valley Township	144.5	64.9	39.6	40.1
Washington Township	719.9	174.1	284.6	261.2
Wayne Township	24.1	13.0	5.4	5.7
West Franklin Township	176.7	67.0	56.6	53.1
West Kittanning Borough	0.0	0.0	0.0	0.0
Worthington Borough	19.5	8.7	5.6	5.2
Armstrong County (Total)	**12,509.4**	**7,038.6**	**2,872.2**	**2,598.6**

Source: HAZUS-MH v4.2

Impact on the Environment

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, which improves soil fertility. However, the destruction of riparian buffers, changes to land use and land cover throughout a watershed, and introduction of chemical or biological contaminants, which often accompany human presence, cause environmental harm when floods occur. Hazardous material facilities are potential sources of contamination during flood events. Other environmental impacts of flooding include: waterborne diseases, heavy siltation, erosion of stream banks 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.

Future Growth and Development

As discussed in Section 4.4, areas targeted for future growth and development have been identified across the County. Any areas of growth could be impacted by the flood hazard if construction occurs within identified hazard areas. The County intends to discourage development in vulnerable areas or to encourage higher regulatory standards on the local level.

Effect of Climate Change on Vulnerability

PADEP was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of potential impacts of global climate change on the Commonwealth. The June 2009 Pennsylvania Climate Impact Assessment's main findings indicate that Pennsylvania is very likely to undergo increased temperatures in the 21st century. An increase in variability of temperature and precipitation may lead to increased frequency and/or severity of storm events. Summer floods and general stream flow variability are projected to increase due to increased variability in precipitation. Even with the anticipated increase in winter precipitation occurring as rain rather than snow, increased winter temperatures and a reduced snowpack may decrease rain-on-snow events and thus affect major flooding events in Pennsylvania. This conclusion, however, remains speculative until further studies can validate it. Future improvements in modeling smaller-scale climatic processes are expected and will lead to improved understanding of how the changing climate will alter temperature, precipitation, storms, and flood events in Pennsylvania (Shortle et al. 2009).

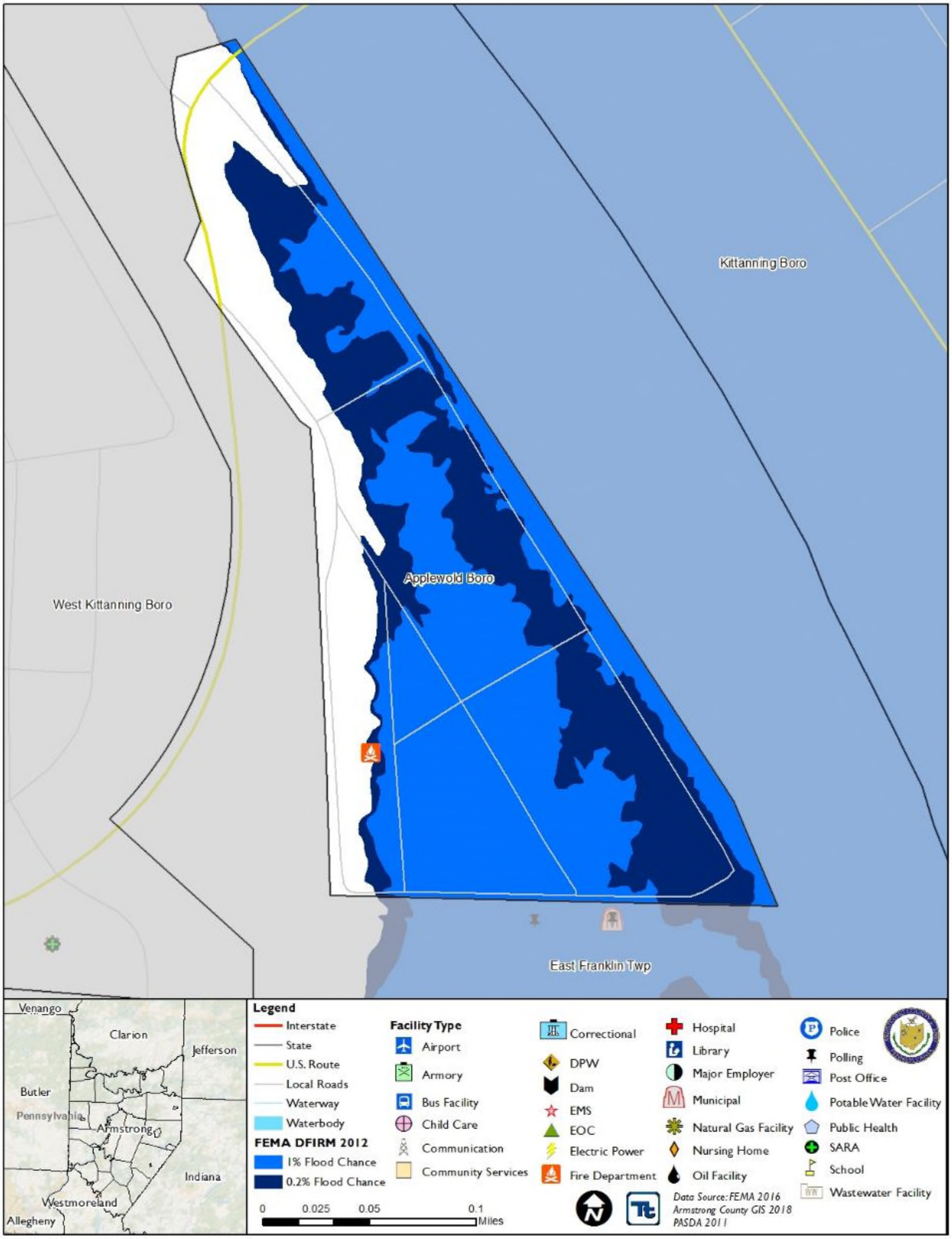
The increase in rainfall has the potential to affect drinking water, increase the risk to flash flooding and riverine flooding, and flood critical transportation corridors and infrastructure. Increases in precipitation may alter and expand the floodplain boundaries and runoff patterns, resulting in populations, buildings, and critical facilities and infrastructure that were previously outside the floodplain. This increase in exposure would result in an increased risk to life and health, an increase in structural losses, a diversion of additional resources to response and recovery efforts, and an increase in business closures affected by future flooding events due to loss of service or access.

Additional Data and Next Steps

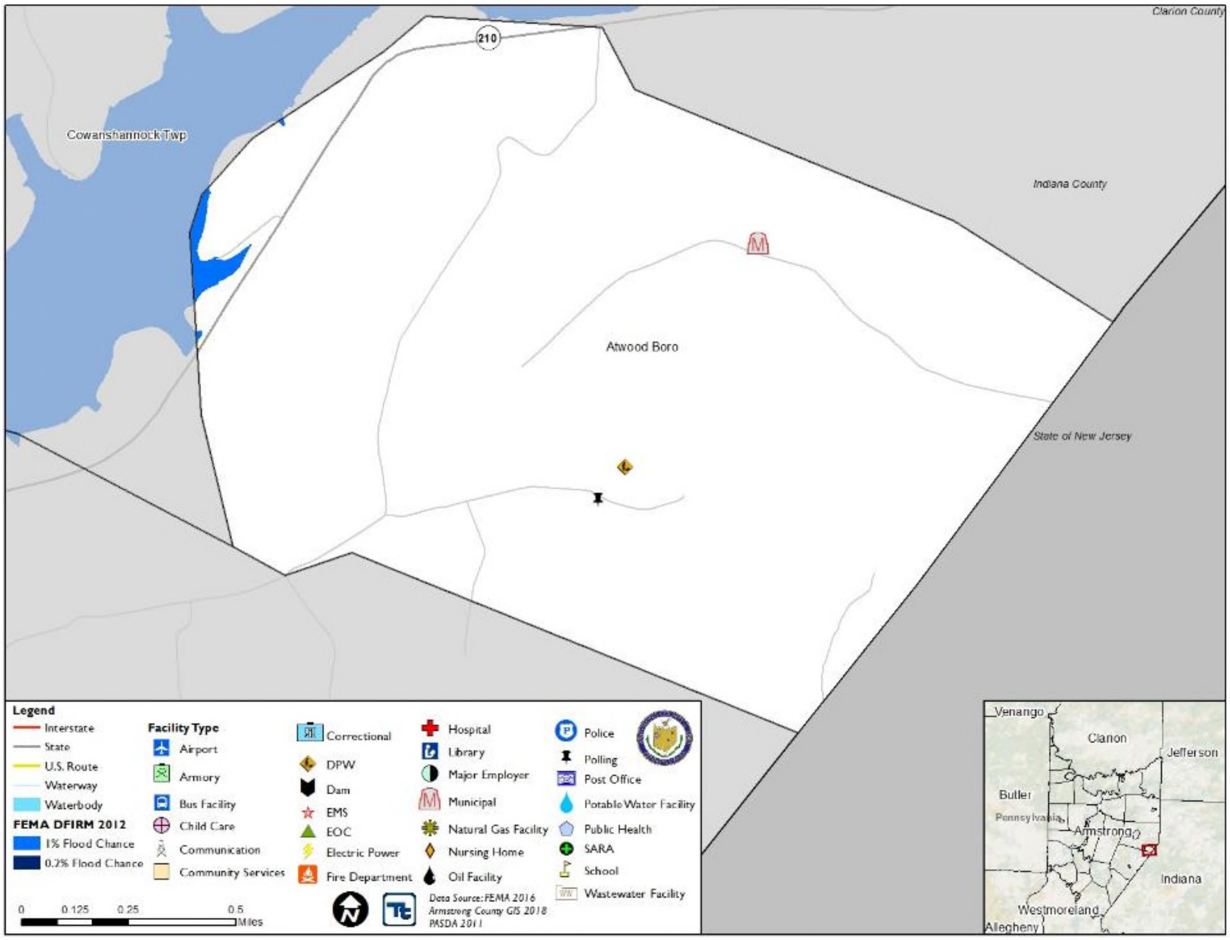
A HAZUS-MH riverine flood analysis for Armstrong County was based on the most current and best-available data, including critical facility inventories and FEMA DFIRM. For future plan updates, more accurate exposure and loss estimates can be produced by updating the default general building stock inventory in HAZUS-MH and conducting the loss estimates at the structure level.

Apollo Borough

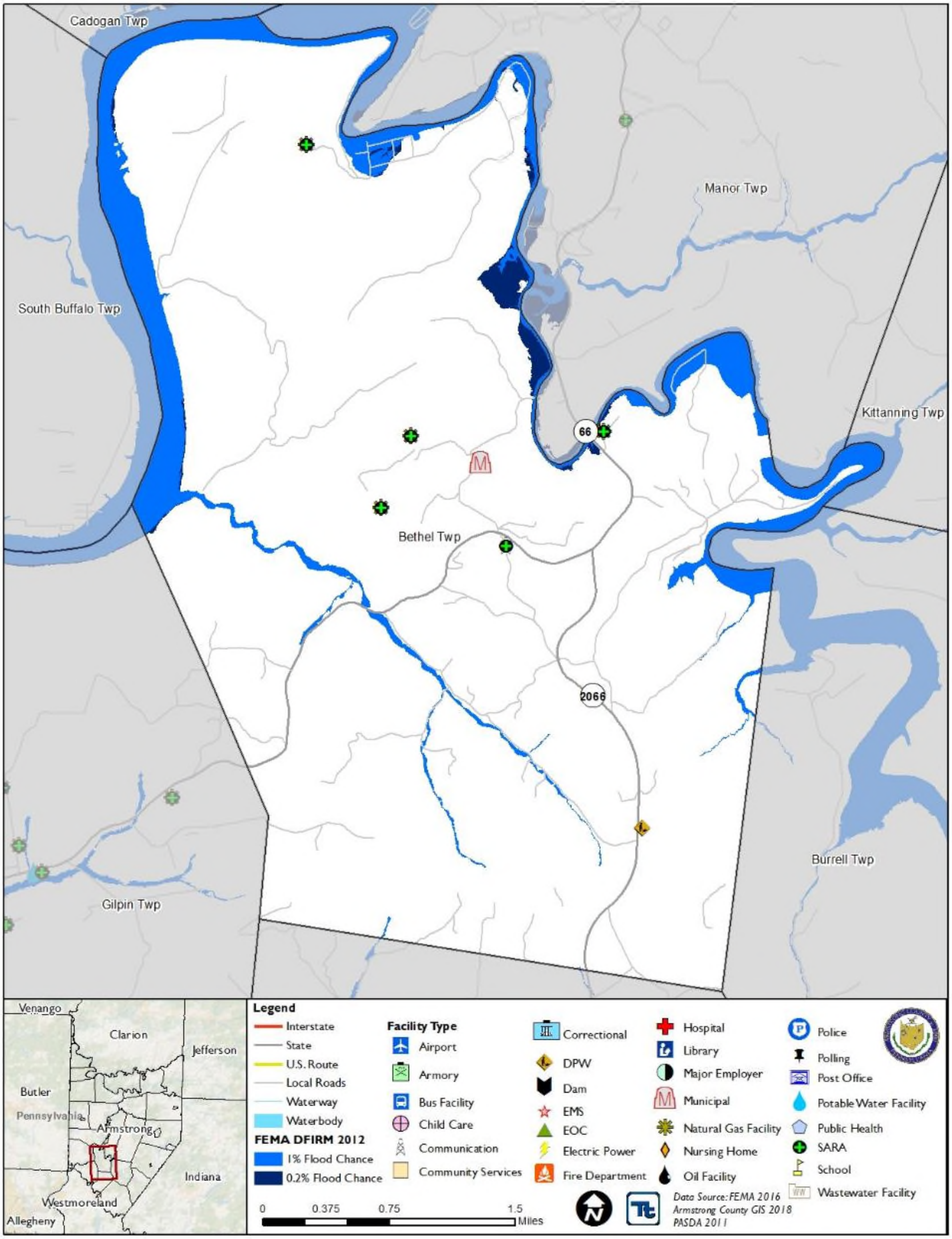
Applewold Borough



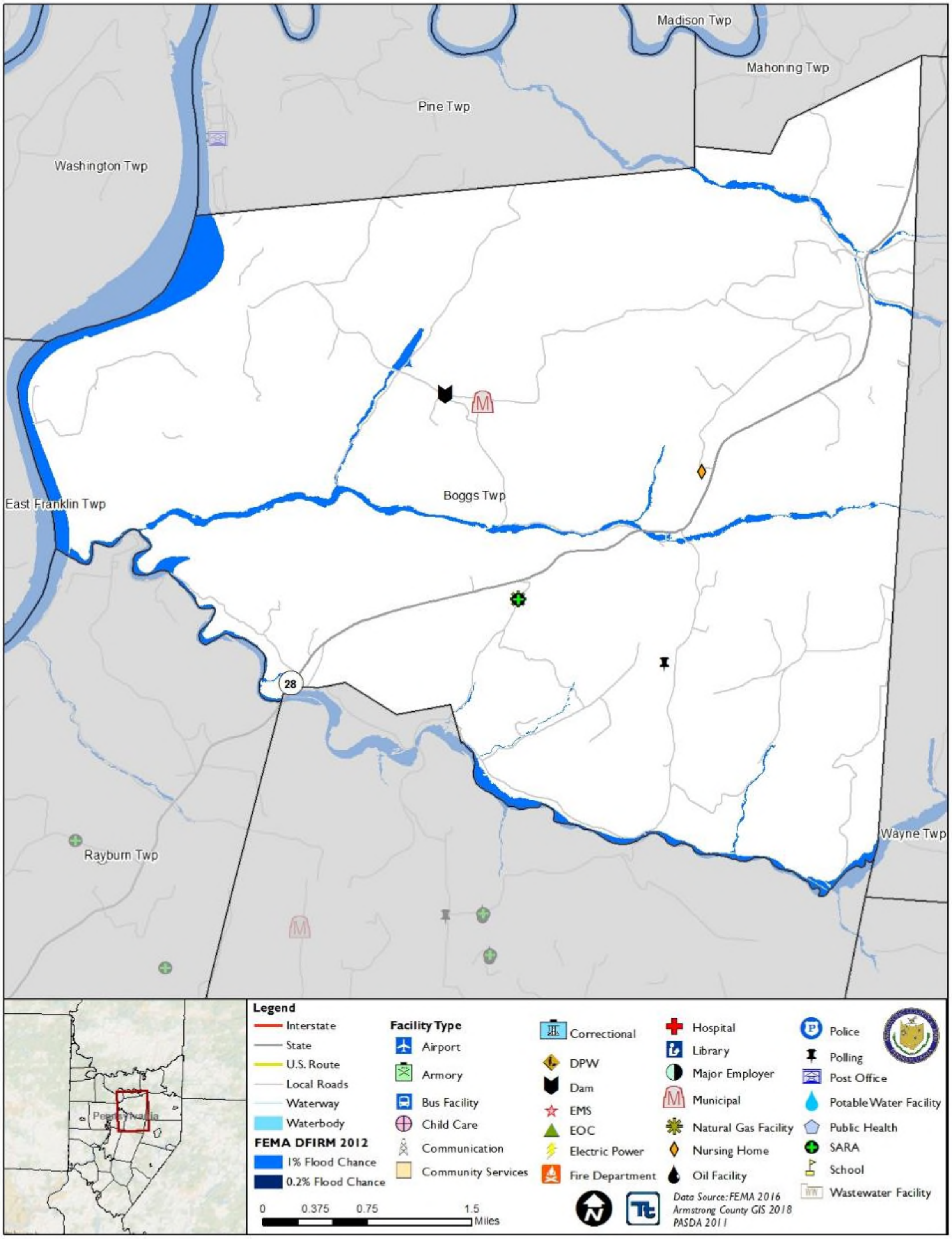
Atwood Borough



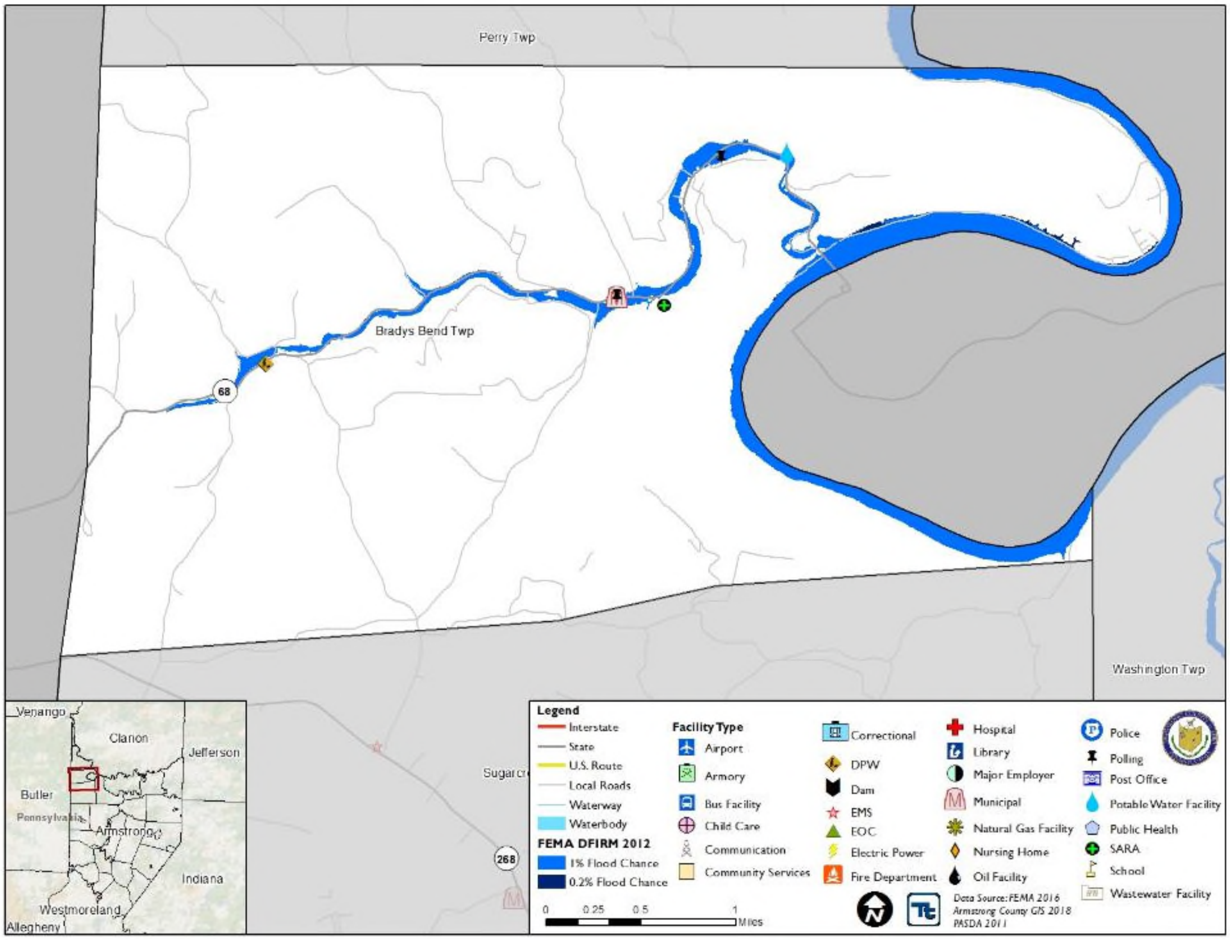
Bethel Township



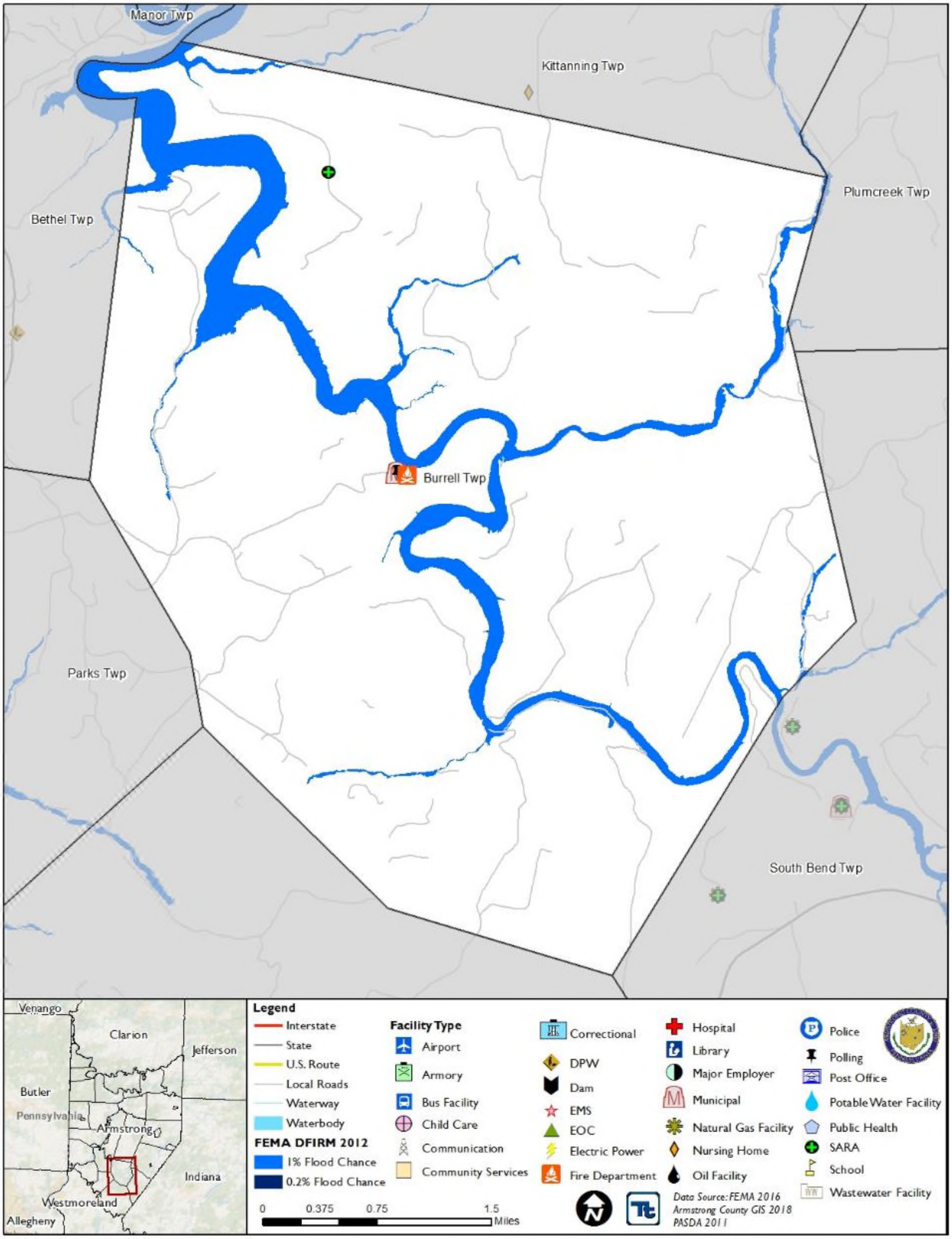
Boggs Township



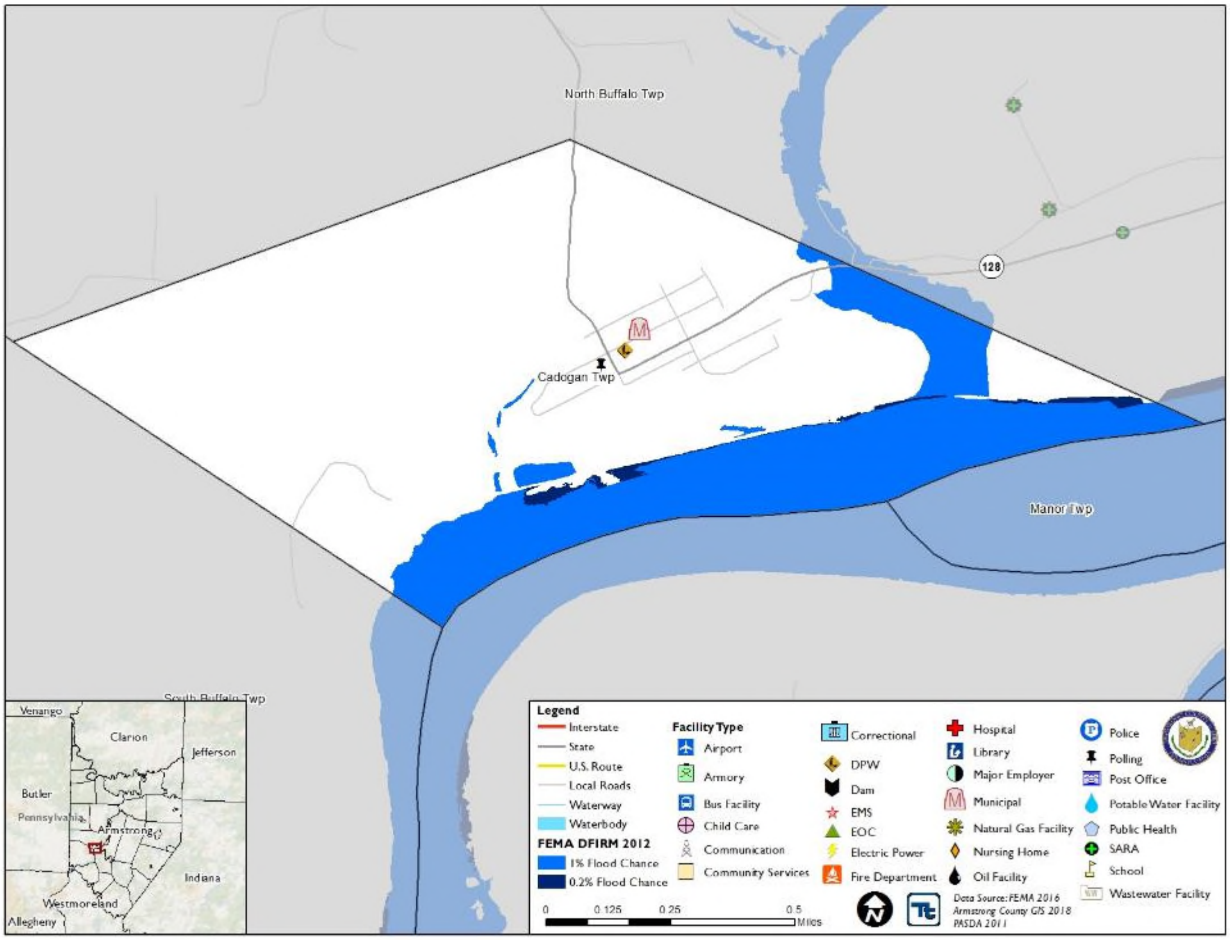
Bradys Bend Township



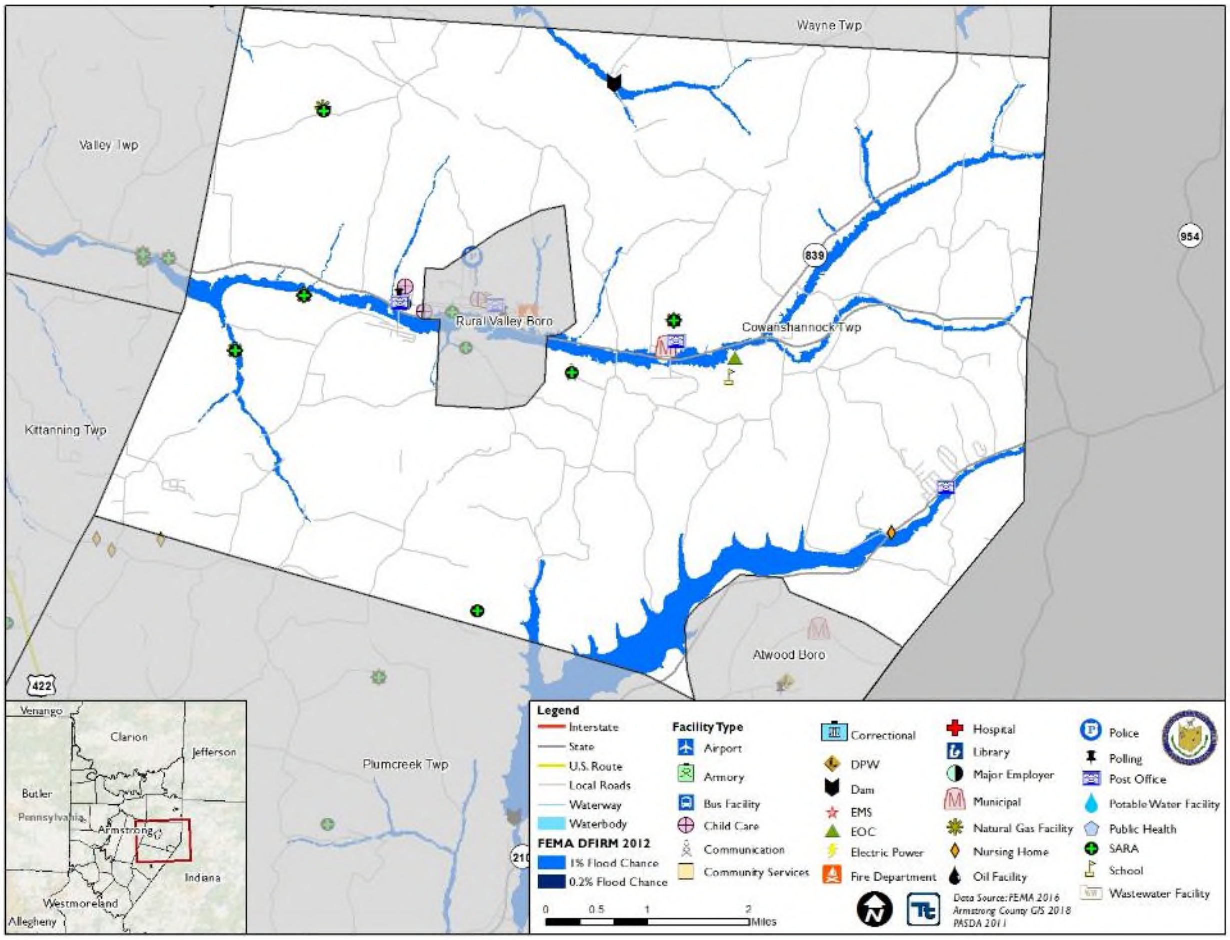
Burrell Township



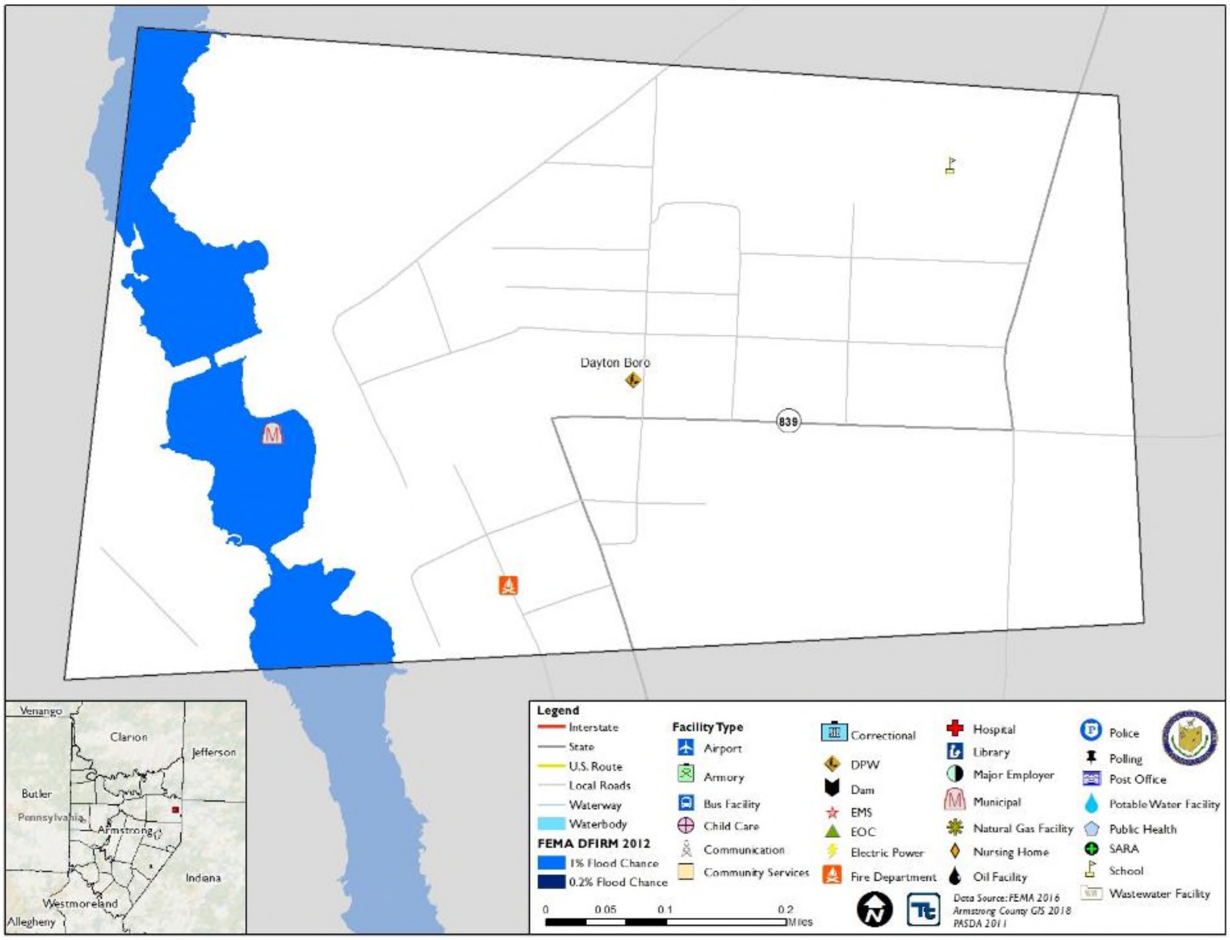
Cadogan Township



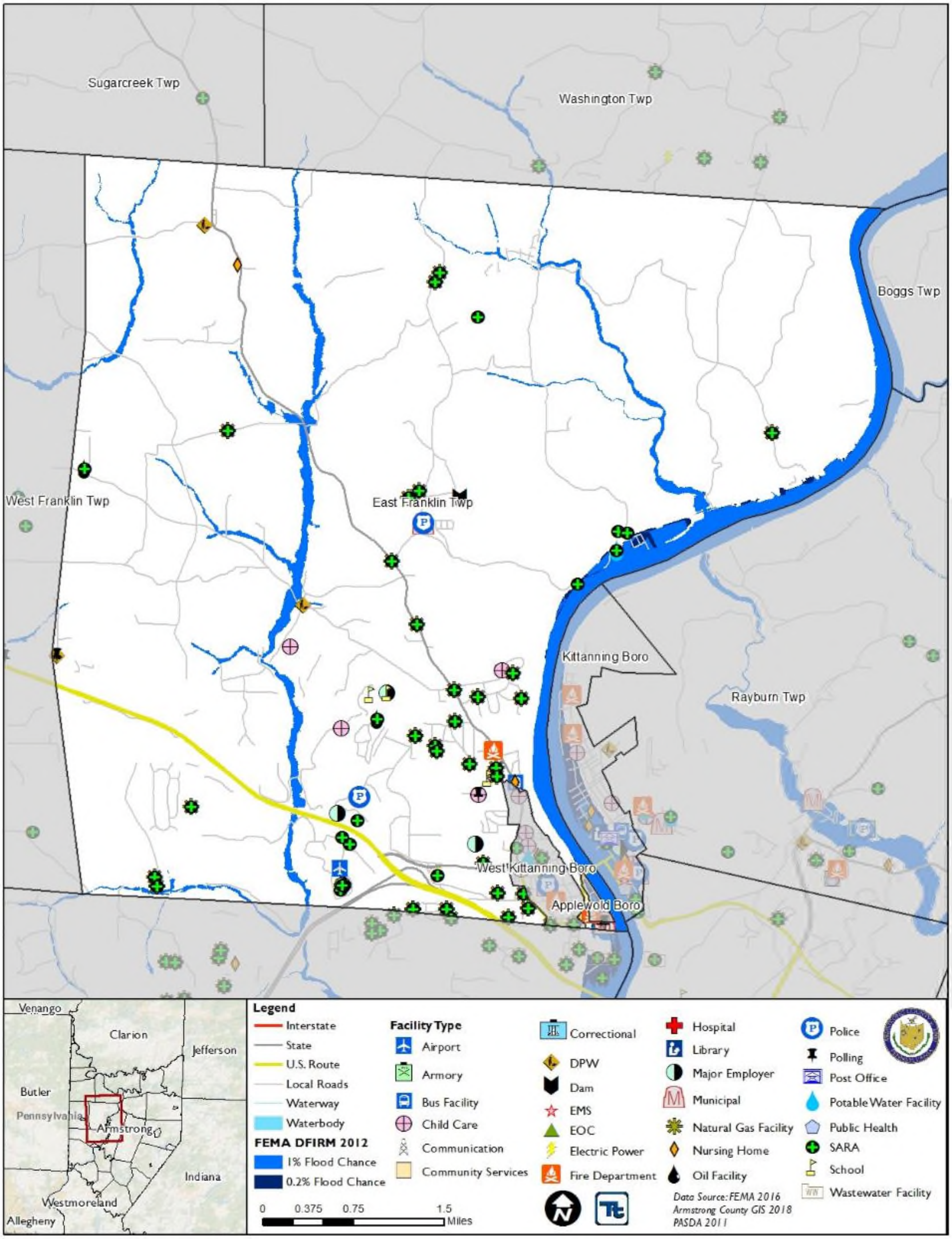
Cowanshannock Township



Dayton Borough

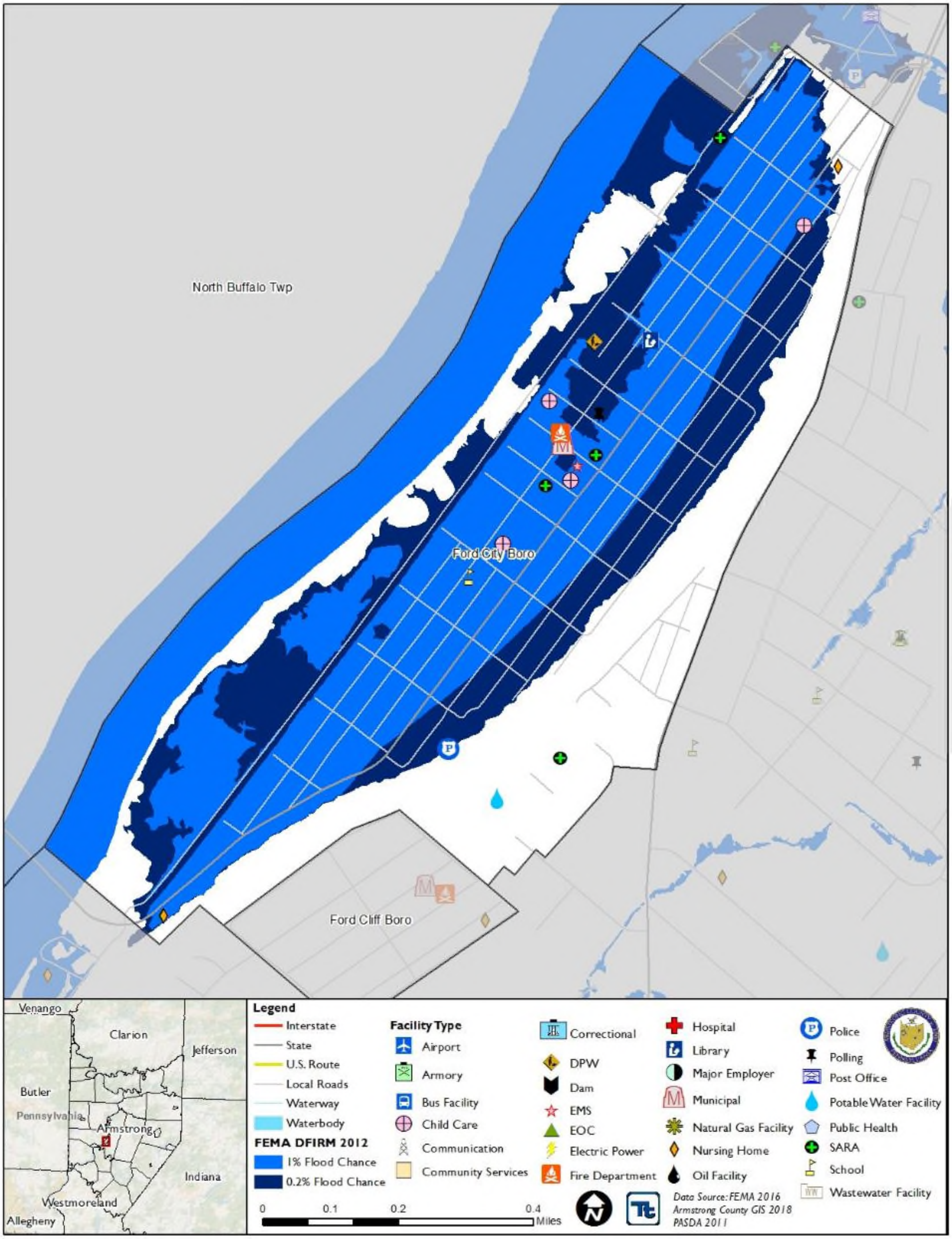


East Franklin Township

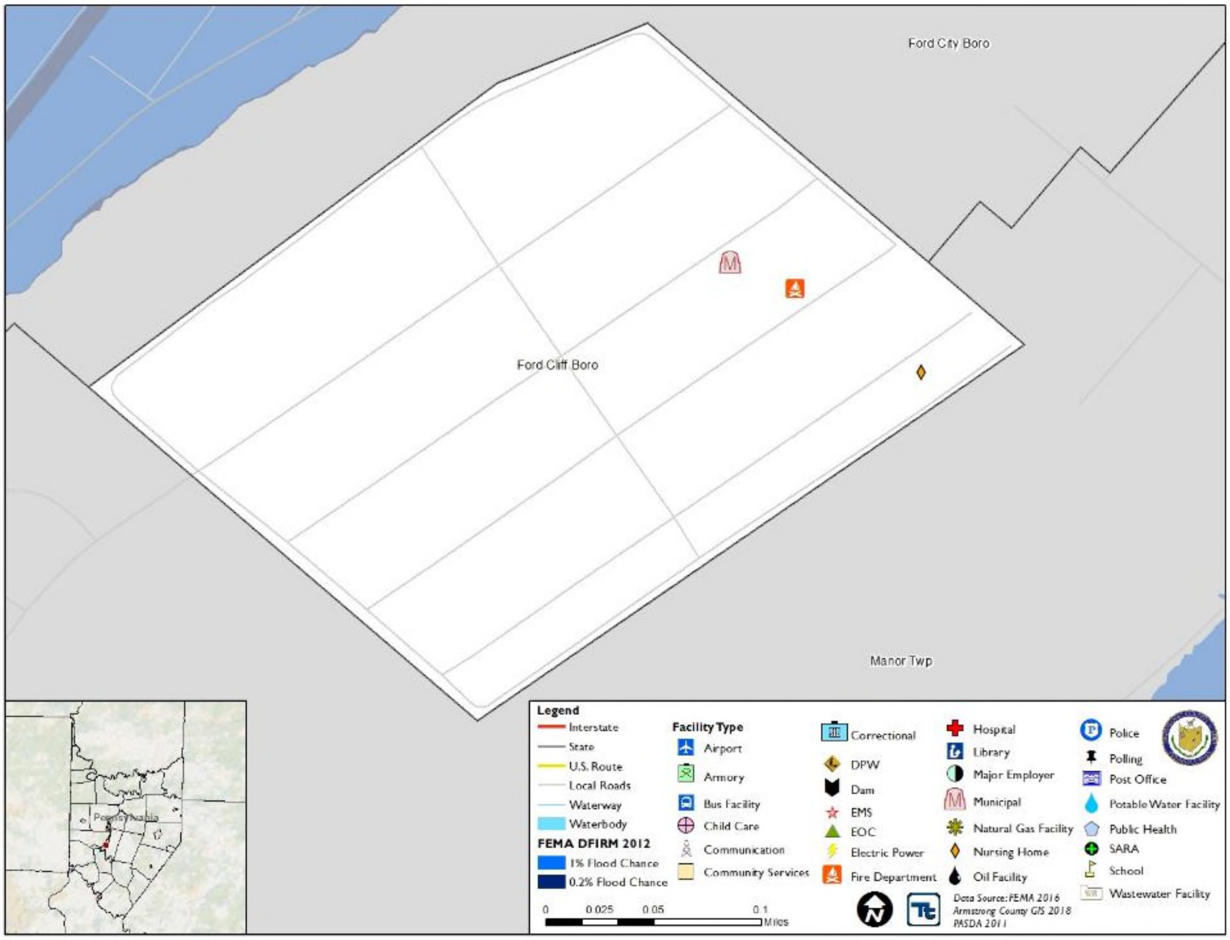


Elderton Borough

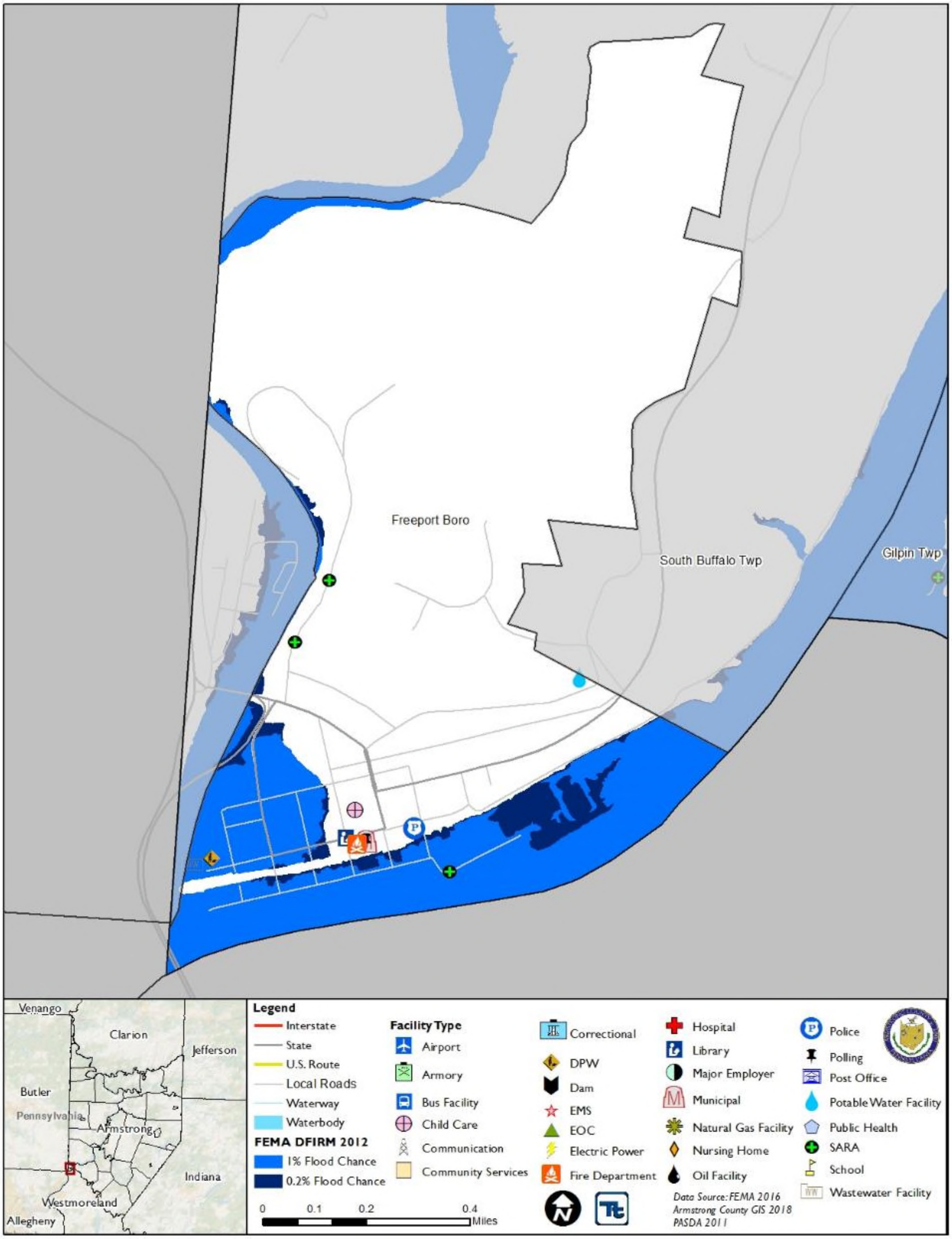
Ford City Borough



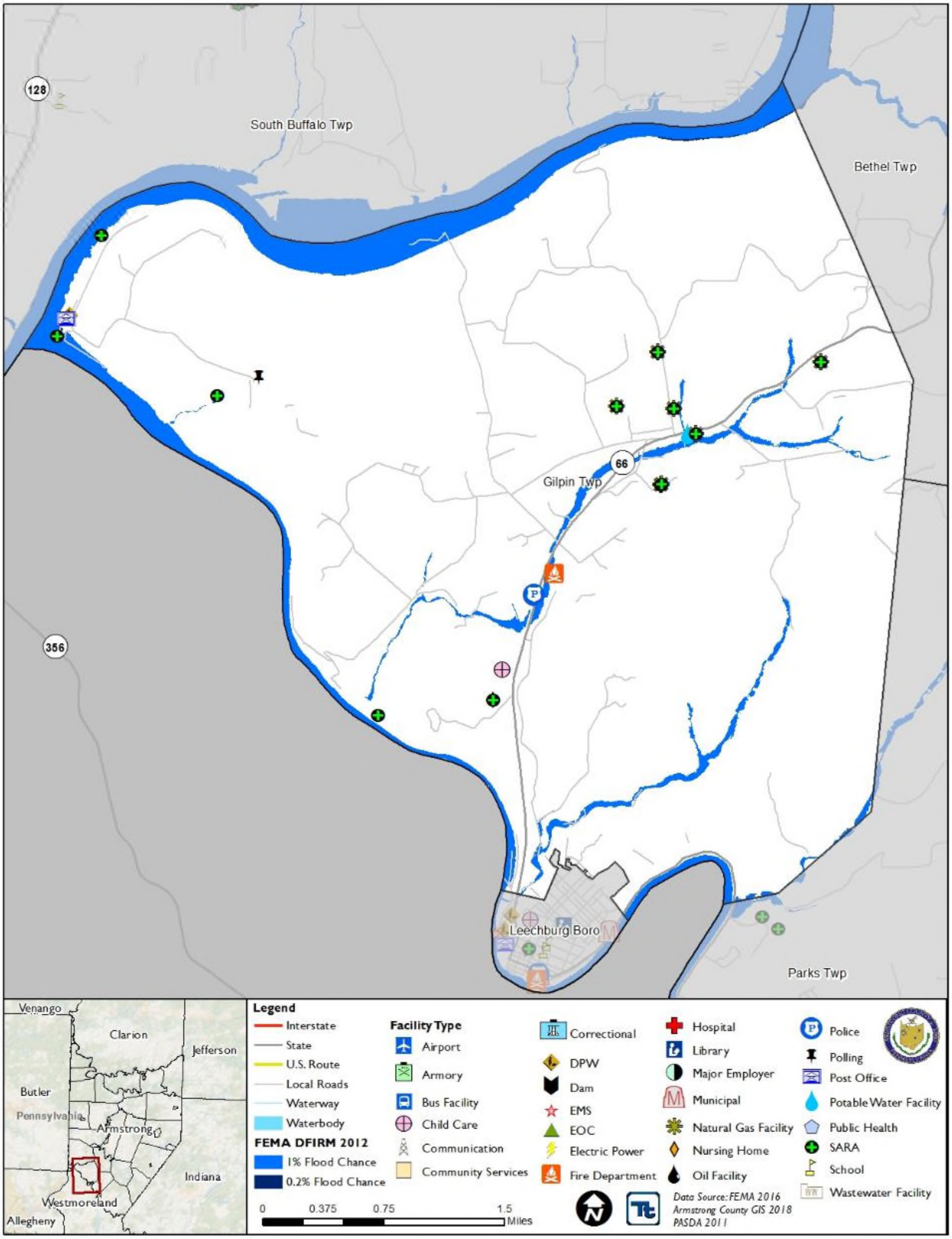
Ford Cliff Borough



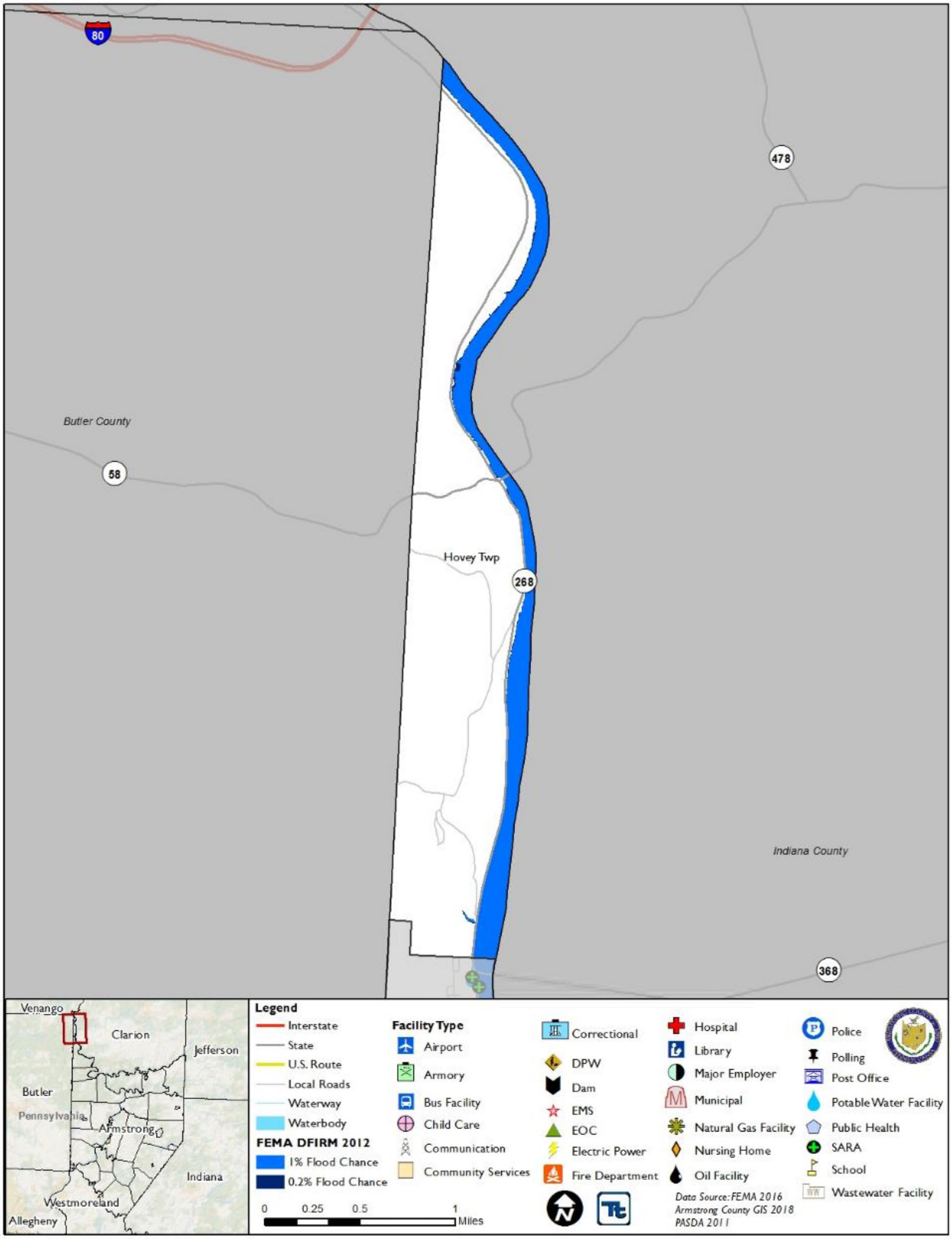
Freeport Borough



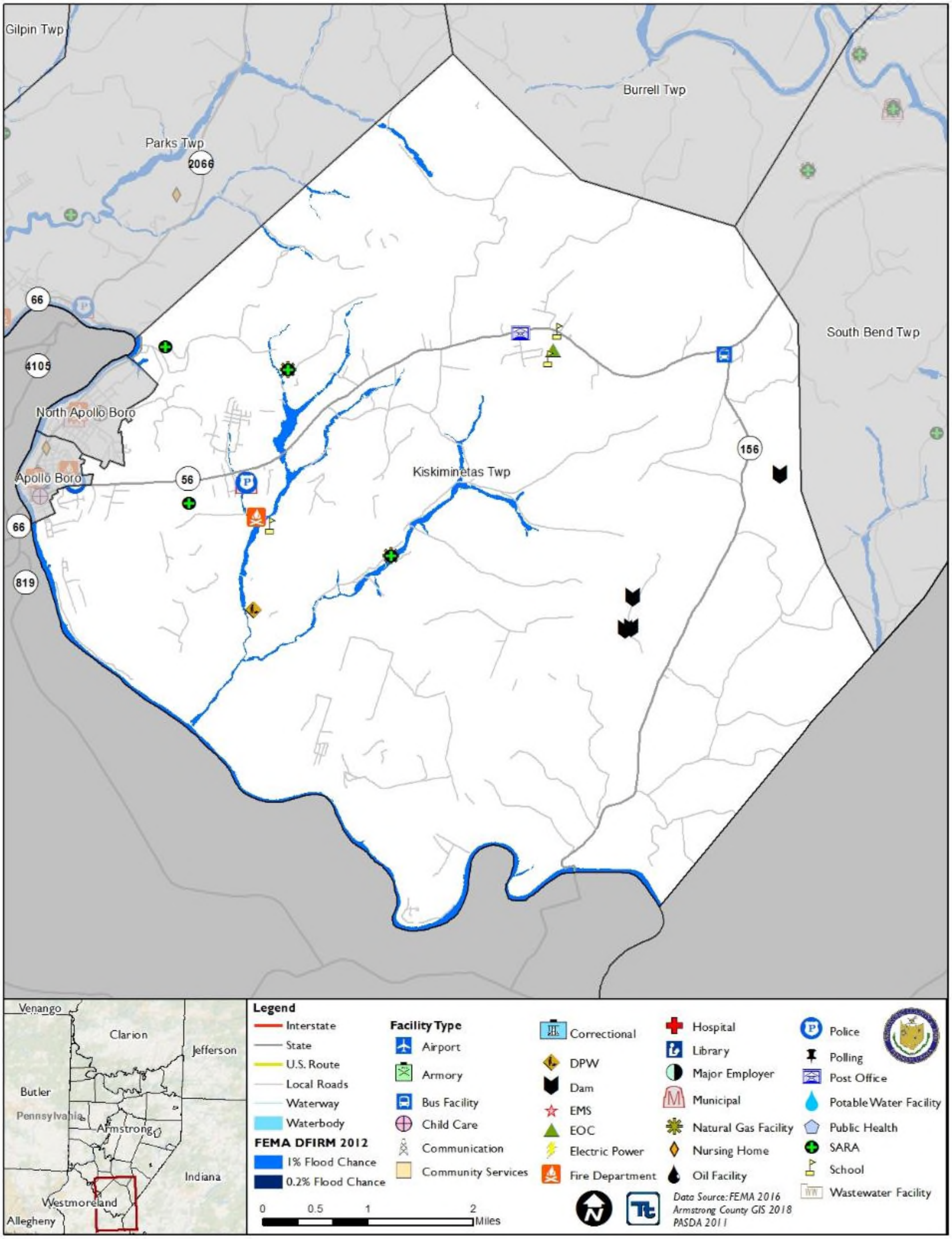
Gilpin Township



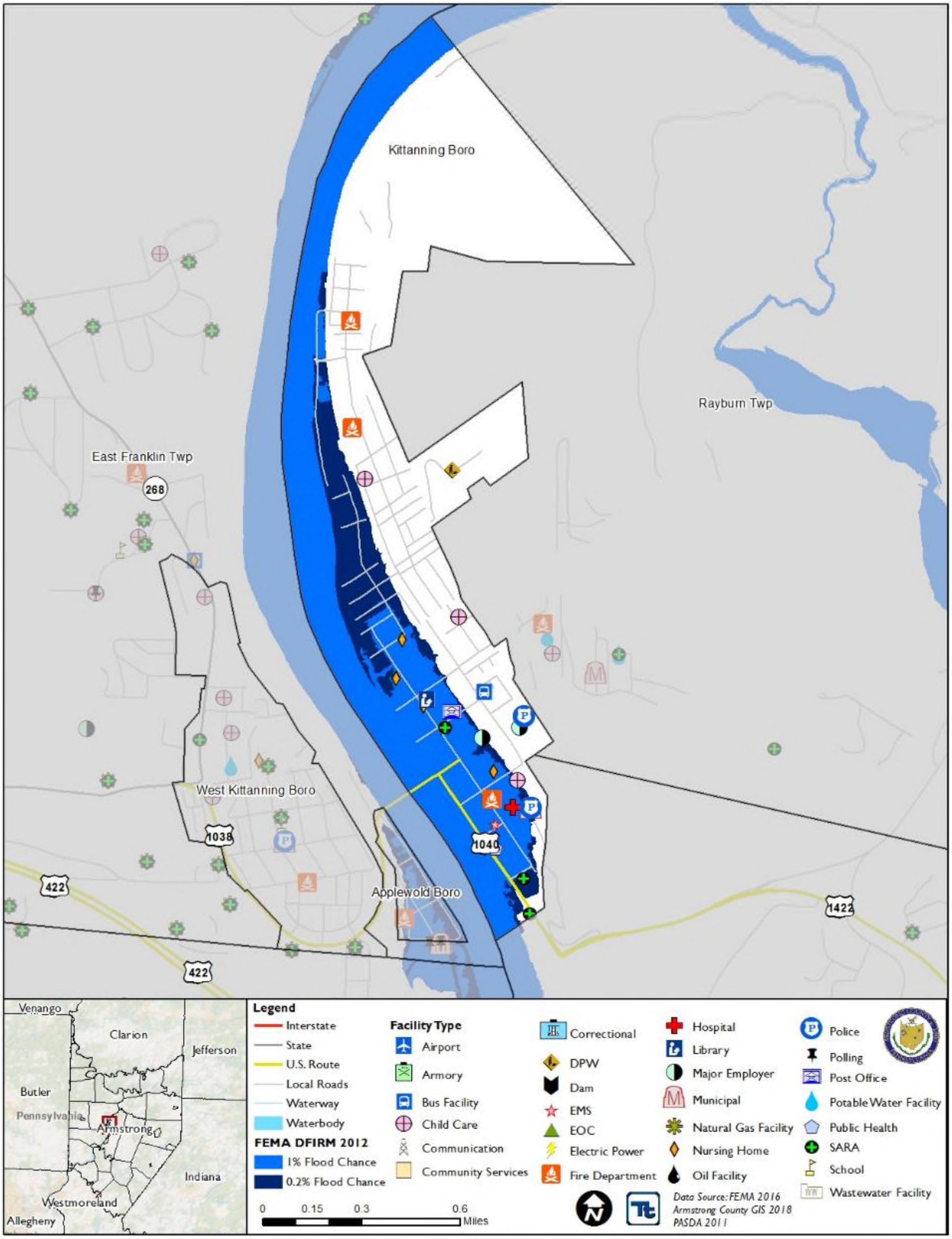
Hovey Township



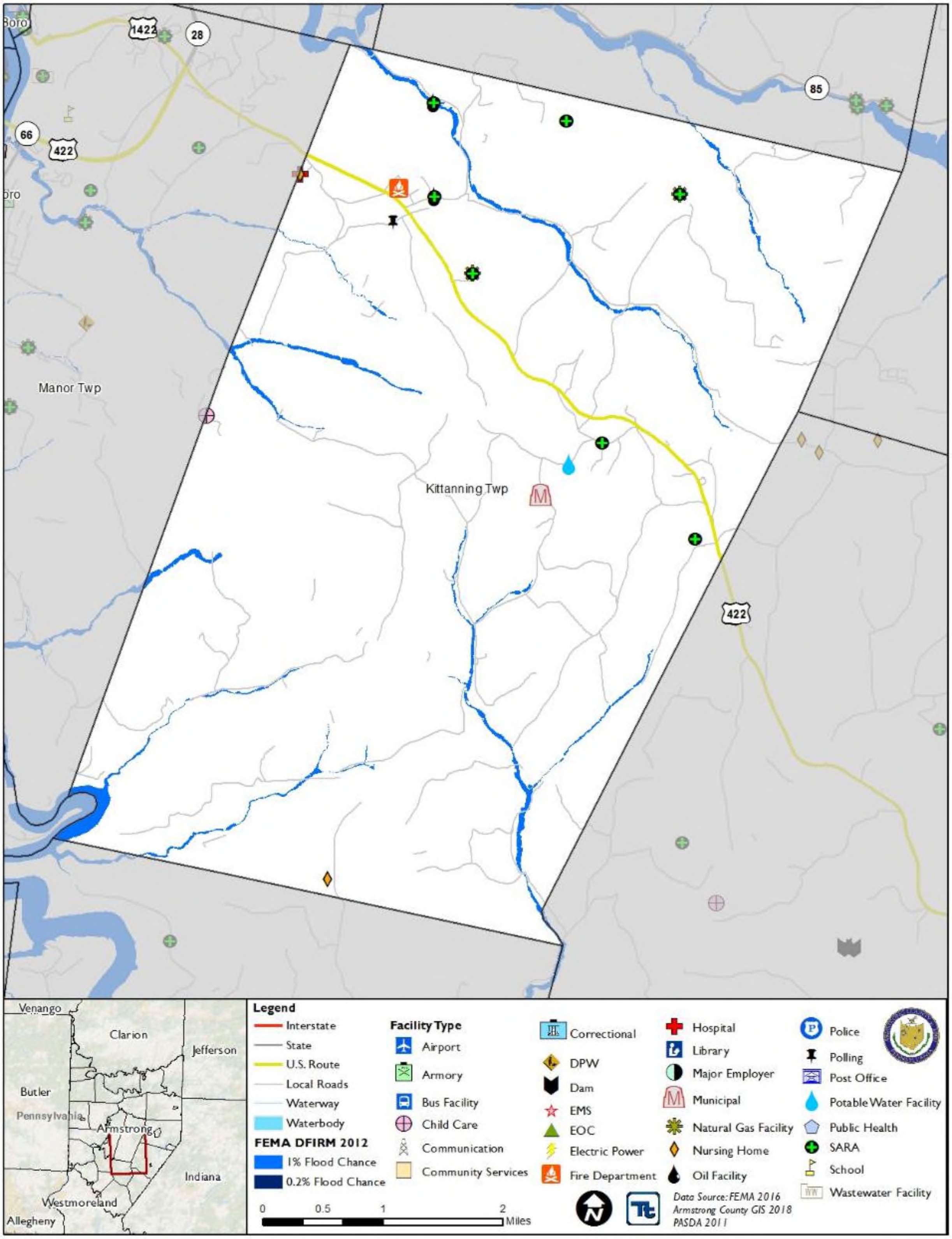
Kiskiminetas Township



Kittanning Borough

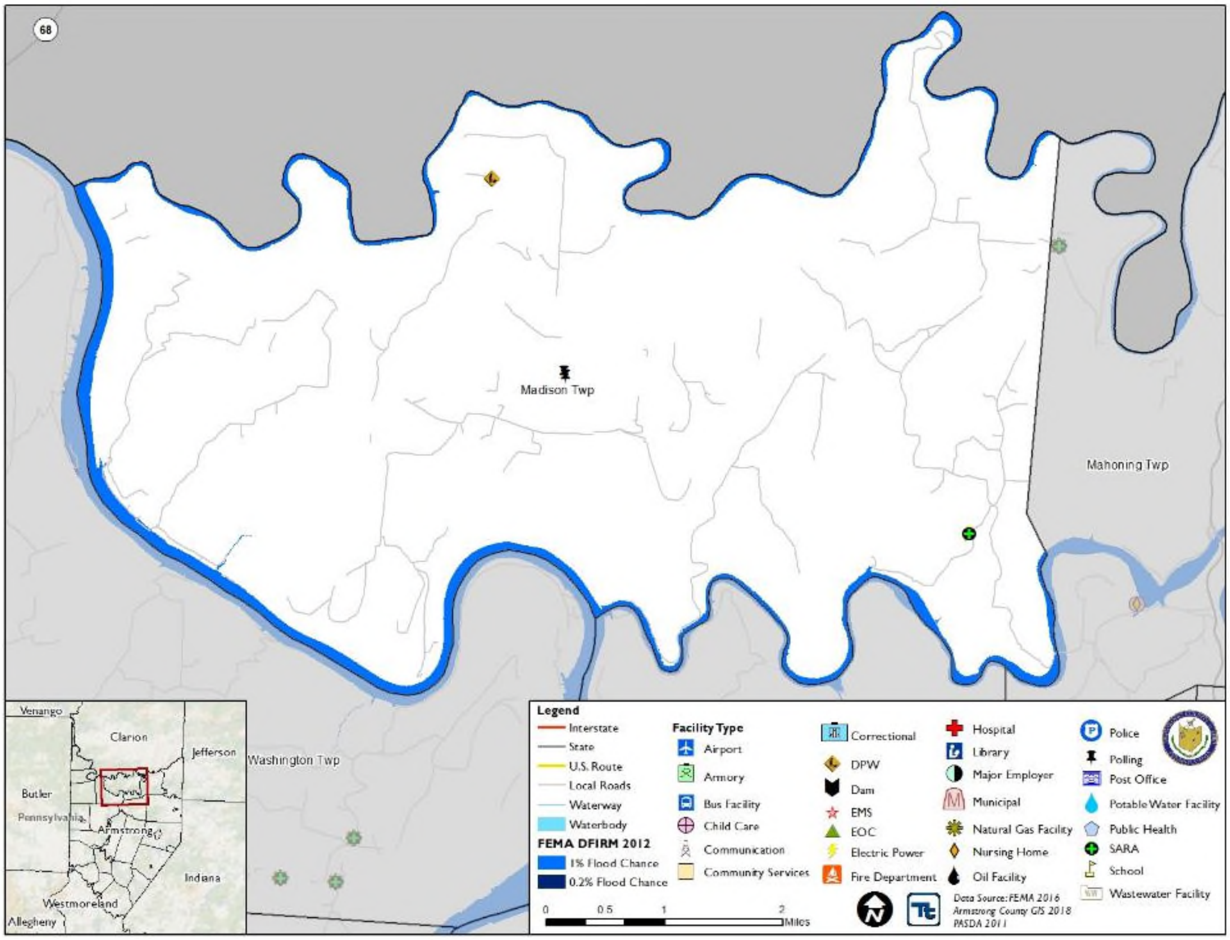


Kittanning Township

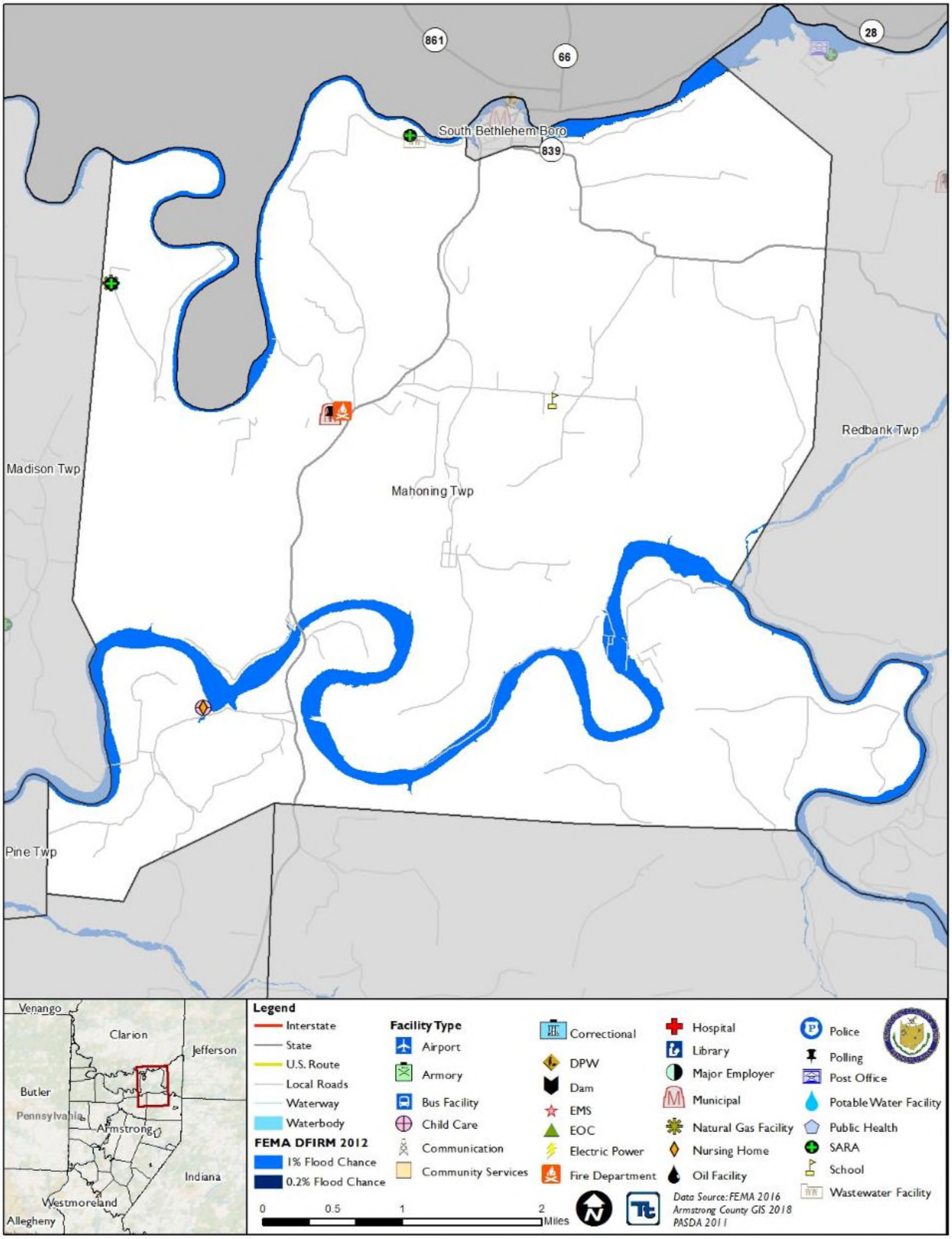


Leechburg Borough

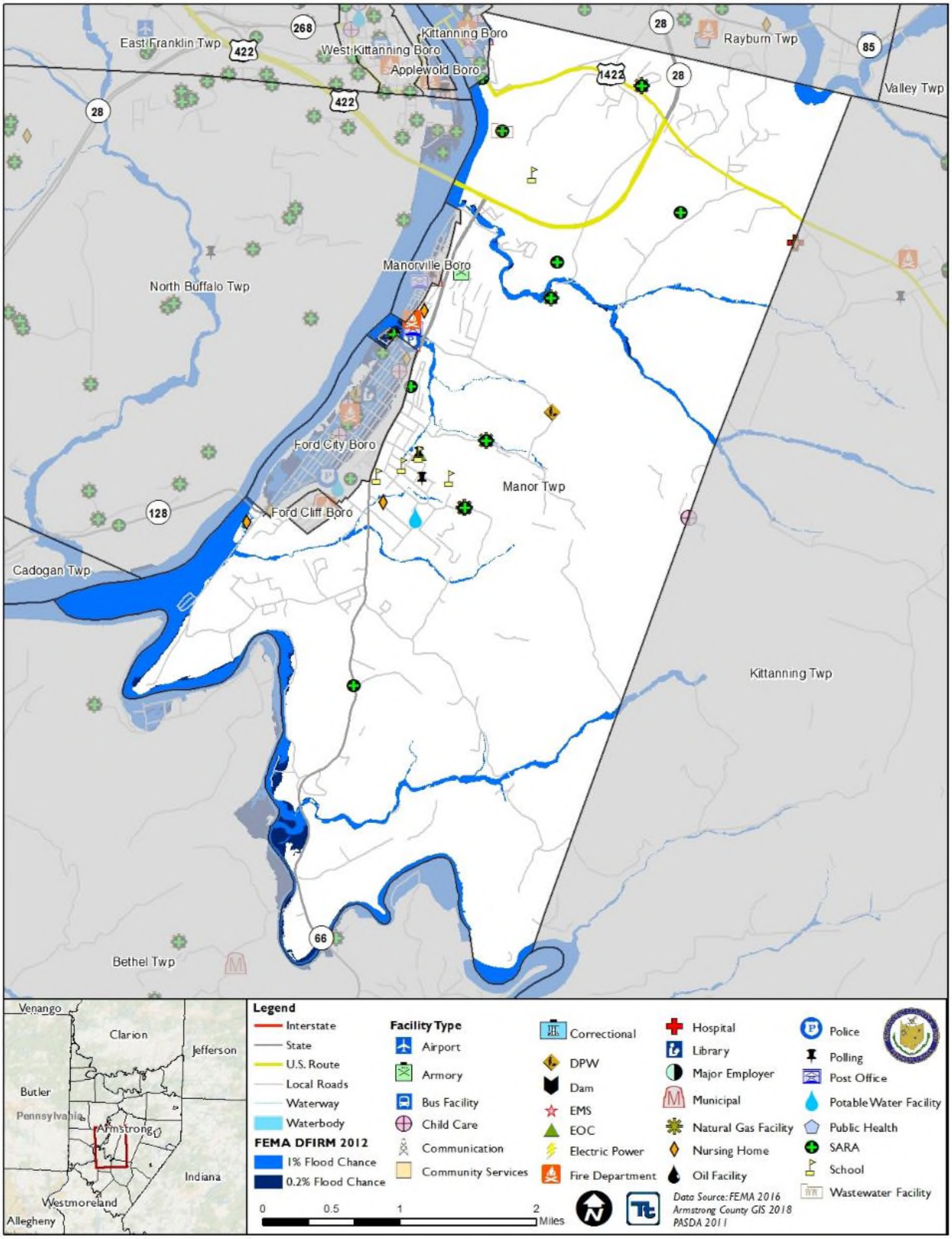
Madison Township



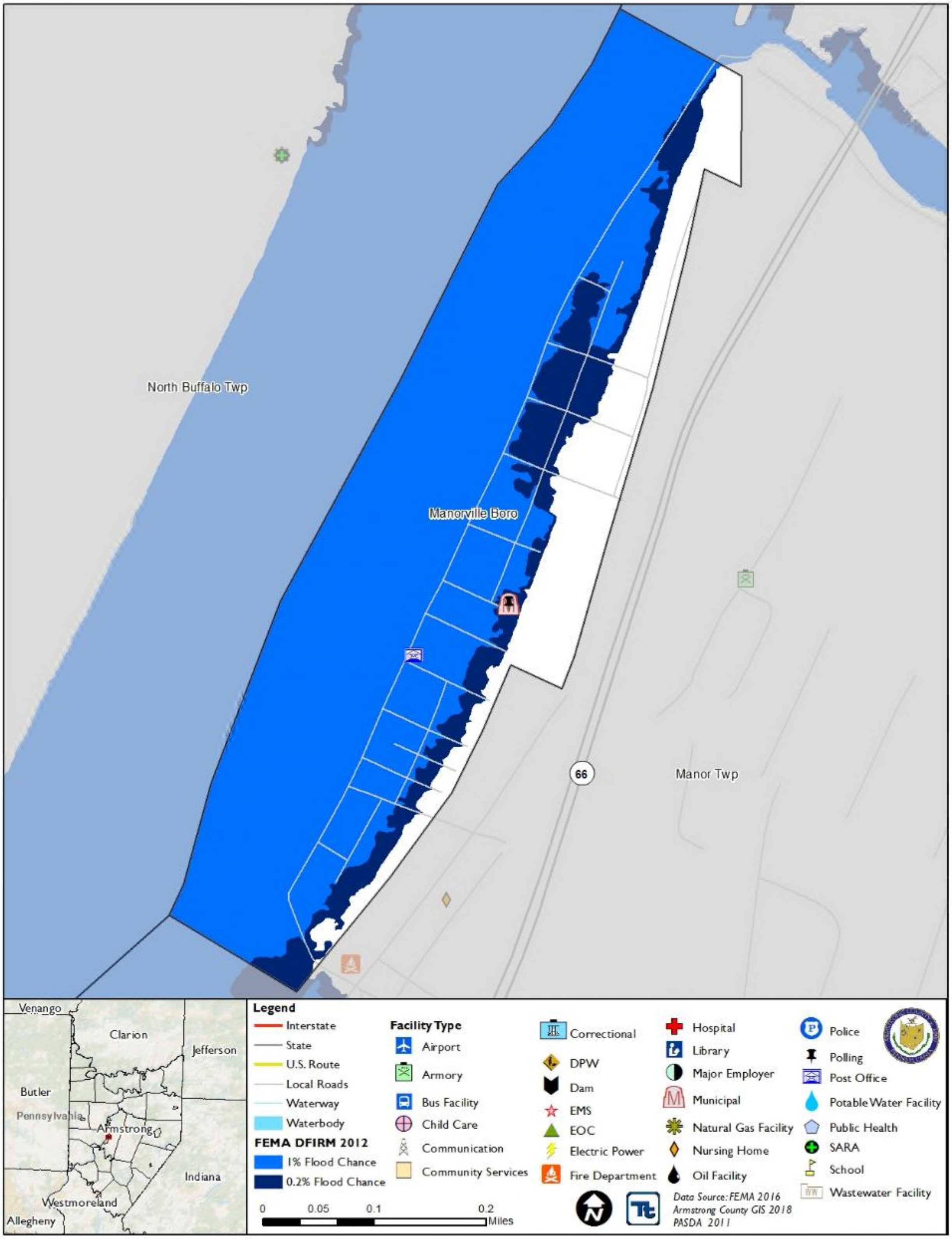
Mahoning Township



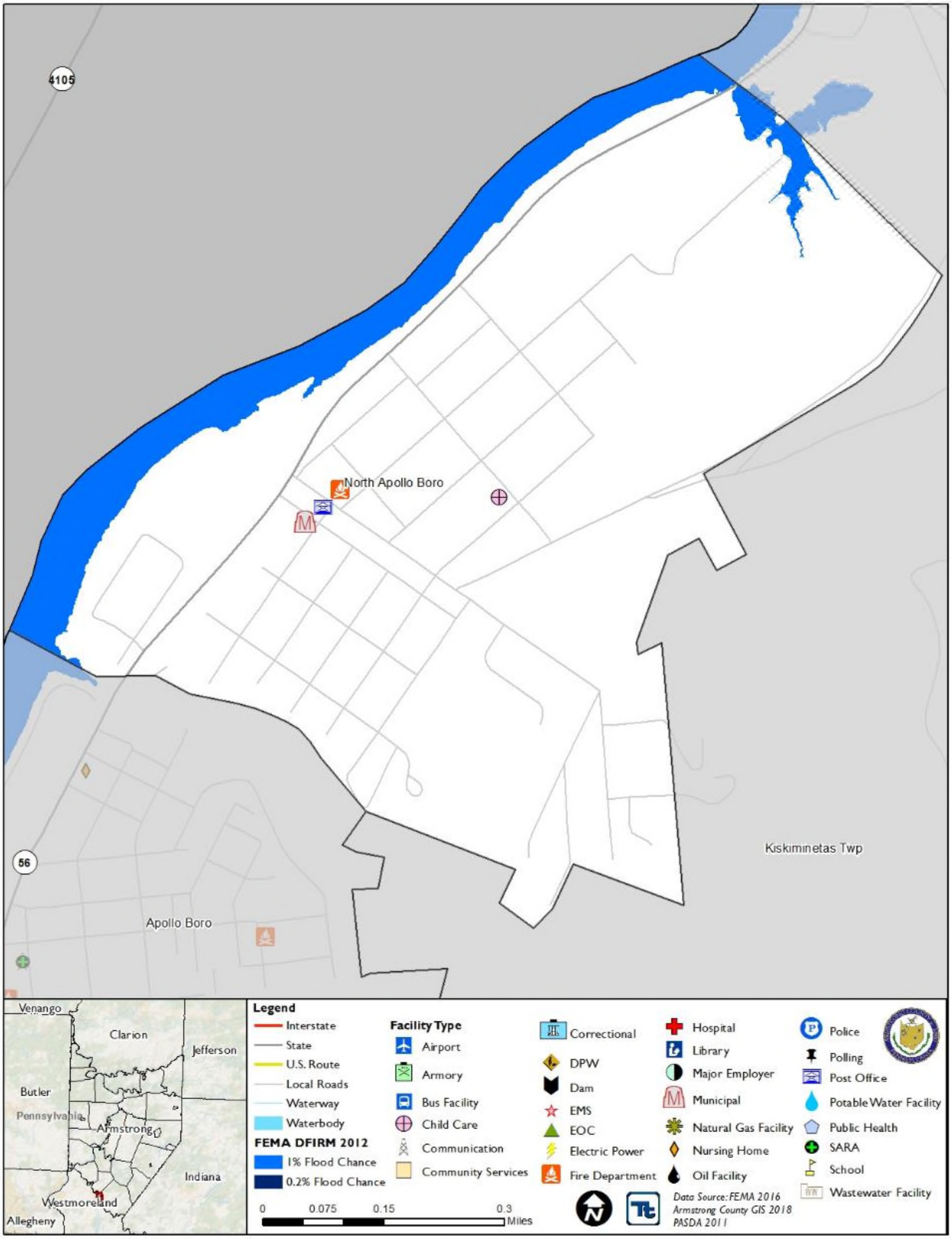
Manor Township



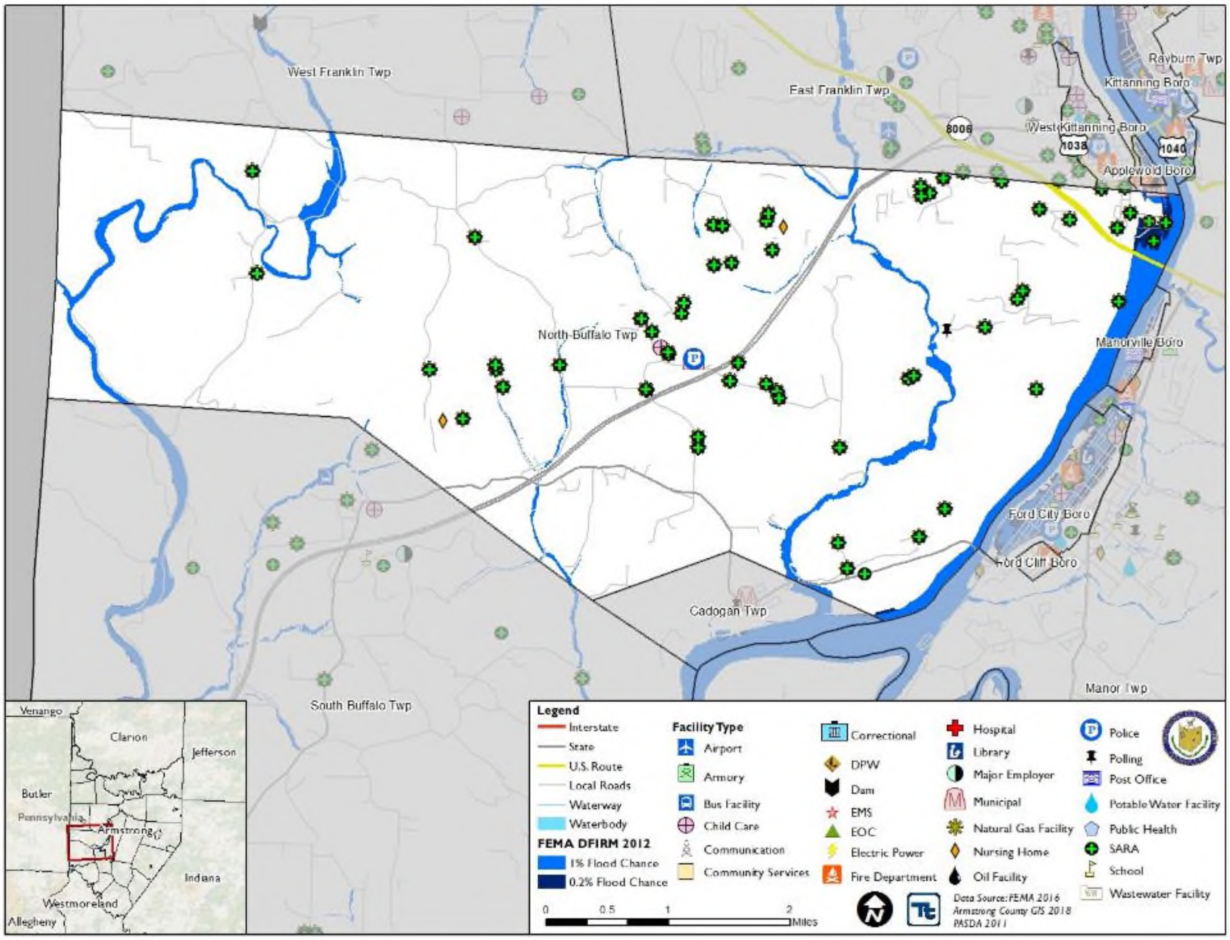
Manorville Borough



North Apollo Borough

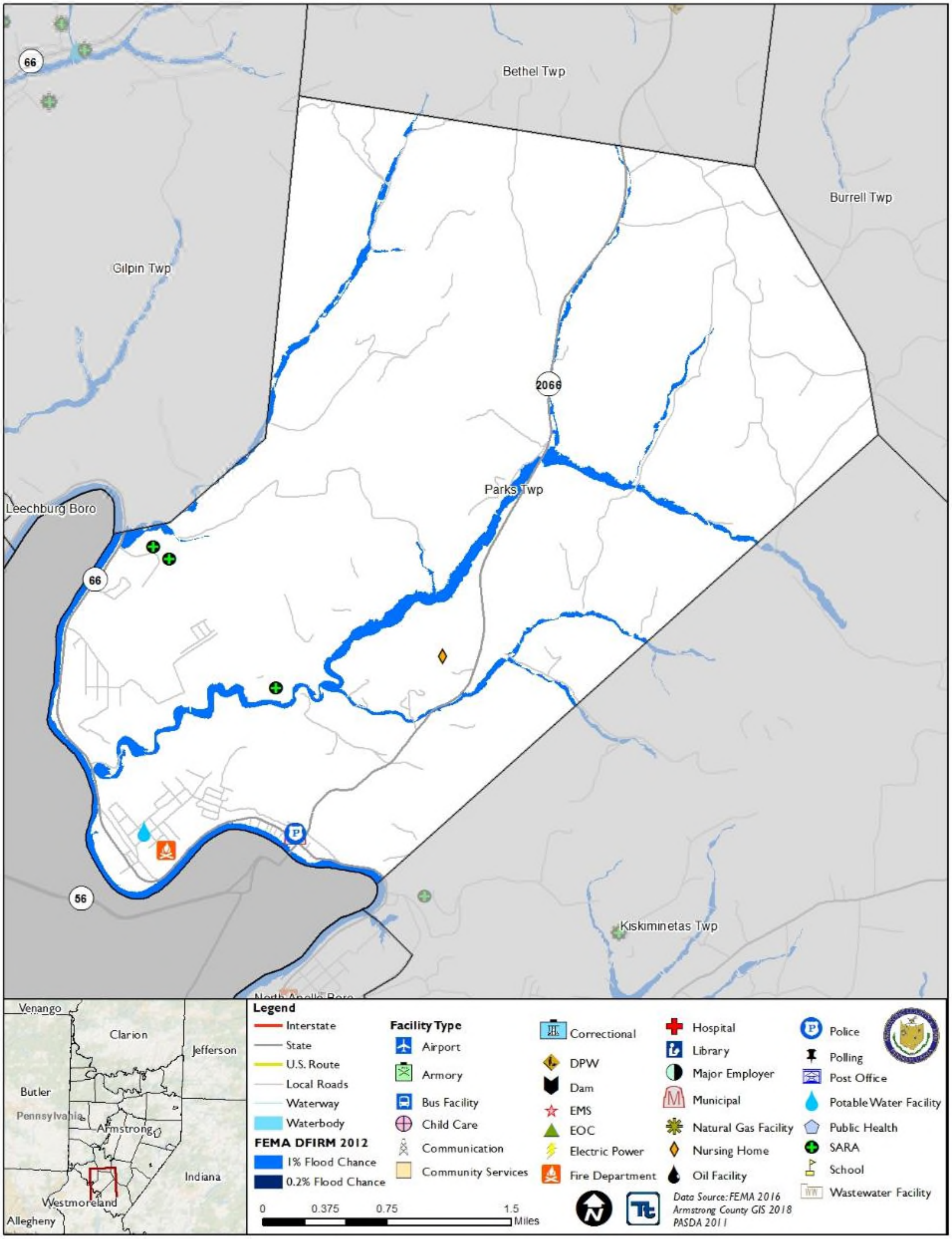


North Buffalo Township

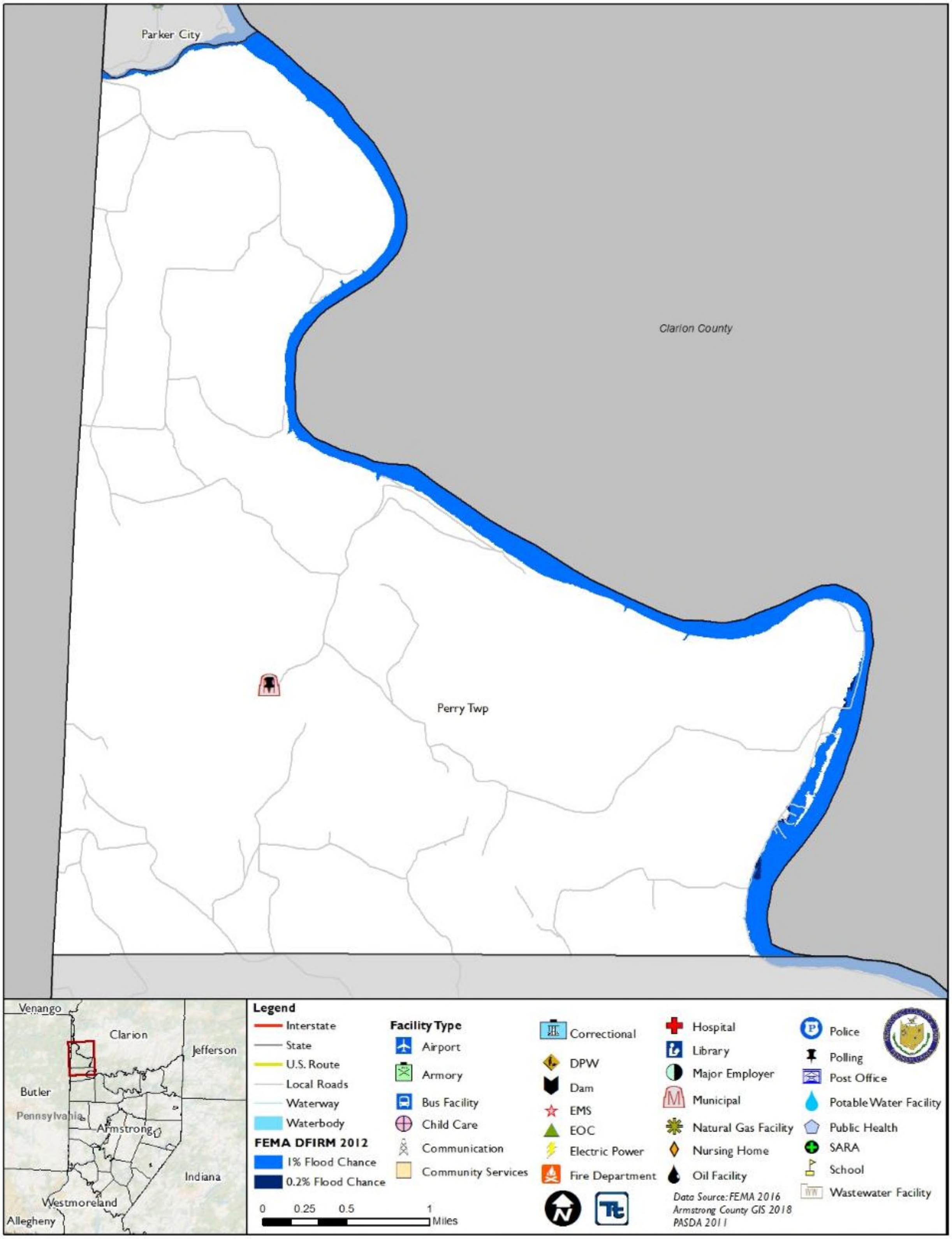


City of Parker

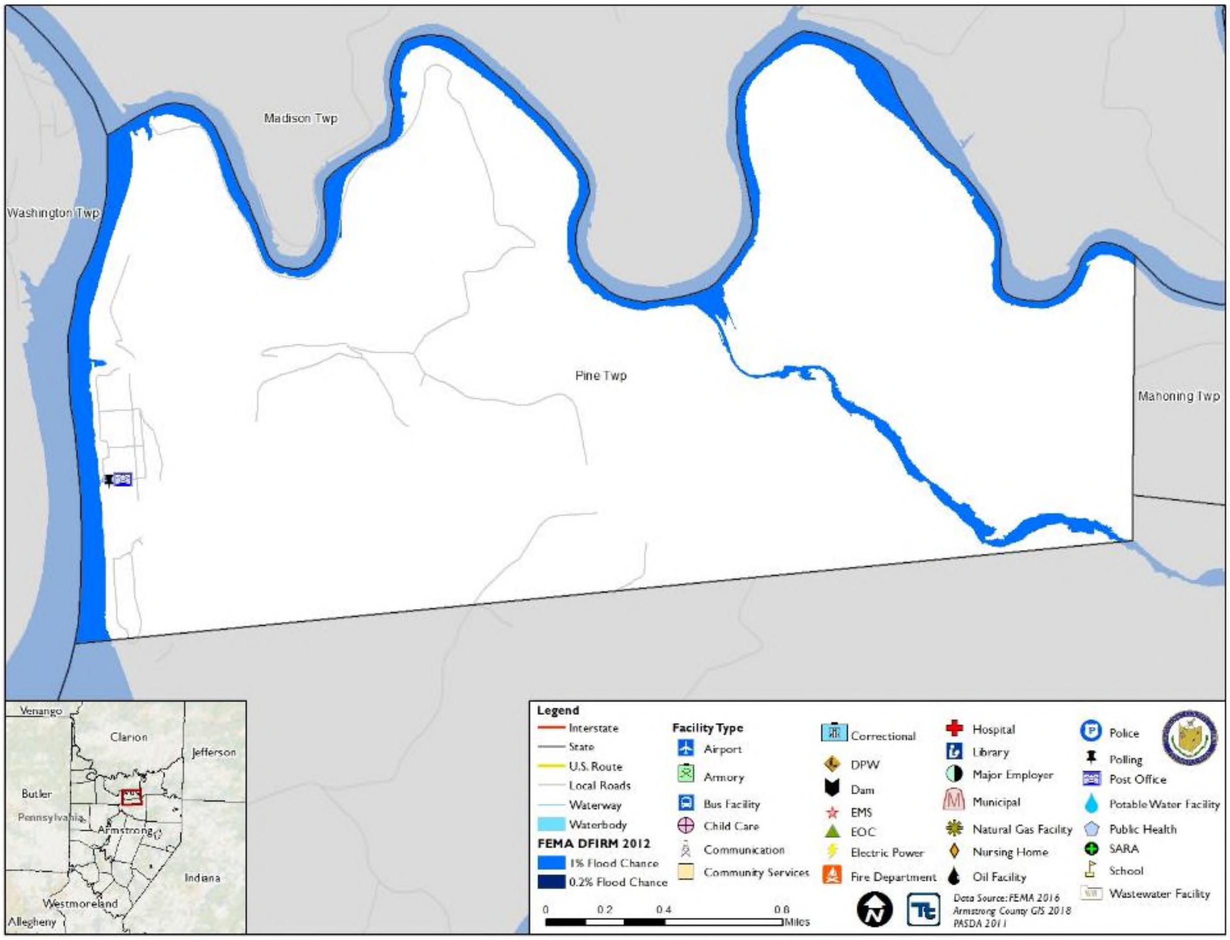
Parks Township



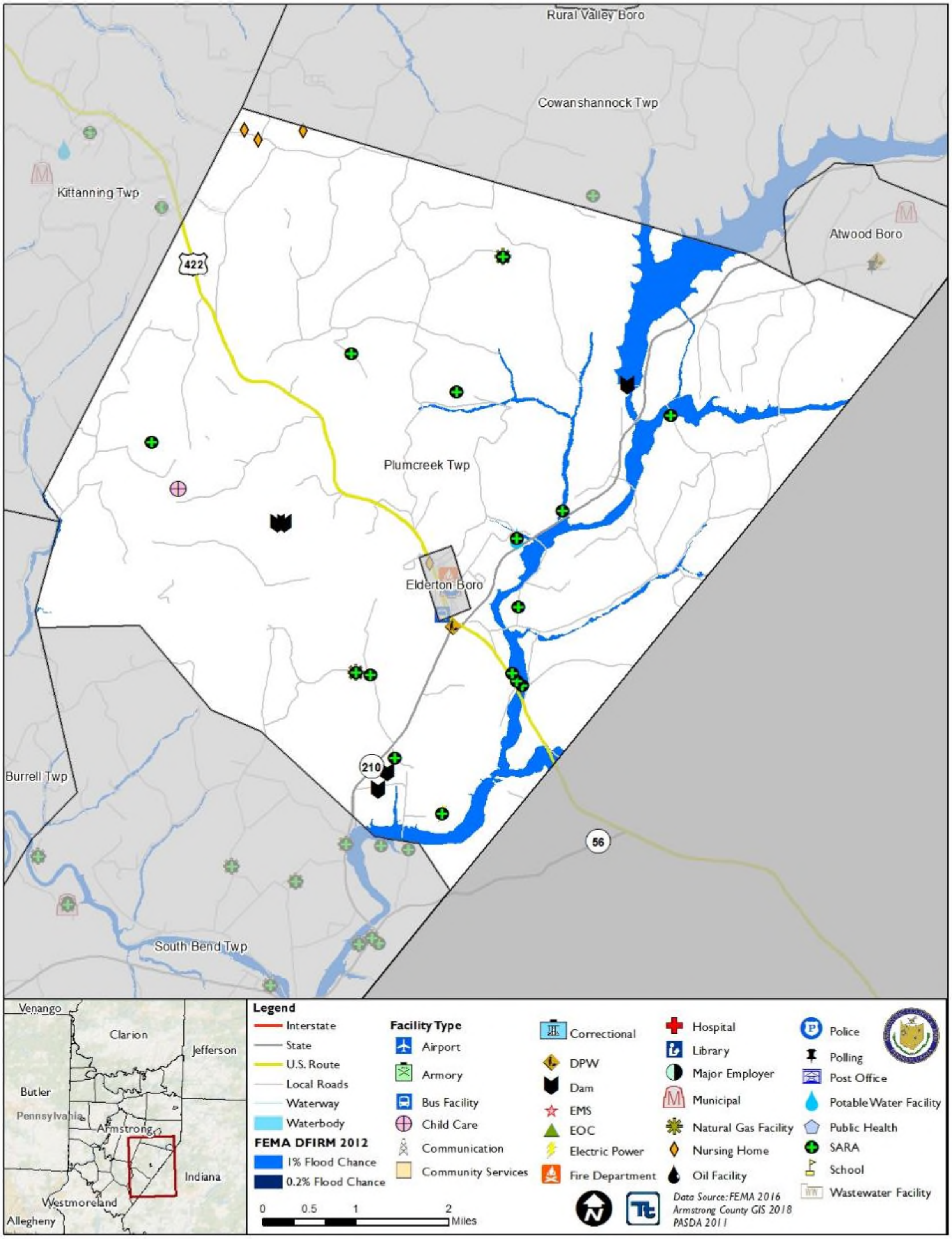
Perry Township



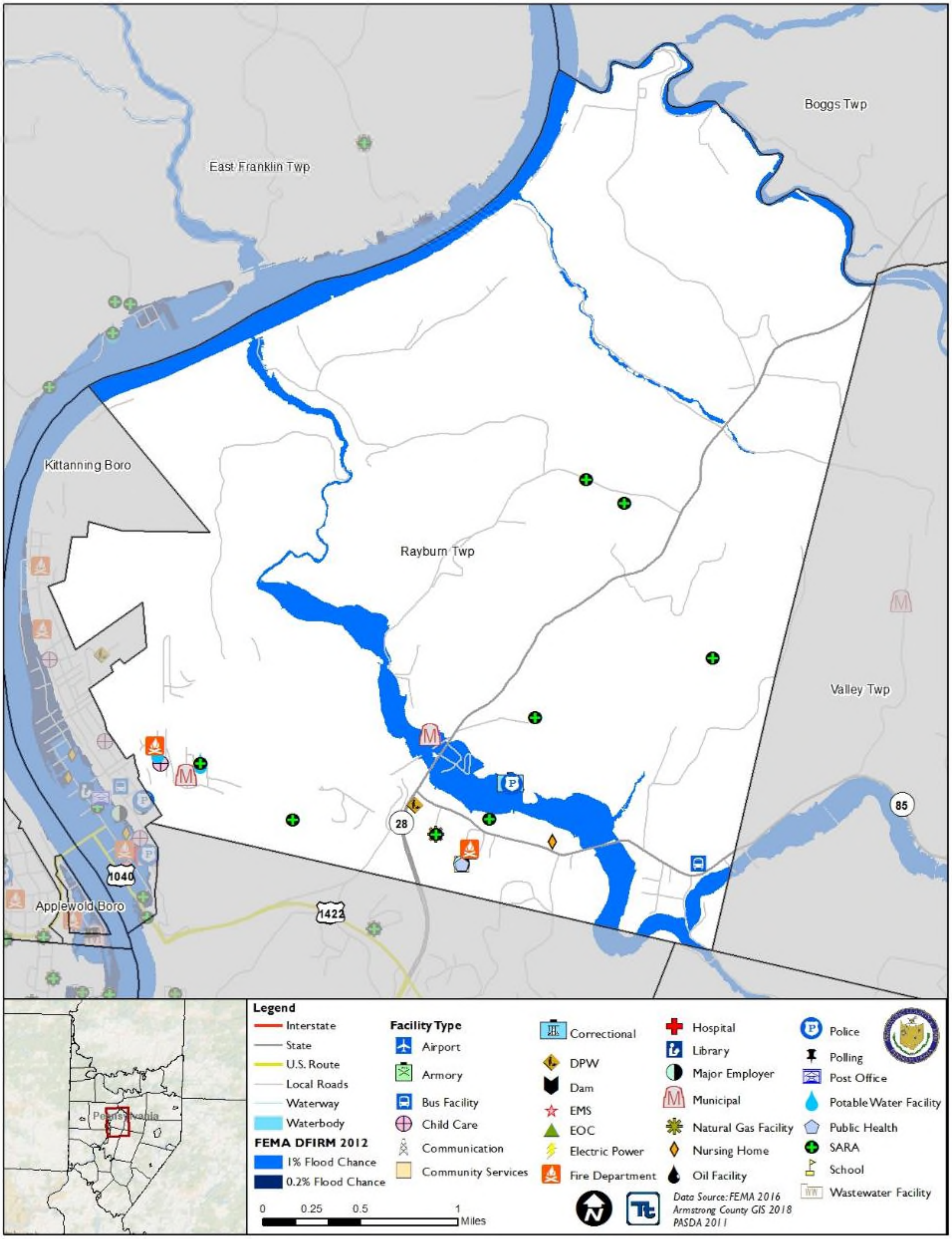
Pine Township



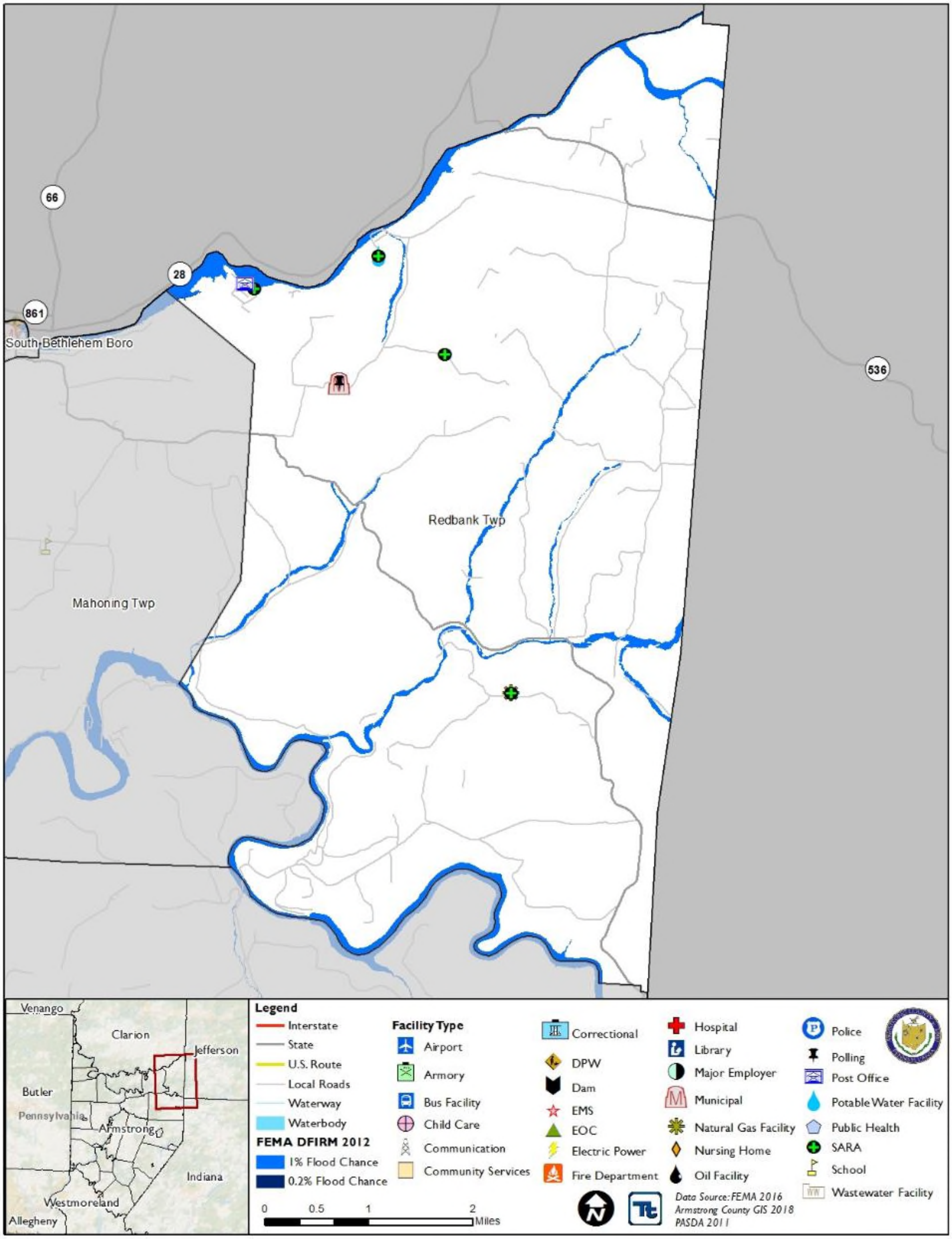
Plumcreek Township



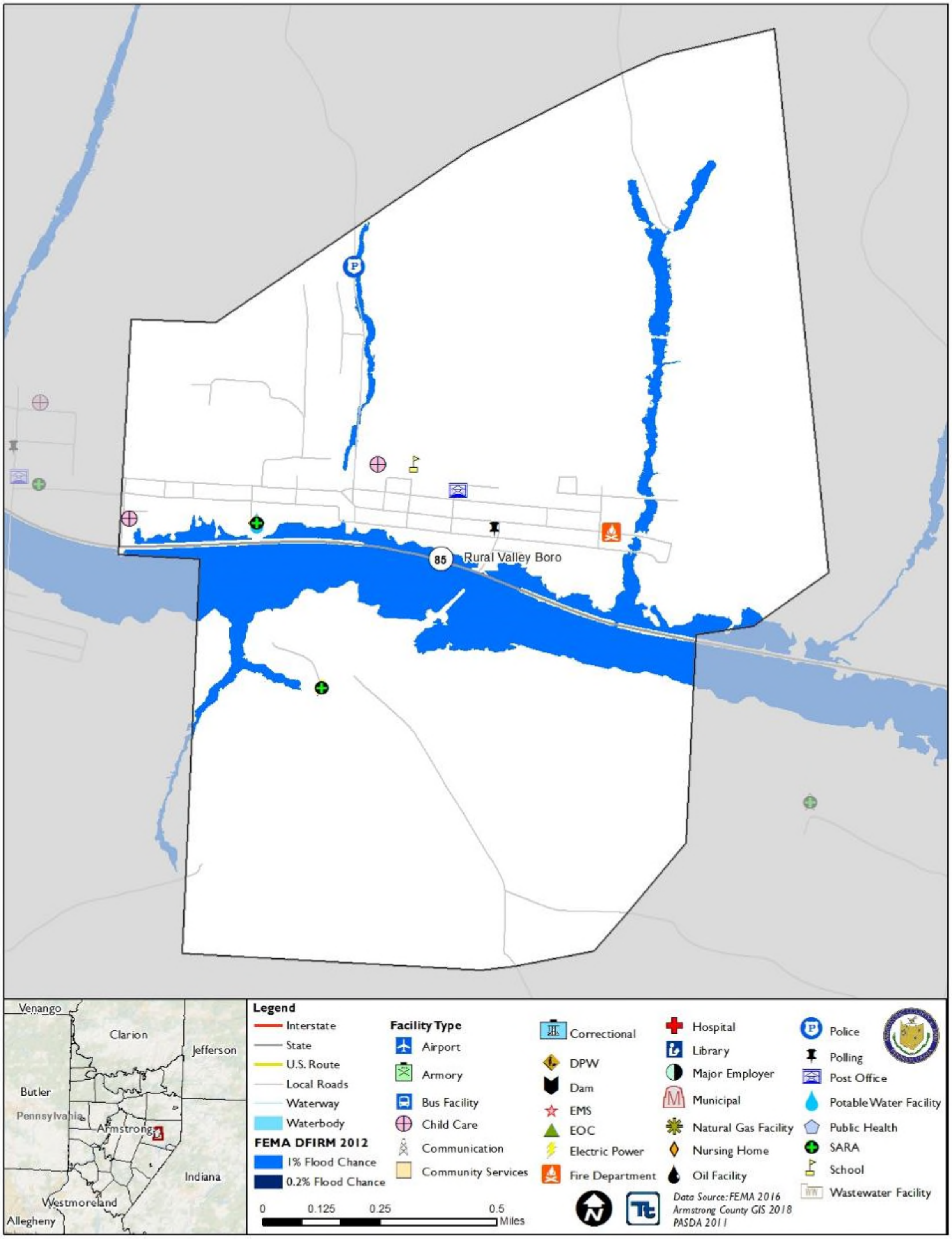
Rayburn Township



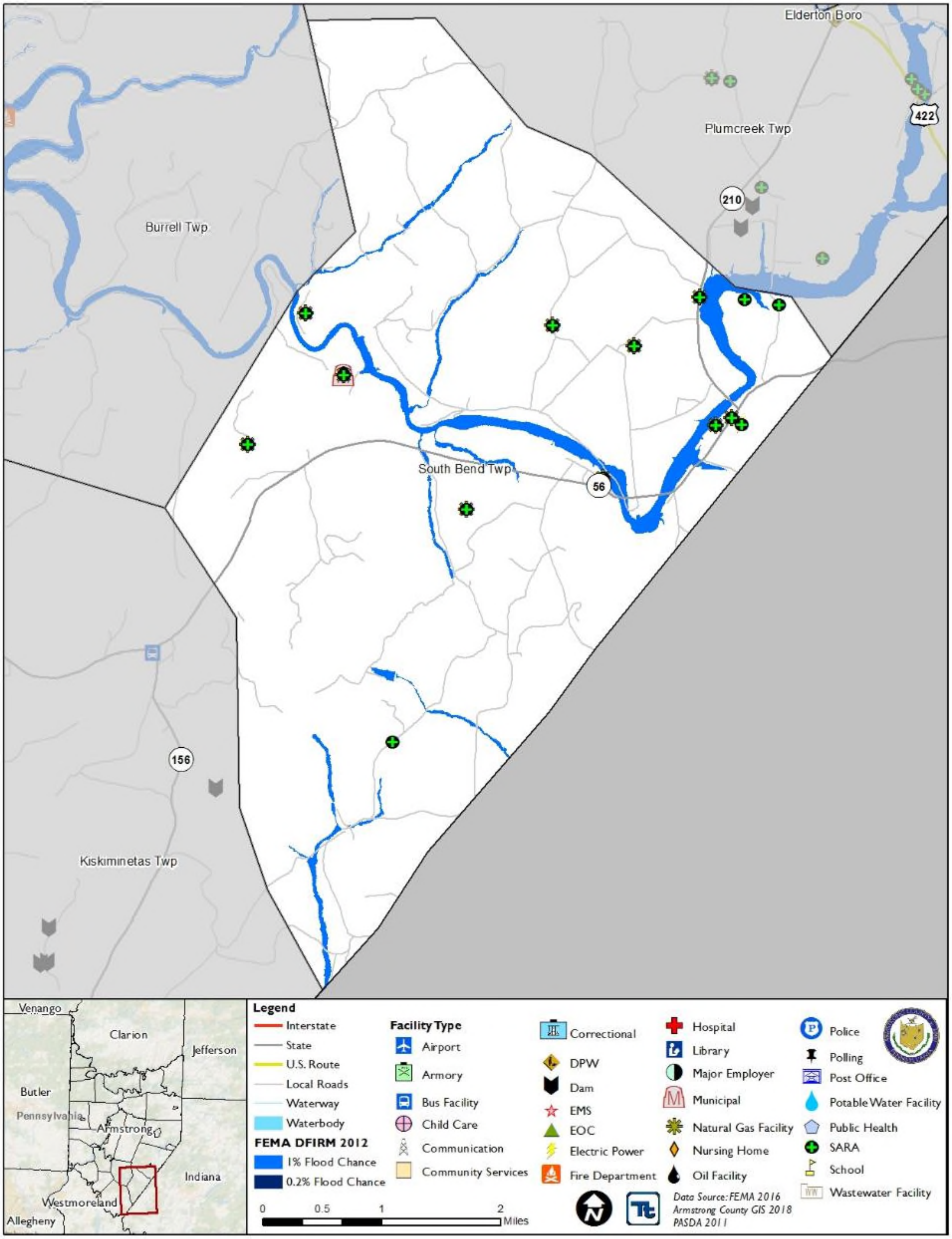
Redbank Township



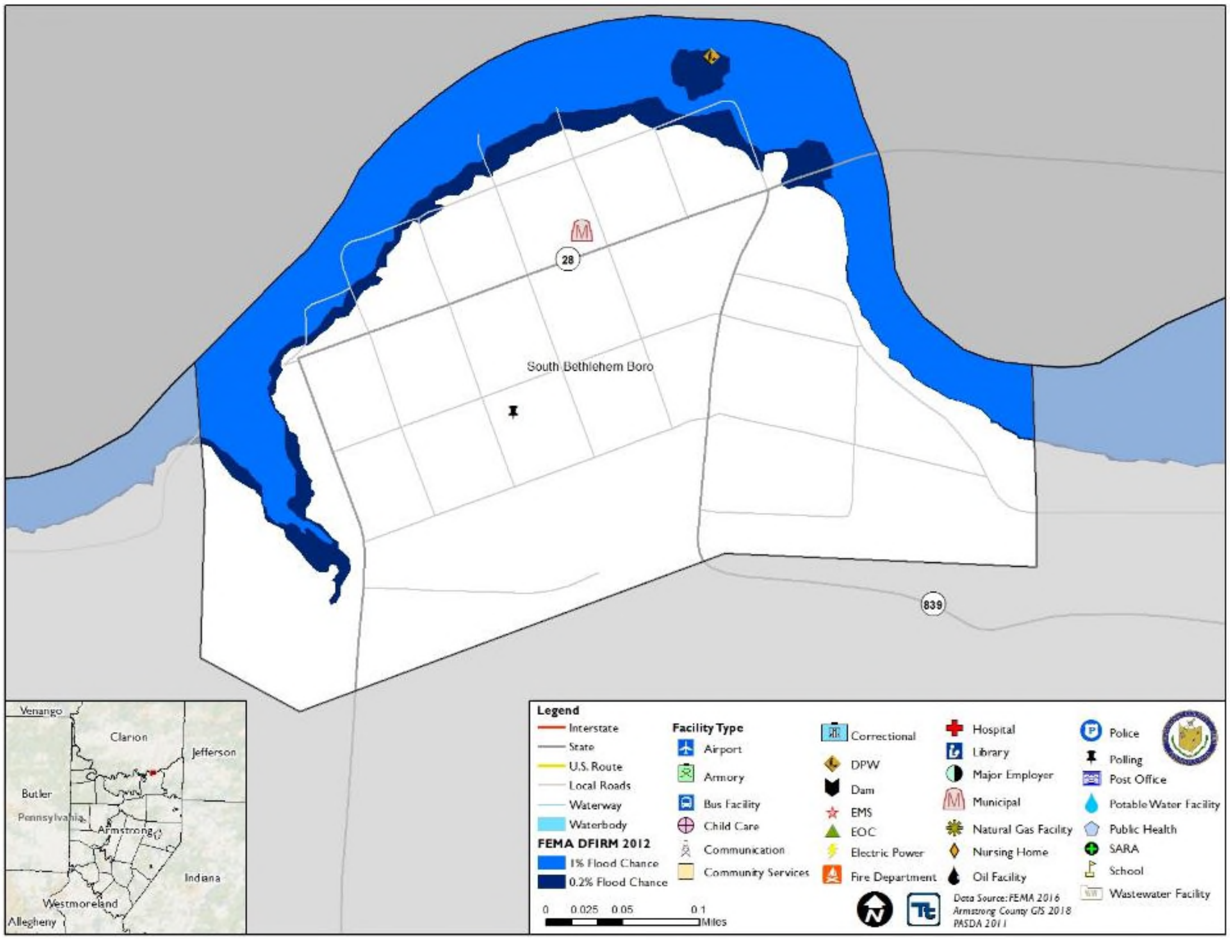
Rural Valley Borough



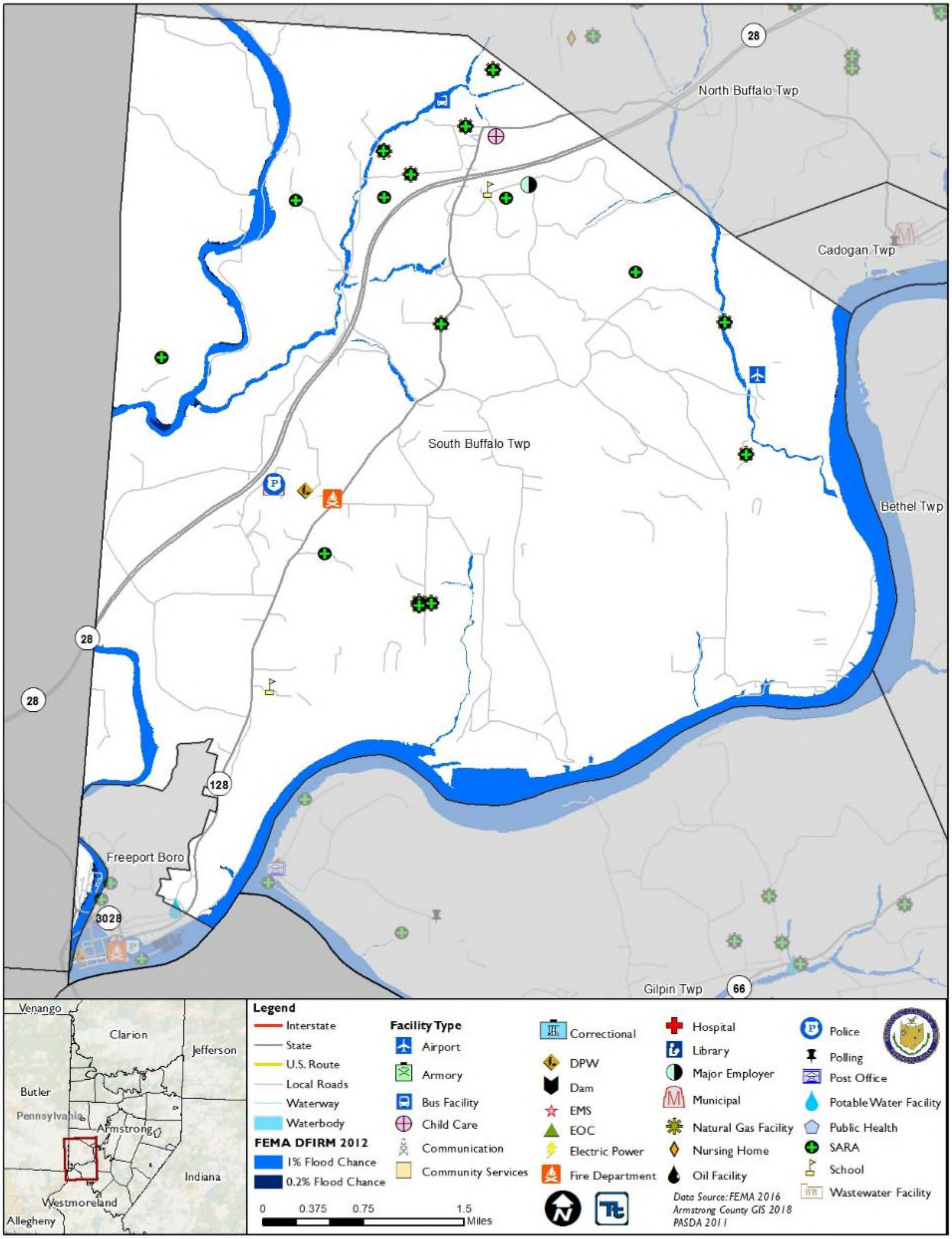
South Bend Township



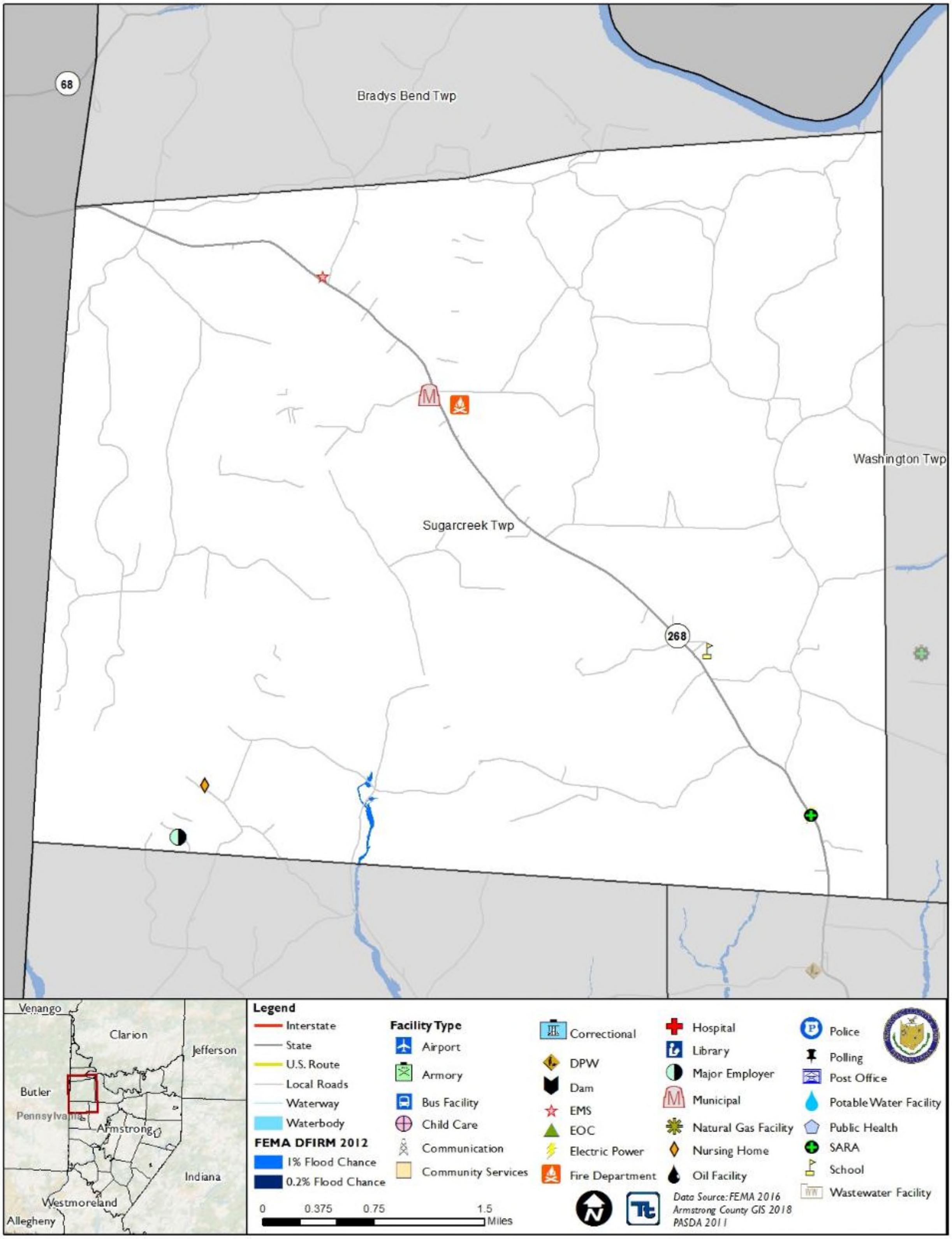
South Bethlehem Borough



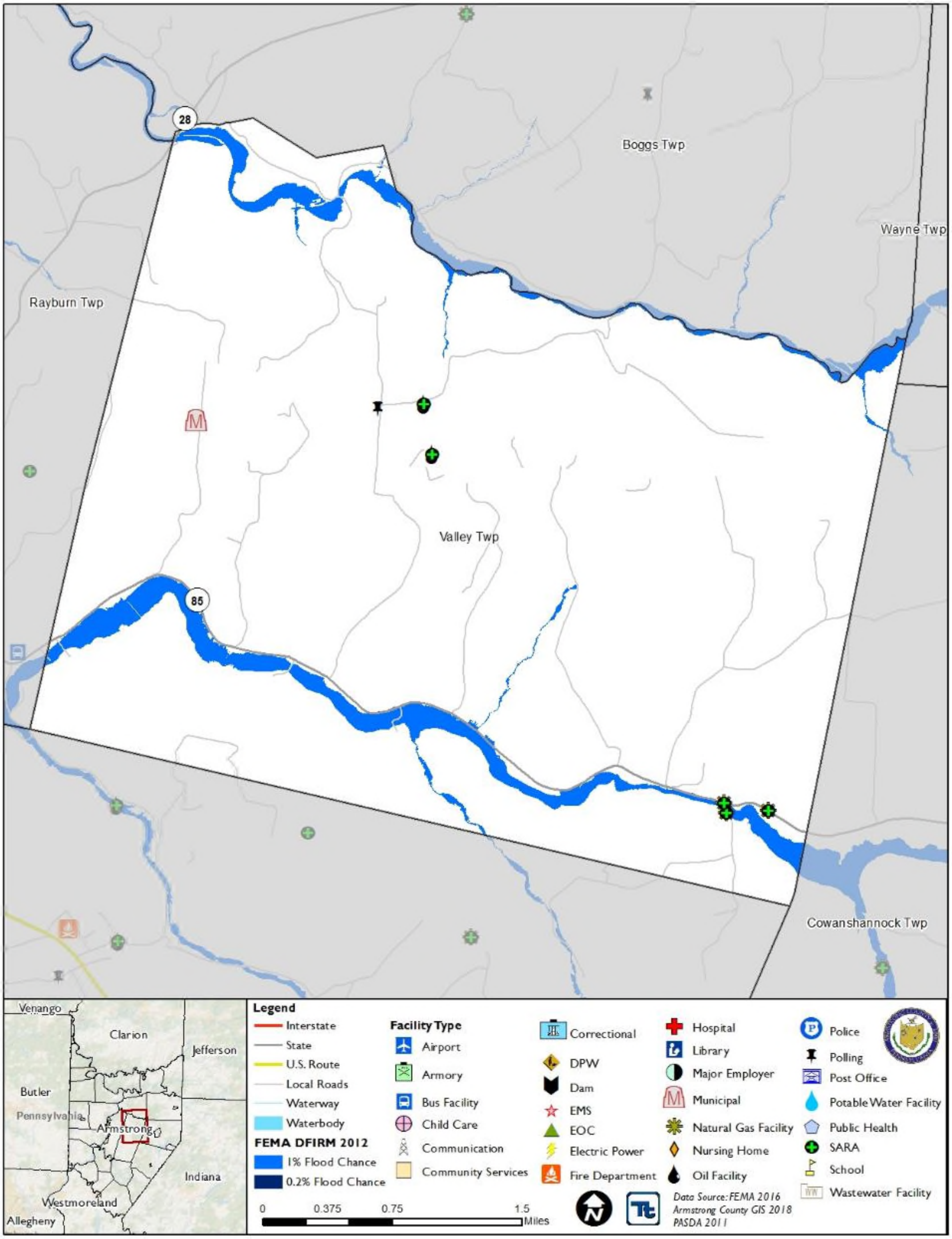
South Buffalo Township



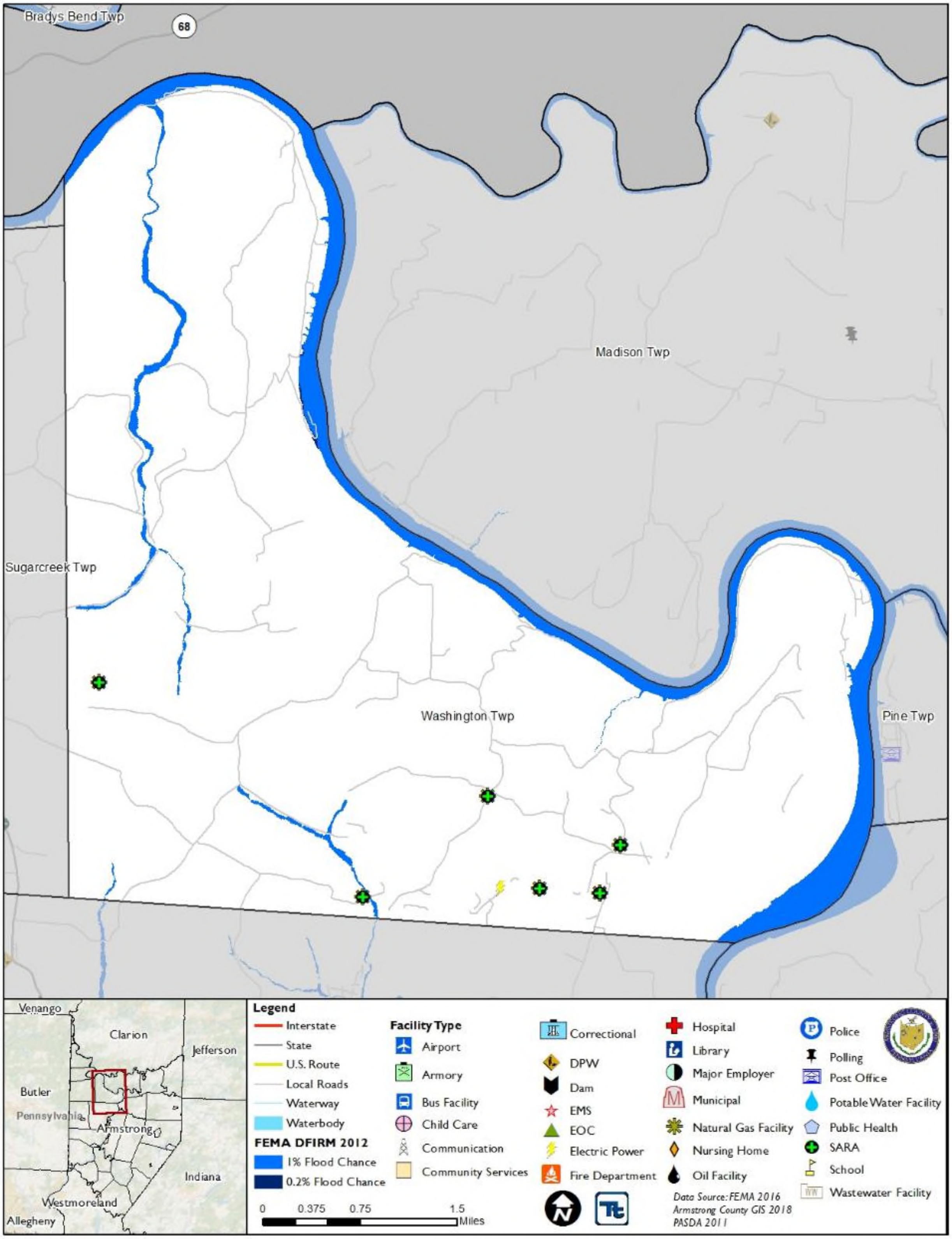
Sugarcreek Township



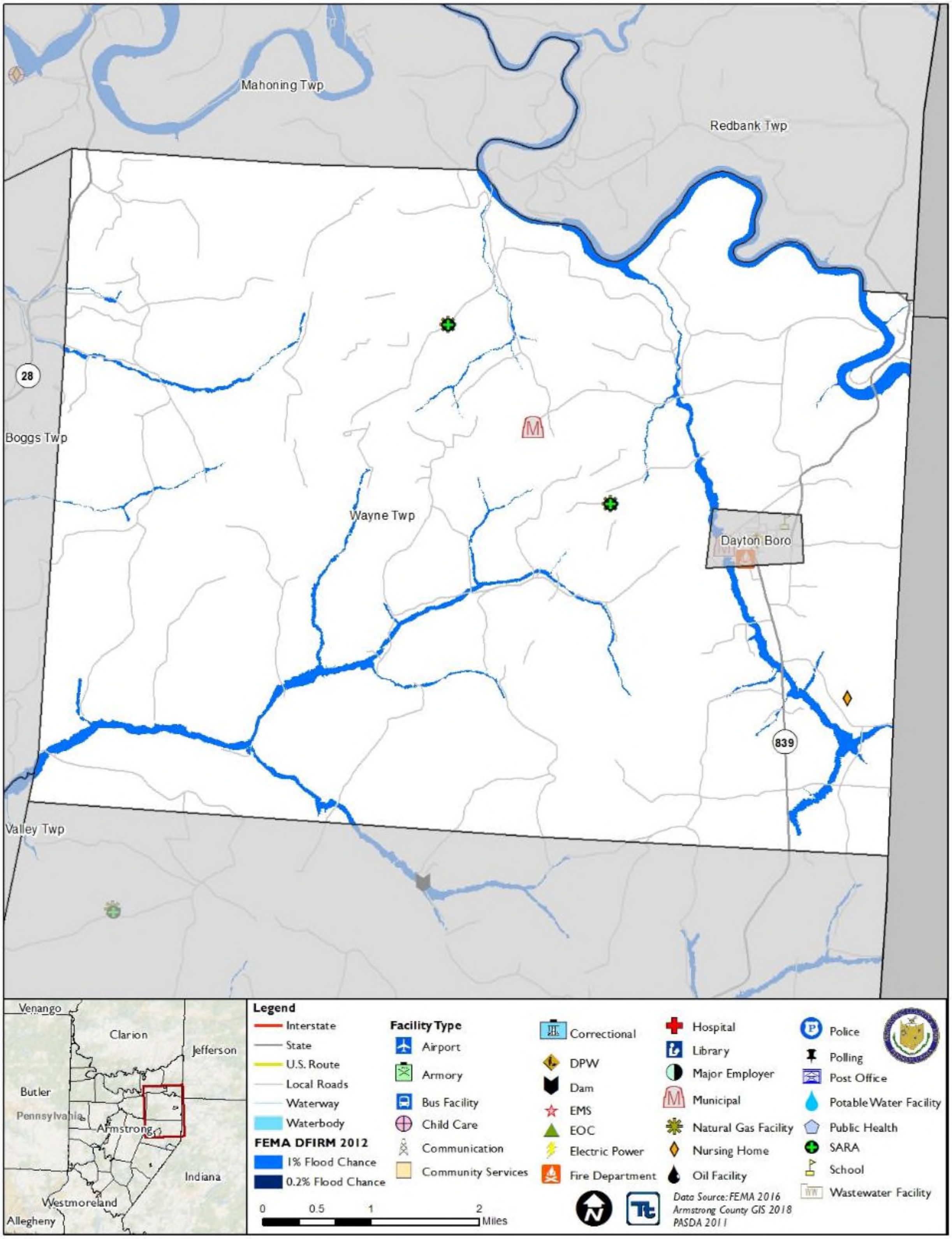
Valley Township



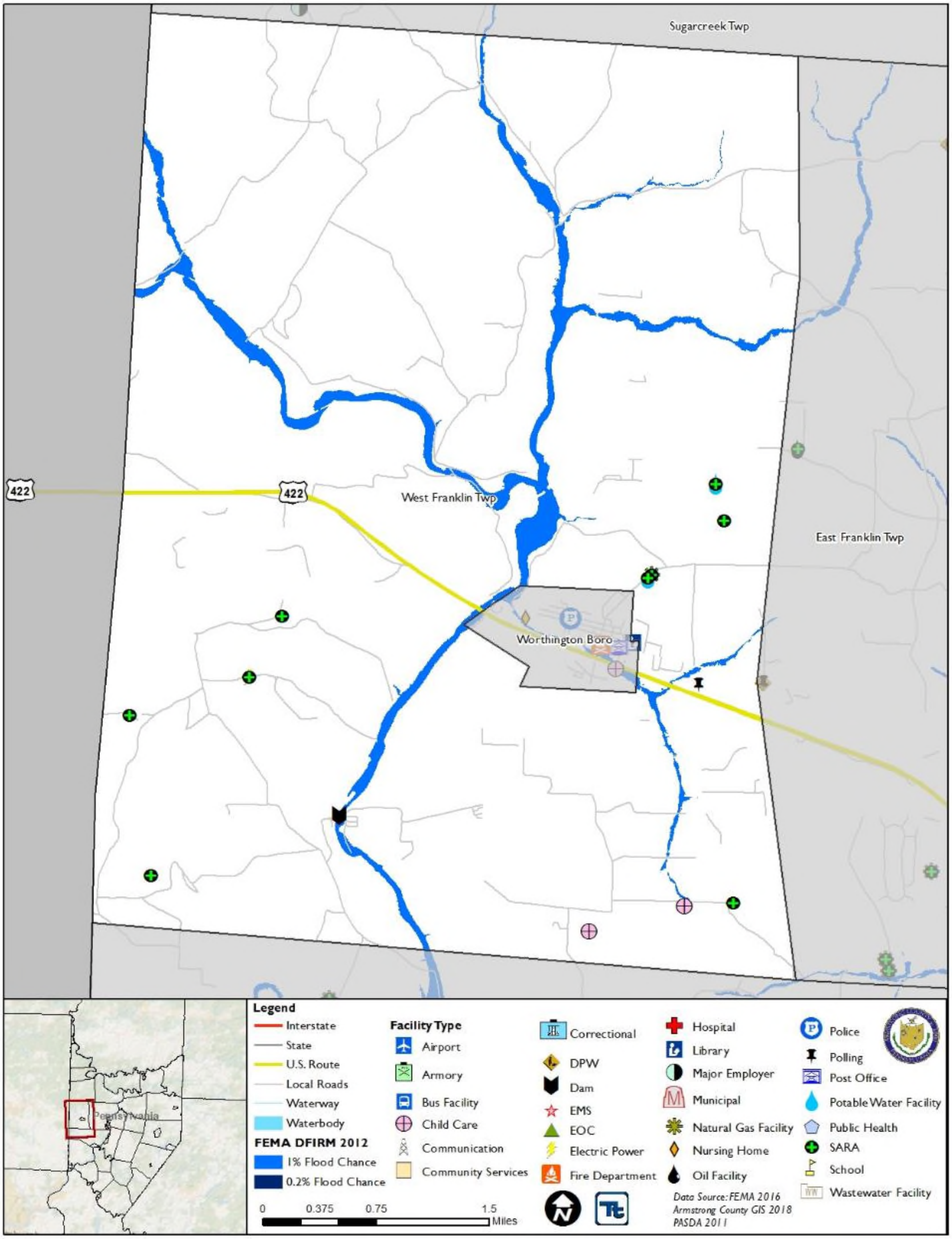
Washington Township



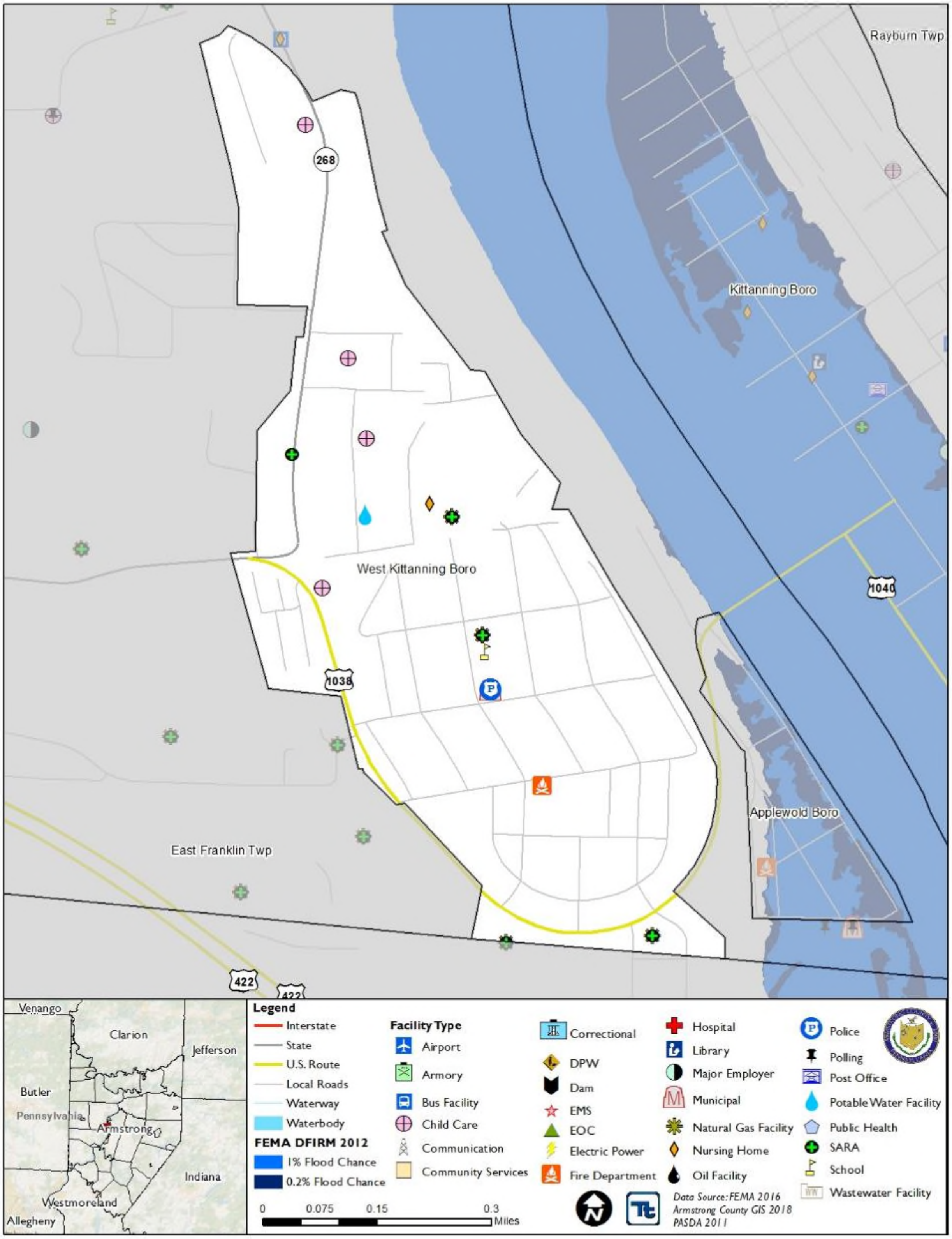
Wayne Township



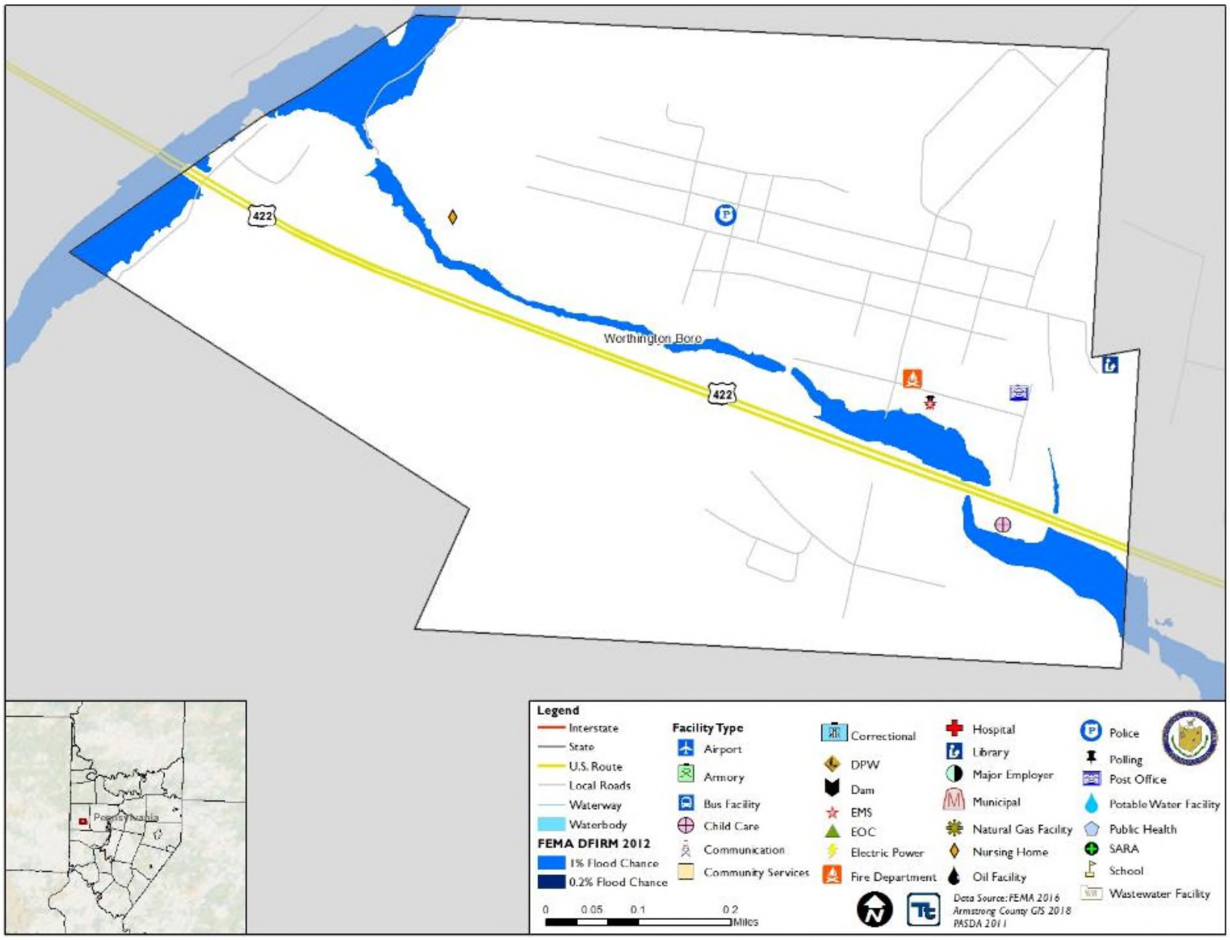
West Franklin Township



West Kittanning Borough



Worthington Borough



4.3.6 Invasive Species

This section provides a profile and vulnerability assessment for the invasive species hazard for the Armstrong County Hazard Mitigation Plan (HMP).

An invasive species is an organism that is not indigenous to a given ecosystem and that, when introduced to a nonnative environment, is likely to cause harm to native plants, posing a hazard to human health and the environment. Invasive species threats are generally divided into two main subsets:

- *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 life cycle 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.

The Governor's Pennsylvania Invasive Species Council (PISC) serves as the lead organization for invasive species threats and has identified over 100 species threats that are or could potentially become significant in Pennsylvania. Of these threats, County and municipal leaders believe that the most significant are terrestrial invasive species. Potential invasive forest pests of note include the Emerald Ash Borer, Eurasian Wood Wasp, Asian Longhorned Beetle, Sudden Oak Death, Hemlock Woolly Adelgid, Gypsy Moth, and vascular plants, such as Goat's Rue.

4.3.6.1 Location and Extent

The location and extent of these invasive threats depend on the preferred habitat of the species as well as the species' ease of movement and establishment. For example, Goat's Rue is an aggressive vascular plant; it has fairly wide ecological parameters, thriving in marshy fields, meadows, woodlands, sunny forest edges, semi-shaded fields, and along roadsides and stream banks (U.S. Department of Agriculture [USDA] Forest Service 2005).

Other species have limited extent due to the diligence of state agencies. Pennsylvania Department of Conservation and Natural Resources (PA DCNR) has planned a gypsy moth suppression program for 2013 and has discovered that emamectin benzoate is effective against the Emerald Ash Borer through tree injection.

4.3.6.2 Range of Magnitude

The magnitude of an invasive species threat ranges from nuisance to widespread killer. Some invasive species are not considered agricultural pests and do not harm humans. Other invasive species can cause significant changes in the composition of Pennsylvania's ecosystems. For example, the Emerald Ash Borer has a 99 percent mortality rate for any ash tree it infects. This and other forest-feeding invasive species could have a significant economic impact in the County, as over 50 percent of the County consists of forested land and the Emerald Ash Borer has already been detected in the County. In fact, PA DCNR confirmed that nine counties reported instances of the Emerald Ash Borer in 2012, bringing the total number of Pennsylvania counties with confirmed detection sites up to approximately 50.

Additionally, some invasive species can cause widespread illness or death in humans. One species of particular concern with this magnitude is anthrax, considered by the Center for Disease Control and Prevention (CDC) to be a Category A agent that may pose a significant, widespread threat to public health.

Invasive species can cause a wide range of environmental impacts. 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 harm to human, animal, and plant populations, invasive species can cause beyond harming host species and ecosystems, particularly in the case of invasive species that attack forests. Forests prevent soil degradation and erosion, protect watersheds, stabilize slopes, and absorb carbon dioxide emissions. Woodland's key role in the hydrologic system means that if forest land is wiped out, the effects of erosion and flooding will be amplified, which will also impact agricultural harvests.

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. An example of a possible worst-case scenario for invasive species is if the Emerald Ash Borer would break through the quarantine in Pennsylvania and would invade the County's ash trees. With the high mortality rate associated with the Emerald Ash Borer, the forests would be devastated, causing logging establishments to shut down and a potential drop in forest-based tourism. The blow to the logging and tourism industries would, in turn, result in the loss of jobs and valuable income to the County.

4.3.6.3 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, the Commonwealth has enacted 26 acts and quarantines to prevent the spread of invasive species (Pennsylvania Emergency Management Agency [PEMA] 2018). A total of 293 invasive species have been reported in Armstrong County (iMap Invasives 2018). Based on this information, Armstrong County has been impacted by invasive species; however, specific occurrences and quantified losses were not identified at the time of this plan update.

4.3.6.4 Future Occurrence

According to the PISC, the probability of future occurrence for invasive species threat 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 new countries and regions, and establish themselves around the world. Furthermore, climate change is contributing to the introduction of new invasive species. As maximum and minimum seasonal temperatures change, pests are able to establish themselves in previously inhospitable climates. This also gives introduced species an earlier start and increases the magnitude of their growth, which may shift the dominance of ecosystems in the favor of nonnative species (PEMA 2018).

Based on historical documentation, increased incidences of infestation throughout Pennsylvania and the overall impact of changing climate trends, it is estimated that Armstrong County and all its jurisdictions will continue to experience the impacts of invasive species that may induce secondary hazards and health threats to the County population if they are not prevented, controlled, or eradicated effectively. Future occurrences of invasive species can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (further discussed in Section 4.4).

4.3.6.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable in the area identified. This section evaluates and estimates the potential impact of the invasive species hazard on Armstrong County, in the following sections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, health, and safety; (2) general building stock and critical facilities; (3) economy; and (4) future growth and development
- Effect of climate change on vulnerability
- Additional data and next steps

Overview of Vulnerability

Armstrong County's exact vulnerability depends on the invasive species in question. In general, the University of Arizona and the National Invasive Species Information Center have identified the following characteristics of areas that are more likely to be vulnerable to this hazard:

- Lack of natural predators or diseases similar to those that kept the species under control in its native environment
- Present vacant ecological niches that can be exploited by nonnative species
- Lack of species diversity
- Lack of a multitiered canopy (in the case of invasive plants)
- Recently disturbed by fire, construction, or agriculture prior to species invasion (University of Arizona 2006)

Estimated losses are difficult to quantify; however, infestation can impact Armstrong County's population and economy. Direct effects of infestation lead to cascading indirect impacts. As vegetation dies or becomes stressed and weakened by pests such as the emerald ash borer, available fuel and high-intensity wildfires increase. As species compositions change due to infestation outbreaks, whole fire regimes can shift. Physical stresses on trees may also affect the ways the trees respond to other natural hazards such as hurricanes, drought, and ice storms (Kurtz 2007).

Data and Methodology

Because of lack of quantifiable loss information, a qualitative assessment has been used to evaluate assets exposed to this hazard and potential impacts associated with this hazard.

Impact on Life, Health, and Safety

The entire population of Armstrong County is vulnerable to invasive species to some extent, but direct impacts to life, health, and safety are minor.

Impact on General Building Stock and Critical Facilities

No structures are anticipated to be affected directly by infestation or invasive species; however, the emerald ash borer may cause a catastrophic loss of the ash tree throughout state forests, which could result in stream bank instability, erosion, and increased sedimentation. In addition, a preponderance of dead tree limbs could increase the occurrence of downed trees on roadways and power lines during storms with heavy winds.

Impact on Economy

The impact invasive species has on the economy and estimated dollar losses are difficult to measure and quantify. Costs associated with the activities and programs implemented to conduct surveillance and address invasive species have not been quantified in available documentation. Not only do invasive species have a negative impact on the natural native environment, but they may impact the fishing, boating, agricultural, and tourism economies in Armstrong County as well.

Impact on the Environment

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, particularly in the case of 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 lost, 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 population, invasive species remain a hazard for the economic livelihood of the state (PEMA 2018).

According to the Nature Conservancy, invasive species have contributed directly to the decline of 42% of the threatened and endangered species in the United States. The annual cost to the United States economy is estimated at $120 billion a year, with over 100 million acres (an area roughly the size of California) suffering from invasive plant infestations. Freshwater ecosystems and estuaries are especially vulnerable because these areas are more difficult to contain invasive species and reverse any impacts they may have had on the ecosystem. Forests have suffered from the impacts of invasive species because they weaken trees and cause extensive die-offs (for example, eastern hemlock trees infested by Hemlock Woolly Adelgid) (The Nature Conservancy 2018; PennState Extension 2018).

Impact of Future Growth and Development

As discussed in Section 2, areas targeted for future growth and development have been identified across the County. Any areas of growth could be impacted by the infestation hazard because the entire planning area is exposed and vulnerable.

Change of Vulnerability

Overall, the County's vulnerability has not changed since the 2014 HMP, and exposure and vulnerability to invasive species will continue throughout Armstrong County.

Additional Data and Next Steps

For the HMP update, any additional information regarding localized concerns and past impacts will be collected and analyzed. These data will be developed to support future revisions to the plan. Mitigation efforts could include building on existing efforts established at the state, county, and local levels.

4.3.7 Landslide

This section provides a profile and vulnerability assessment of the landslide hazard. A landslide is described in the Commonwealth of Pennsylvania 2013 and 2018 Standard All-Hazard Mitigation Plan (PA HMP) as downward and outward movement of slope-forming soil, rock, and vegetation reacting to the force of gravity. Materials can move at speeds as high as 120 miles per hour (mph) or more; slides can last a few seconds or a few minutes, or can be gradual, slower movements over several hours or days. Types of landslides include:

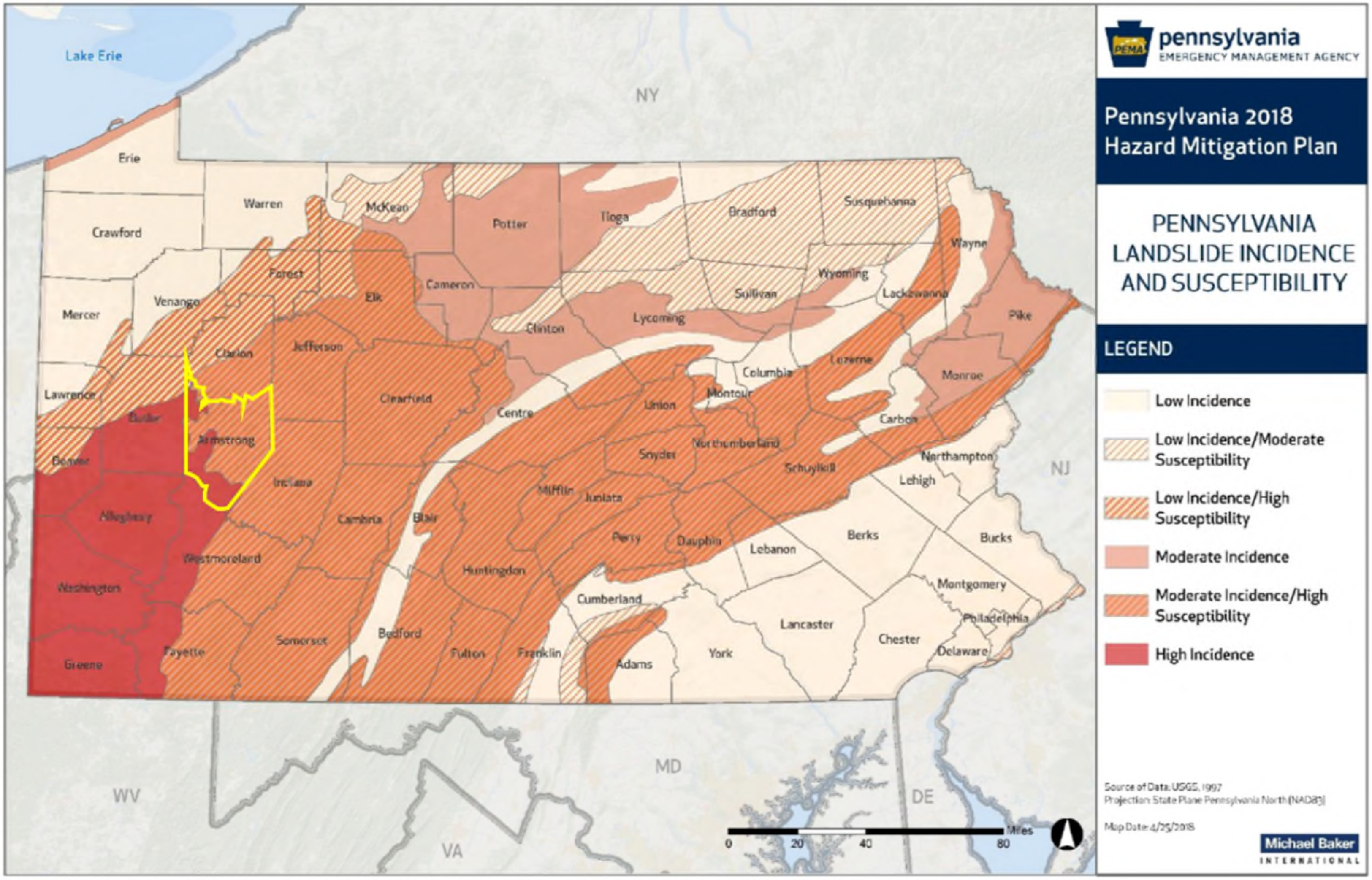
- *Rock Fall* involves detachment of mass from a steep slope or cliff, and descent by free-fall, bounding, or rolling.
- *Rock Topple* involves tilt or rotation of a mass forward as a unit.
- *Slide* involves displacement of a mass on one or more recognizable surfaces, which may be curved or planar.
- *Flow* involves movement of a mass downslope with a fluid motion. A significant amount of water may or may not be part of the mass (PEMA 2013).

Landslides may be triggered by both natural and human-caused changes in the environment, including heavy rain, rapid snow melt, steepening of slopes through construction or erosion, earthquakes, and changes in groundwater levels. Areas generally prone to landslide hazards include previous landslide areas, bases of steep slopes, bases of drainage channels, developed hillsides, and areas recently burned by forest and brush fires (Delano and Wilshusen 2001). Human activities that contribute to slope failure include alteration of the natural slope gradient, increase of soil water content, and removal of vegetation cover.

4.3.7.1 Location and Extent

According to the 2018 PA HMP draft (PEMA 2018), landslides have occurred in many parts of Pennsylvania but are most abundant and troublesome in much of the western and north-central portions of the State and adjacent states. Rockfalls and other slope failures can occur in areas of Armstrong County at locations of moderate to steep slopes. Areas undergoing erosion, decline in vegetation cover, and earthquakes are also susceptible to landslides. Figure 4.3.7-1 shows areas of low, moderate, and high landslide susceptibility as identified by the U.S. Geological Survey (USGS). The western and southern areas of Armstrong County rank as having a high incidence of landslides. The central, eastern, and northern areas of the County have high susceptibility and a moderate number of incidents. The extreme northwest section of the County has high susceptibility and a low number of incidents.

Figure 4.3.7-1. U.S. Geological Survey. Landslide Incidence and Susceptibility



Source: PEMA 2018

Note: Highlight added.

To determine the extent of a landslide hazard, the affected areas need to be identified, and the probability of the landslide occurring within some time period needs to be assessed. Natural variables that contribute to the overall extent of potential landslide activity in any particular area include soil properties, topographic position and slope, and historical incidence. Predicting a landslide is difficult, even under ideal conditions and with reliable information. As a result, the landslide hazard is often represented by landslide incidence and/or susceptibility, as defined below:

- Landslide incidence is the number of landslides that have occurred in a given geographic area. High incidence means greater than 15% of a given area has been involved in landsliding; medium incidence means that 1.5 to 15% of an area has been involved; and low incidence means that less than 1.5% of an area has been involved (Radbruch-Hall 1982).
- Landslide susceptibility is defined as the probable degree of response of geologic formations to natural or artificial cutting, to loading of slopes, or to unusually high precipitation. It can be assumed that unusually high precipitation or changes in existing conditions can initiate landslide movement in areas where rocks and soils have experienced numerous landslides in the past. Landslide susceptibility depends on slope angle and the geologic material underlying the slope. Landslide susceptibility only identifies areas potentially affected and does not imply a time frame when a landslide might occur. High, medium, and low susceptibility are delimited by the same percentages used for classifying the incidence of landsliding (Radbruch-Hall 1982).

4.3.7.2 Range of Magnitude

Landslides have the potential to damage transportation routes, utilities, and buildings. They can also create travel delays and other side effects. Fortunately, deaths and injuries caused by landslides are rare in Pennsylvania, and most landslides in the Commonwealth are moderate to slow moving, damaging things rather than people. Almost all of the known deaths caused by 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 (PEMA 2018).

According to Pennsylvania Department of Conservation and Natural Resources (DCNR), the Pennsylvania Department of Transportation and large municipalities incur substantial costs due to landslide damage and extra construction costs for new roads in known landslide-prone areas. One PA DOT estimate in 1991 showed an average of $10 million per year in landslide repair contracts across the Commonwealth and a similar amount in mitigation costs for grading projects (DCNR 2014).

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 (PA HMP 2013)

The worst-case scenario for a landslide in Armstrong County would be an event similar to one in Beaver County in 1942 (PEMA 2013). In that event, 150 cubic yards of rock fell from a highway cut onto a bus. Twenty-two people were killed, and four others were injured. In Armstrong County's worst-case scenario, the landslide would hit Route 422 or another busy highway. Depending on the time of day and the number of vehicles on the road at that time, this could trigger a severe traffic accident, resulting in multiple fatalities. Closure of a major transportation route would affect commerce in the County as well as the Commonwealth. This is the worst-case scenario because it could exert the greatest impact on the County, surrounding counties, and the Commonwealth. The most likely landslide would occur within an unpopulated area and likely would be undetected.

4.3.7.3 Past Occurrence

No comprehensive list of landslide incidents is available at this time, as there is no formal reporting system in place in the County or the Commonwealth. Armstrong County has experienced a number of slides related to extensive strip mining, especially in northern Armstrong County (USGS 1992). In August 1980, a precipitation event caused a landslide to occur in East Brady (PEMA 2018). Based on anecdotal information from the County and municipal officials, minor landslides occur each year, typically during periods of heavy rains. Most recently, a landslide in early June 2013 closed part of Route 28 for approximately three weeks (Armstrong County HMP 2014).

The Southwestern Pennsylvania Commission (SPC) converted 125 USGS topographic maps in southwest Pennsylvania that USGS had classified as including active or recently active landslide events. 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 part 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. This summary of landslides showed 235 landslides occurring in Armstrong County, losing a total of 457 acres (PEMA 2018).

Between 1954 and 2018, Pennsylvania was included in one Federal Emergency Management Agency (FEMA) disaster declaration related to landslides. In June 2006, FEMA declared several counties in Pennsylvania a major disaster (DR-1649) as a result of severe storms, flooding, and mudslides. Armstrong County was included in the declaration.

4.3.7.4 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 (PEMA 2018).

Based on historical events, landslide events resulting in loss of life and property damage are *unlikely* in Armstrong County. However, with a higher susceptibility to landslides, the probability of landslides occurring in the County is *highly likely*. Mismanaged, intense development in steeply sloped areas could increase the frequency of occurrence. Landslide is a moderate occurrence, as defined by the Risk Factor Methodology, described in more detail later in Section 4.4.

4.3.7.5 Vulnerability Assessment

To understand risk, a community must evaluate assets exposed or vulnerable within the hazard area identified. The following section discusses potential impacts of the landslide hazard on Armstrong County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on (1) life, (2) health and safety, (3) general building stock, (4) critical facilities and economy, and (5) future growth and development
- Effect of climate change on vulnerability

- Additional data and next steps.

Overview of Vulnerability

Vulnerability to ground failure hazards is a function of location, soil type, geology, type of human activity, use, and frequency of events. Effects of landslides on people and structures can be reduced by total avoidance of hazard areas or by restricting, prohibiting, or imposing conditions on hazard-zone activity. Local governments can reduce effects of landslides through land use policies and regulations. Individuals can reduce their exposure to hazards by educating themselves on the past hazard history of the site and by inquiring about hazards to planning and engineering departments of local governments (National Atlas 2007).

Overall, the entire County is exposed to the landslide hazard, with the most vulnerable portion of the County located within the high susceptibility/moderate incidence hazard area; approximately 68.3% of the County is within this hazard area (refer to Figure 4.3.7-1 earlier in this section). The remainder of the County is located within the high susceptibility/low incidence and the high incidence hazard areas; these encompass approximately 1.2% and 30.5% of the total County area, respectively. Further information regarding these hazard areas is described below.

Data and Methodology

Unlike the flood, wind, and earthquake hazards, there are no standard loss estimation models or methodologies for the landslide hazard. In an attempt to estimate Armstrong County's vulnerability, the Landslide Incidence and Susceptibility GIS layer from USGS was used to coarsely define the general landslide susceptible area (herein "hazard area") (Figure 4.3.7-1). Limitations of this analysis are recognized, and results of it are used only to provide a general estimate. Over time, additional data will be acquired to allow better analysis of this hazard. Available information and a preliminary assessment appear below.

Impacts on Life, Health, and Safety

Potential landslide events can directly and indirectly damage the County's population via impacts on buildings. To estimate the population vulnerable to landslide events, the hazard area boundaries were overlaid upon 2010 Census population data (U.S. Census 2010). Census blocks with their centers (centroids) within the boundaries of steep slope hazard areas were used to calculate the estimated population considered exposed to this hazard. Because census blocks do not align exactly with hazard areas, these estimates should be considered for planning purposes only.

Table 4.3.7-1 summarizes the population exposed by municipality (U.S. Census 2010). Populations downslope of landslide hazard areas are particularly vulnerable to this hazard. Identifying populations vulnerable to mass movements of geological material by reference only to census block data is difficult. But via this approach, 32,997 people, or 47.9% of the overall population, are within the high incidence areas; 972 people, or 1.4% of the overall population, are within the high susceptibility/low incidence areas; and 34,972 people, or 50.7% of the overall population, are within the high susceptibility/moderate incidence areas.

Table 4.3.7-1. Estimated Armstrong County Population Located Within the Landslide Hazard Areas

Municipality	Total Population	Population within High Incidence Areas	Percent Population within High Incidence Areas	Population within High Susceptibility/ Low Incidence	Percent Population within High Susceptibility/ Low Incidence Areas	Population within High Susceptibility/ Moderate Incidence Areas	Percent Population within High Susceptibility/ Moderate Incidence Areas
Apollo Borough	1,647	1,647	100.0%	0	0.0%	0	0.0%
Applewold Borough	310	71	22.9%	0	0.0%	239	77.1%
Atwood Borough	107	0	0.0%	0	0.0%	107	100.0%
Bethel Township	1,183	273	23.1%	0	0.0%	910	76.9%
Boggs Township	941	0	0.0%	0	0.0%	941	100.0%
Bradys Bend Township	783	518	66.2%	0	0.0%	265	33.8%
Burrell Township	684	279	40.8%	0	0.0%	405	59.2%
Cadogan Township	344	344	100.0%	0	0.0%	0	0.0%
Cowanshannock Township	2,893	0	0.0%	0	0.0%	2,893	100.0%
Dayton Borough	559	0	0.0%	0	0.0%	559	100.0%
East Franklin Township	4,089	2,911	71.2%	0	0.0%	1,178	28.8%
Elderton Borough	355	0	0.0%	0	0.0%	355	100.0%
Ford City Borough	3,035	0	0.0%	0	0.0%	3,035	100.0%
Ford Cliff Borough	371	0	0.0%	0	0.0%	371	100.0%
Freeport Borough	1,813	1,813	100.0%	0	0.0%	0	0.0%
Gilpin Township	2,500	2,454	98.2%	0	0.0%	46	1.8%
Hovey Township	97	0	0.0%	97	100.0%	0	0.0%
Kiskiminetas Township	4,776	4,776	100.0%	0	0.0%	0	0.0%
Kittanning Borough	4,044	3,102	76.7%	0	0.0%	942	23.3%
Kittanning Township	2,265	0	0.0%	0	0.0%	2,265	100.0%
Leechburg Borough	2,152	2,152	100.0%	0	0.0%	0	0.0%
Madison Township	824	0	0.0%	0	0.0%	824	100.0%
Mahoning Township	1,420	0	0.0%	0	0.0%	1,420	100.0%
Manor Township	4,183	46	1.1%	0	0.0%	4,137	98.9%
Manorville Borough	410	0	0.0%	0	0.0%	410	100.0%
North Apollo Borough	1,302	1,302	100.0%	0	0.0%	0	0.0%
North Buffalo Township	3,015	2,685	89.1%	0	0.0%	330	10.9%
Parker City	840	0	0.0%	840	100.0%	0	0.0%
Parks Township	2,749	2,749	100.0%	0	0.0%	0	0.0%
Perry Township	352	178	50.6%	35	9.9%	139	39.5%
Pine Township	413	0	0.0%	0	0.0%	413	100.0%
Plumcreek Township	2,382	0	0.0%	0	0.0%	2,382	100.0%
Rayburn Township	1,907	203	10.6%	0	0.0%	1,704	89.4%
Redbank Township	1,063	0	0.0%	0	0.0%	1,063	100.0%
Rural Valley Borough	876	0	0.0%	0	0.0%	876	100.0%
South Bend Township	1,186	561	47.3%	0	0.0%	625	52.7%
South Bethlehem Borough	481	0	0.0%	0	0.0%	481	100.0%
South Buffalo Township	2,636	2,603	98.7%	0	0.0%	33	1.3%
Sugarcreek Township	1,529	888	58.1%	0	0.0%	641	41.9%
Valley Township	648	0	0.0%	0	0.0%	648	100.0%
Washington Township	923	86	9.3%	0	0.0%	837	90.7%

Municipality	Total Population	Population within High Incidence Areas	Percent Population within High Incidence Areas	Population within High Susceptibility/ Low Incidence	Percent Population within High Susceptibility/ Low Incidence Areas	Population within High Susceptibility/ Moderate Incidence Areas	Percent Population within High Susceptibility/ Moderate Incidence Areas
Wayne Township	1,198	0	0.0%	0	0.0%	1,198	100.0%
West Franklin Township	1,849	188	10.2%	0	0.0%	1,661	89.8%
West Kittanning Borough	1,168	1,168	100.0%	0	0.0%	0	0.0%
Worthington Borough	639	0	0.0%	0	0.0%	639	100.0%
Armstrong County (Total)	**68,941**	**32,997**	**47.9%**	**972**	**1.4%**	**34,972**	**50.7%**

Sources: U.S. Census 2010; USGS 2011.

Impact on General Building Stock

Direct building losses are estimated costs to repair or replace damage caused to buildings. Similar to the population, building stock data are presented by census block. To estimate the value of building stock exposed to landslides, the hazard area boundaries were overlaid upon HAZUS-MH building stock data in GIS. Using the default general building stock, replacement cost values of the Census blocks with their centroids in hazard areas were totaled. Approximately $5.8 billion, or 47.9% of the overall replacement cost value, are within the high incidence areas, $115 million, or 1.4% of the overall replacement cost value, are within the high susceptibility low incidence areas, and $4.9 billion, or 50.7% of the overall replacement cost value, are within the high susceptibility-moderate incidence areas.

To estimate the number of structures exposed to the hazard boundary, the County's spatial layer of structures was overlaid by the landslide hazard areas. In total, 15,365 structures, or 47.0% of the overall total building count, are within the high incidence areas, 498 structures, or 1.5% of the overall total building count, are within the high susceptibility/low incidence areas, and 16,851 structures, or 51.5% of the overall total building count, are within the high susceptibility/moderate incidence areas. Building stock exposures per municipality are listed in Table 4.3.7-2 and Table 4.3.7-3.

Table 4.3.7-2. Estimated General Building Stock Located Within the Landslide Hazard Areas

Municipality	Total Number of Buildings	Number of Buildings within High Incidence Areas	Percentage of Buildings within High Incidence Areas	Number of buildings High Susceptibility/ Low Incidence	Percent Population within High Susceptibility/ Low Incidence Areas	Population within High Susceptibility/ Moderate Incidence Areas	Percent Population within High Susceptibility/ Moderate Incidence Areas
Apollo Borough	734	734	100.0%	0	0.0%	0	0.0%
Applewold Borough	139	19	13.7%	0	0.0%	120	86.3%
Atwood Borough	51	0	0.0%	0	0.0%	51	100.0%
Bethel Township	684	169	24.7%	0	0.0%	515	75.3%
Boggs Township	458	0	0.0%	0	0.0%	458	100.0%
Bradys Bend Township	610	279	45.7%	0	0.0%	331	54.3%
Burrell Township	358	133	37.2%	0	0.0%	225	62.8%
Cadogan Township	192	192	100.0%	0	0.0%	0	0.0%
Cowanshannock Township	1,328	0	0.0%	0	0.0%	1,328	100.0%
Dayton Borough	274	0	0.0%	0	0.0%	274	100.0%
East Franklin Township	1,804	1,331	73.8%	0	0.0%	473	26.2%
Elderton Borough	174	0	0.0%	0	0.0%	174	100.0%
Ford City Borough	1,353	1	<1%	0	0.0%	1,352	99.9%
Ford Cliff Borough	182	0	0.0%	0	0.0%	182	100.0%
Freeport Borough	601	601	100.0%	0	0.0%	0	0.0%
Gilpin Township	1,435	1,411	98.3%	0	0.0%	24	1.7%
Hovey Township	98	0	0.0%	98	100.0%	0	0.0%
Kiskiminetas Township	2,269	2,269	100.0%	0	0.0%	0	0.0%
Kittanning Borough	1,610	1,263	78.4%	0	0.0%	347	21.6%
Kittanning Township	969	0	0.0%	0	0.0%	969	100.0%
Leechburg Borough	1,026	1,026	100.0%	0	0.0%	0	0.0%
Madison Township	584	0	0.0%	0	0.0%	584	100.0%
Mahoning Township	703	0	0.0%	0	0.0%	703	100.0%

Municipality	Total Number of Buildings	Number of Buildings within High Incidence Areas	Percentage of Buildings within High Incidence Areas	Number of buildings High Susceptibility/ Low Incidence	Percent Population within High Susceptibility/ Low Incidence Areas	Population within High Susceptibility/ Moderate Incidence Areas	Percent Population within High Susceptibility/ Moderate Incidence Areas
Manor Township	2013	66	3.3%	0	0.0%	1,947	96.7%
Manorville Borough	166	0	0.0%	0	0.0%	166	100.0%
North Apollo Borough	652	652	100.0%	0	0.0%	0	0.0%
North Buffalo Township	1,333	1,155	86.6%	0	0.0%	178	13.4%
Parker City	375	0	0.0%	375	100.0%	0	0.0%
Parks Township	1,249	1,249	100.0%	0	0.0%	0	0.0%
Perry Township	280	90	32.1%	25	8.9%	165	58.9%
Pine Township	282	0	0.0%	0	0.0%	282	100.0%
Plumcreek Township	994	0	0.0%	0	0.0%	994	100.0%
Rayburn Township	800	14	1.8%	0	0.0%	786	98.3%
Redbank Township	536	0	0.0%	0	0.0%	536	100.0%
Rural Valley Borough	409	0	0.0%	0	0.0%	409	100.0%
South Bend Township	522	274	52.5%	0	0.0%	248	47.5%
South Bethlehem Borough	213	0	0.0%	0	0.0%	213	100.0%
South Buffalo Township	1,264	1,240	98.1%	0	0.0%	24	1.9%
Sugarcreek Township	617	442	71.6%	0	0.0%	175	28.4%
Valley Township	322	0	0.0%	0	0.0%	322	100.0%
Washington Township	729	56	7.7%	0	0.0%	673	92.3%
Wayne Township	537	0	0.0%	0	0.0%	537	100.0%
West Franklin Township	878	108	12.3%	0	0.0%	770	87.7%
West Kittanning Borough	593	591	99.7%	0	0.0%	2	0.3%
Worthington Borough	314	0	0.0%	0	0.0%	314	100.0%
Armstrong County (Total)	**32,714**	**15,365**	**47.0%**	**498**	**1.5%**	**16,851**	**51.5%**

Sources: Armstrong County 2018, USGS 2011.

Table 4.3.7-3. Estimated General Building Stock Located Within the Landslide Hazard Areas

Municipality	Total RCV	RCV within High Incidence Areas	Percentage of RCV within High Incidence Areas	RCV within High Susceptibility/ Low Incidence	Percent RCV within High Susceptibility/ Low Incidence Areas	RCV within High Susceptibility/ Moderate Incidence Areas	Percent RCV within High Susceptibility/ Moderate Incidence Areas
Apollo Borough	$251,670,000	$251,670,000	100.0%	$0	0.0%	$0	0.0%
Applewold Borough	$74,252,000	$18,328,000	24.7%	$0	0.0%	$55,924,000	75.3%
Atwood Borough	$10,050,000	$0	0.0%	$0	0.0%	$10,050,000	100.0%
Bethel Township	$128,949,000	$37,412,000	29.0%	$0	0.0%	$91,537,000	71.0%
Boggs Township	$76,331,000	$0	0.0%	$0	0.0%	$76,331,000	100.0%
Bradys Bend Township	$131,764,000	$61,272,000	46.5%	$0	0.0%	$70,492,000	53.5%
Burrell Township	$73,172,000	$33,124,000	45.3%	$0	0.0%	$40,048,000	54.7%
Cadogan Township	$65,238,000	$65,238,000	100.0%	$0	0.0%	$0	0.0%
Cowanshannock Township	$303,507,000	$0	0.0%	$0	0.0%	$303,507,000	100.0%
Dayton Borough	$84,832,000	$0	0.0%	$0	0.0%	$84,832,000	100.0%
East Franklin Township	$1,027,803,000	$861,452,000	83.8%	$0	0.0%	$166,351,000	16.2%
Elderton Borough	$75,474,000	$0	0.0%	$0	0.0%	$75,474,000	100.0%
Ford City Borough	$538,129,000	$0	0.0%	$0	0.0%	$538,129,000	100.0%
Ford Cliff Borough	$42,367,000	$0	0.0%	$0	0.0%	$42,367,000	100.0%
Freeport Borough	$314,661,000	$314,661,000	100.0%	$0	0.0%	$0	0.0%
Gilpin Township	$375,439,000	$370,043,000	98.6%	$0	0.0%	$5,396,000	1.4%
Hovey Township	$25,518,000	$0	0.0%	$25,518,000	100.0%	$0	0.0%
Kiskiminetas Township	$529,524,000	$529,524,000	100.0%	$0	0.0%	$0	0.0%
Kittanning Borough	$933,567,000	$553,794,000	59.3%	$0	0.0%	$379,773,000	40.7%
Kittanning Township	$224,824,000	$0	0.0%	$0	0.0%	$224,824,000	100.0%
Leechburg Borough	$490,357,000	$490,357,000	100.0%	$0	0.0%	$0	0.0%
Madison Township	$176,372,000	$0	0.0%	$0	0.0%	$176,372,000	100.0%
Mahoning Township	$155,073,000	$0	0.0%	$0	0.0%	$155,073,000	100.0%

Municipality	Total RCV	RCV within High Incidence Areas	Percentage of RCV within High Incidence Areas	RCV within High Susceptibility/ Low Incidence	Percent RCV within High Susceptibility/ Low Incidence Areas	RCV within High Susceptibility/ Moderate Incidence Areas	Percent RCV within High Susceptibility/ Moderate Incidence Areas
Manor Township	$578,870,000	$11,270,000	1.9%	$0	0.0%	$567,600,000	98.1%
Manorville Borough	$40,861,000	$0	0.0%	$0	0.0%	$40,861,000	100.0%
North Apollo Borough	$163,435,000	$163,435,000	100.0%	$0	0.0%	$0	0.0%
North Buffalo Township	$364,294,000	$323,090,000	88.7%	$0	0.0%	$41,204,000	11.3%
Parker City	$83,797,000	$0	0.0%	$83,797,000	100.0%	$0	0.0%
Parks Township	$502,517,000	$502,517,000	100.0%	$0	0.0%	$0	0.0%
Perry Township	$72,571,000	$20,983,000	28.9%	$5,935,000	8.2%	$45,653,000	62.9%
Pine Township	$51,655,000	$0	0.0%	$0	0.0%	$51,655,000	100.0%
Plumcreek Township	$219,089,000	$0	0.0%	$0	0.0%	$219,089,000	100.0%
Rayburn Township	$225,689,000	$36,088,000	16.0%	$0	0.0%	$189,601,000	84.0%
Redbank Township	$211,247,000	$0	0.0%	$0	0.0%	$211,247,000	100.0%
Rural Valley Borough	$154,259,000	$0	0.0%	$0	0.0%	$154,259,000	100.0%
South Bend Township	$116,754,000	$51,320,000	44.0%	$0	0.0%	$65,434,000	56.0%
South Bethlehem Borough	$132,137,000	$0	0.0%	$0	0.0%	$132,137,000	100.0%
South Buffalo Township	$454,112,000	$448,934,000	98.9%	$0	0.0%	$5,178,000	1.1%
Sugarcreek Township	$190,498,000	$114,297,000	60.0%	$0	0.0%	$76,201,000	40.0%
Valley Township	$88,371,000	$0	0.0%	$0	0.0%	$88,371,000	100.0%
Washington Township	$111,171,000	$6,874,000	6.2%	$0	0.0%	$104,297,000	93.8%
Wayne Township	$108,168,000	$0	0.0%	$0	0.0%	$108,168,000	100.0%
West Franklin Township	$347,597,000	$165,232,000	47.5%	$0	0.0%	$182,365,000	52.5%
West Kittanning Borough	$412,394,000	$412,394,000	100.0%	$0	0.0%	$0	0.0%
Worthington Borough	$144,717,000	$0	0.0%	$0	0.0%	$144,717,000	100.0%
Armstrong County (Total)	**$10,883,076,000**	**$5,843,309,000**	**53.7%**	**$115,250,000**	**1.1%**	**$4,924,517,000**	**45.2%**

Sources: HAZUS-MH 4.2, USGS 2011.

Critical Facilities and the Economy

As with impacts on population and general building stock of the County, the landslide hazard area was referenced to estimate vulnerabilities of critical facilities within the County. Sixteen facilities are located within the high susceptibility/low incidence areas, 423 facilities are located within the high susceptibility/moderate incidence areas, and 441 facilities are located within the high incidence areas.

A landslide's impact on the economy and estimated dollar losses are difficult to measure. As stated previously, landslides can impose direct and indirect impacts on society. Direct costs include actual damage sustained by buildings, property, and infrastructure. Indirect costs, such as cleanup costs, business interruption, loss of tax revenues, reduced property values, and loss of productivity, are difficult to measure. Additionally, ground failure threatens transportation corridors, fuel and energy conduits, and communication lines (USGS 2003). Losses to the County's total building inventory replacement value would affect the local tax base and economy.

Table 4.3.7-4. Critical Facilities Located Within High Susceptibility and Low Incidence Landslide Areas

Municipality	Communication Facility	DPW	Fire Department	Municipal	Polling	Post Office	Potable Water Facility	SARA	Wastewater Facility
Hovey (T)	0	1	0	1	1	0	0	0	0
Parker (C)	1	1	1	1	2	1	1	4	1
Armstrong County (Total)	**1**	**2**	**1**	**2**	**3**	**1**	**1**	**4**	**1**

Sources: Armstrong County, USGS 2011

Table 4.3.7-5. Critical Facilities Located Within High Susceptibility and Moderate Incidence Landslide Areas

Municipality	Armory	Bus Facility	Child Care	Communication Facility	Community Services	Correctional	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Oil Facility	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
Applewold (B)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atwood (B)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Bethel (T)	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	1	3	0	0	0	0	1	0	0	0	4	0	0
Boggs (T)	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	1	1	0	0	0	1	0	0
Bradys Bend (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	1	0	0
Burrell (T)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0
Cowanshannock (T)	0	0	1	1	0	0	1	1	0	0	1	0	0	0	0	0	1	4	0	0	0	1	3	3	0	0	8	1	0
Dayton (B)	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0
East Franklin (T)	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	1	5	0	1	0	0	1	0	0	0	7	0	0
Elderton (B)	0	1	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	0	1	1	0
Ford City (B)	0	0	4	0	0	0	0	1	0	1	0	1	1	0	1	0	1	0	0	0	1	0	4	0	1	0	4	2	0
Ford Cliff (B)	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Kittanning (B)	0	1	1	0	0	0	0	1	0	1	0	1	0	1	0	2	1	0	1	0	5	0	1	0	0	1	2	0	0
Kittanning (T)	0	0	1	0	0	0	0	1	0	0	0	1	1	1	0	0	1	2	1	2	0	0	1	0	1	0	9	0	0
Madison (T)	0	0	0	0	0	0	0	1	2	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	2	0	0
Mahoning (T)	0	0	1	0	0	0	0	1	0	0	0	1	0	0	0	0	1	3	1	0	0	0	1	0	0	0	4	1	1
Manor (T)	1	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	1	6	0	0	1	1	3	1	1	0	12	5	2
Manorville (B)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
North Buffalo (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	11	0	1
Pine (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0

Municipality	Armory	Bus Facility	Child Care	Communication Facility	Community Services	Correctional	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Oil Facility	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
Plumcreek (T)	0	0	1	0	0	0	6	1	1	0	0	0	0	0	0	0	1	2	0	0	0	3	1	0	1	0	16	0	0
Rayburn (T)	0	1	1	0	1	1	0	1	0	0	3	2	0	0	0	1	1	1	0	0	1	1	1	0	2	1	8	0	0
Redbank (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	0	4	0	0
Rural Valley (B)	0	0	2	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	1	0	2	1	0
South Bend (T)	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	9	0	0	0	0	1	0	0	0	12	0	0
South Bethlehem (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
South Buffalo (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0
Sugarcreek (T)	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	0	0	0	0	0	1	0	0	0	0	1	1	0
Valley (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	3	0	2	0	0	1	0	0	0	6	0	0
Washington (T)	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	6	0	0	0	0	1	0	0	0	6	0	0
Wayne (T)	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	2	0	0	0	1	1	0	0	0	2	0	0
West Franklin (T)	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	2	0	5	0	0
Worthington (B)	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1	0	0	0	0	0	1	1	1	1	0	0	0	1	0
Armstrong County	**1**	**3**	**15**	**3**	**1**	**1**	**8**	**26**	**7**	**3**	**5**	**14**	**5**	**3**	**2**	**4**	**27**	**59**	**3**	**5**	**11**	**11**	**36**	**9**	**11**	**2**	**130**	**14**	**4**

Sources: Armstrong County 2018, USGS 2011

Table 4.3.7-6. Critical Facilities Located Within High Incidence Landslide Areas

Municipality	Airport	Bus	Bus Facility	Child Care	Communication Facility	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Helipad	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Oil Facility	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	SARA	School	Wastewater Facility
Apollo (B)	0	0	0	2	1	0	1	0	0	0	2	1	0	0	1	0	0	0	0	0	1	0	1	0	0	1	0	0
Bethel (T)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0
Bradys Bend (T)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Cadogan (T)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
East Franklin (T)	0	0	1	5	0	1	1	1	0	0	1	0	1	3	0	4	1	29	1	1	2	2	3	0	1	41	3	0
Ford City (B)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Freeport (B)	0	0	0	1	0	0	1	0	1	0	1	0	0	0	1	0	1	0	0	0	1	0	2	0	1	5	0	1
Gilpin (T)	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	7	0	0	1	1	2	1	1	13	0	0
Kiskiminetas (T)	0	1	0	0	0	4	1	0	0	1	1	0	0	0	0	0	1	2	0	0	1	0	4	1	0	4	5	0
Kittanning (B)	0	0	0	2	1	0	0	0	0	0	2	3	0	0	1	0	0	0	0	0	0	1	3	1	0	1	0	0
Leechburg (B)	0	0	0	1	1	0	2	0	1	0	2	0	0	0	1	0	1	0	0	0	1	0	2	1	0	1	3	0
Manor (T)	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Apollo (B)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
North Apollo (T)	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
North Buffalo (T)	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	1	55	0	0	1	2	2	0	0	56	0	0
Parks (T)	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	0	0	1	0	3	0	1	3	0	0
Perry (T)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
South Bend (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0
South Buffalo (T)	1	0	1	1	0	0	1	2	0	0	1	0	0	0	0	1	1	9	0	0	1	0	2	0	0	15	2	0
Sugarcreek (T)	0	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
West Franklin (T)	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0

West Kittanning (B)	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0
West Kittanning (T)	0	0	0	4	0	0	0	0	0	0	1	1	0	0	0	0	0	4	0	0	1	0	0	0	1	5	1	0
Armstrong County:	**1**	**1**	**2**	**19**	**3**	**6**	**15**	**4**	**3**	**1**	**15**	**8**	**1**	**3**	**4**	**5**	**14**	**109**	**1**	**1**	**11**	**6**	**29**	**5**	**5**	**154**	**14**	**1**

Sources: Armstrong County 2018, USGS 2011.

Impact on the Environment

The impact of landslides on the environment depends on the size and specific location of the event. 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 (PEMA 2013).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 to 10 years have been identified across Armstrong County. Refer to Section 4.4 of this HMP. New development within identified landslide hazard areas will be exposed to these risks.

Effect of Climate Change on Vulnerability

Climate is defined not just as average temperature and precipitation but also by type, frequency, and intensity of weather events. Both globally and at the local scale, climate change can alter prevalence and severity of extremes such as severe storms, including those that may bring intense or prolonged precipitation (U.S. Environmental Protection Agency [EPA] 2006). An increase in rainfall intensity and duration will saturate the soil and potentially erode the local landscape and impair slope stability, leading to an increase of landslide events in Armstrong County.

The climate of Pennsylvania is already changing and will continue to change over the course of this century. Since 1900, temperatures in the northeastern U.S. have increased an average of 1.5°F. The majority of this warming has occurred since 1970. In terms of winter temperatures, the northeastern U.S. has seen an increase in the average temperature by 4°F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007).

High temperatures can contribute to instability of slopes by enhancing thermal breakdown of rock, decreasing the viscosity of groundwater (contributing to more lubrication of sediment), and thawing frozen groundwater so more water infiltrates the soil. Warming could intensify the cycling between wet and dry periods, which can widen gaps in rock and soil, leading to a decrease in slope stability. However, warm conditions can also cause increased evaporation which would lead to more stable conditions in soil, especially during the summer (Climate Impacts Group 2015).

In addition to the effect of increased temperatures, precipitation is expected to increase over the next several decades. Average annual precipitation is projected to increase in the region by 0-10 percent by the 2020s and 5-10 percent by the 2050s. Most of the additional precipitation is expected to come during the winter months (New York City Panel on Climate Change [NPCC] 2013). Extreme precipitation has the potential to cause significant flooding and, in the winter, produce heavy snowfall.

Future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Heavier rain events reduce slope stability, raise the water table, and increase the amount of water draining through soil. Wetter soils are heavier and have greater lubrication among soil layers (Climate Impacts Group 2015).

Increase in global temperature could affect the snowpack and its ability to hold and store water. Higher snow lines result in greater soil saturation as well (Climate Impacts Group 2015).

Climate change may impact rates of vegetation loss through drought, wildfire, insect, or disease, leading to loss of vegetation stability in steep slopes. However, loss of vegetation from wildfire also temporarily reduces the ability of soils to absorb moisture, causing increased surface runoff (Climate Impacts Group 2015).

While predicting changes in these types of events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (EPA 2006). Potential effects of climate change on the County's vulnerability to landslide events must be considered as understanding of regional climate change impacts increases.

Additional Data and Next Steps

More detailed landslide susceptibility zones can be generated so that communities can more specifically identify high hazard areas. A pilot study conducted for Schenectady County, New York, as described in the 2014 New York State Hazard Mitigation Plan, developed higher resolution images of landslide susceptibility zones. The methodology included use of the Natural Resource Conservation Services (NRCS) Digital Soil Survey soil units and their associated properties, including the American Association of State Highway and Transportation Officials (AASHTO) rating, liquid limit, hydrologic group, percentage of silt and clay, erosion potential, and slope, derived from high-resolution digital elevation models. Determining historical damages to buildings and infrastructure incurred from landslides will also help improve loss estimates and future modeling efforts, given a margin of uncertainty. Furthermore, research on rainfall thresholds for forecasting landslide potential may also be an option for Armstrong County.

4.3.8 Levee Failure

This section provides a profile and vulnerability assessment for the levee failure hazard for the Armstrong County Hazard Mitigation Plan (HMP).

Levees and flood walls are manmade structures designed to protect specific areas within a community from flooding. These structures fail when flood waters exceed the height of the protective levee structure, or when the maximum pressure exerted by the flood waters against the levee or flood wall exceeds its capability.

Levee failures, like dam failures, have the potential to place large numbers of people and great amounts of property at risk. Unlike dams, levees are built parallel to a river or another body of water to protect the population and structures behind it from risks to human health and property damage that could be caused by flooding events (Federal Emergency Management Agency [FEMA] 2008). Levees do not serve a purpose beyond providing flood protection and (less frequently) recreational space for community residents. Dams, on the other hand, can serve to store water or generate energy, in addition to protecting areas from flooding.

Levee failures can be caused by a number of factors and can be catastrophic. Damage to the area beyond a failed levee could be more significant than damage caused by the uninhibited flow of flood water (FEMA 2008). Levees are designed to provide a specific level of protection; therefore, excessive water from a flooding event could overtop a levee if the water volume exceeds the levee specifications. Additionally, because levees can fail if they are allowed to decay or deteriorate, regular maintenance is critical.

Regulatory Oversight for Levees

USACE and FEMA

U.S. Army Corps of Engineers (USACE) and FEMA have differing roles and responsibilities related to levees. USACE addresses a range of operation and maintenance, risk communication, risk management, and risk-reduction issues as part of its responsibilities under the Levee Safety Program. FEMA addresses mapping and floodplain management issues related to levees, and it accredits levees as meeting requirements set forth by the National Flood Insurance Program.

Depending on the levee system, USACE and FEMA may be involved with the levee sponsor and community independently or—when a levee system overlaps both agency programs—jointly. Under both scenarios, the long-term goals are similar: to reduce risk and lessen the devastating consequences of flooding. Some USACE and FEMA partnering activities related to levees include:

- Joint meetings with levee sponsors and other stakeholders
- Integration of levee information into the National Levee Database
- State Silver Jackets teams
- Sharing of levee information
- Targeted task forces to improve program alignment

The Silver Jackets is a program that provides an opportunity to consistently bring together multiple state, federal, tribal, and local agencies to learn from each other and apply their knowledge to reduce risk. The Program's primary goals include the following:

- Create or supplement a mechanism to collaboratively identify, prioritize, and address risk management issues and implement solutions
- Increase and improve risk communication through a unified interagency effort

- Leverage information and resources and provide access to such national programs as FEMA's Risk Mapping, Assessment, and Planning (MAP) and USACE's Levee Inventory and Assessment Initiative
- Provide focused, coordinated hazard mitigation assistance in implementing high-priority actions such as those identified by state hazard mitigation plans
- Identify gaps among agency programs and/or barriers to implementation, such as conflicting agency policies or authorities, and provide recommendations for addressing these issues

Pennsylvania has an active Silver Jackets team. The team is an interagency organization dedicated to working collaboratively with the Commonwealth and appropriate stakeholders in developing and implementing solutions to flood hazards by combining available agency resources, which include funding, programs, and technical expertise. The team provides a variety of flood risk management resources for the public – before, during and after a flood – on their website at http://www.nab.usace.army.mil/Home/Silver-Jackets/.

Coordination between USACE and FEMA with regard to levees is now standard within many of each agency's policies and practices. Over the past several years, both agencies coordinated policies where appropriate; jointly participated in meetings with stakeholders; and participated in many multiagency efforts, such as the National Committee on Levee Safety, the Federal Interagency Floodplain Management Task Force, and the Silver Jackets Program.

National Committee on Levee Safety

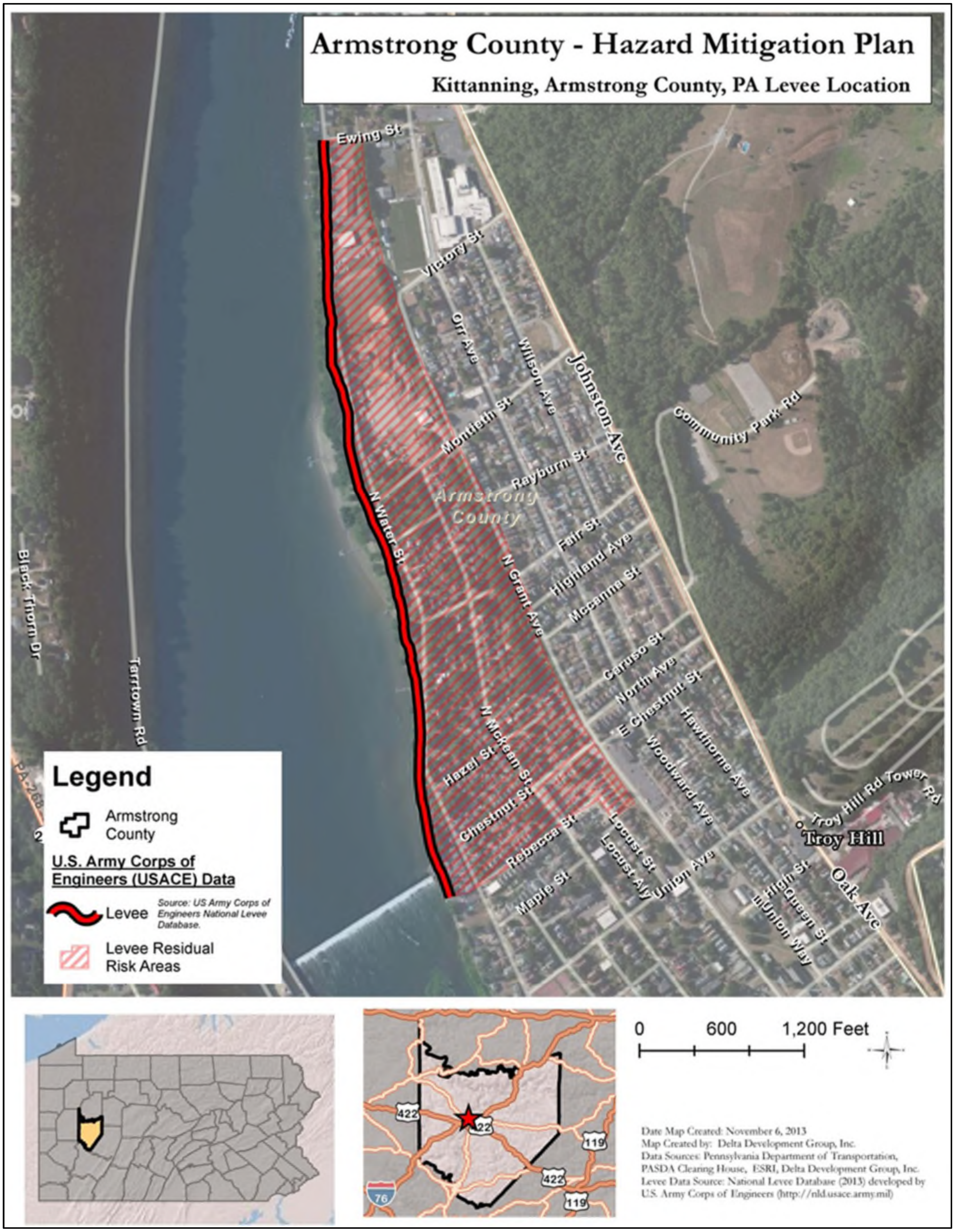
Congress created the National Committee on Levee Safety to "develop recommendations for a national levee safety program, including a strategic plan for implementation of the program." The Committee adopted the vision of "an involved public and reliable levee systems working as part of an integrated approach to protect people and property from floods," and has been working toward this goal since October 2008 (National Committee on Levee Safety 2009).

The Committee is made up of representatives from state, regional, and local agencies; the private sector; USACE; and FEMA.

4.3.8.1 Location and Extent

A total of 317 levee segments and 63 floodwall segments have been identified throughout Pennsylvania, with at least one levee in 51 of 67 counties. Armstrong County has one levee located in Kittanning Borough (Pennsylvania Emergency Management Agency [PEMA] 2018; USACE 2018). According to the USACE's National Levee Database (NLD), the Kittanning Borough levee is 0.87 mile in length with an embankment length of 0.7 mile. It is located on the left bank of the Allegheny River and has low levee safety action risk classification, with 855 people at risk and 214 structures at risk if a failure were to occur. During the last inspection in July 2010, it was deemed unacceptable (USACE NLD 2018). Figure 4.3.8-1 illustrates the extent of the levee and the area that it protects.

Figure 4.3.8-1. Kittanning Levee



Source: USACE NLD 2018
Note: Shading indicates the area protected by the levee.

A complete levee failure, like a dam failure, is rather infrequent and typically coincides with events that cause them such as heavy rainfall, storm surge, or hurricanes. In the event of a levee failure, floodwaters may 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-percent annual chance flood will inundate the approximate 100-year flood plain previously protected by the levee. Residential and commercial buildings located nearest the levee failure or breach location will suffer the most damage from the initial embankment failure flood wave. Landward buildings will be damaged by inundation (FEMA 2004).

Levees require maintenance to continue to provide the level of protection they were designed and built to offer. Maintenance responsibility belongs to a variety of entities including local, state, and federal government and private landowners. Well-maintained levees may obtain certification through independent inspections. Levees may not be certified for maintaining flood protection when the levee owner does not maintain the levee or pay for an independent inspection. The impacts of an un-certified levee include higher risk of levee failure. In addition, insurance rates may increase because FEMA identifies on Flood Insurance Rate Maps that the structures are not certified to protect from a 1-percent annual chance flood event (FEMA 2004).

4.3.8.2 Range of Magnitude

Levee failures can be caused by a number of factors, and can also result in catastrophic effects. If a levee fails, damage to the area beyond the levee could be more significant than if the levee was not present. Levees are designed to provide a specific level of protection; flooding events could overtop the levees if these events exceeded the levee specifications. Additionally, levees can also fail if they are allowed to decay or deteriorate, so regular maintenance of levees is critical.

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

The environmental impacts of a levee failure can include significant water-quality and debris-disposal issues. Flood waters can back up sanitary sewer systems and inundate wastewater treatment plants, causing raw sewage to contaminate residential and commercial buildings and the flooded waterway. The contents of unsecured containers of oil, fertilizers, pesticides, and other chemicals get added to flood waters. Hazardous materials may be released and distributed widely across the floodplain. Water supply and wastewater treatment facilities could be off line for weeks. After the flood waters subside, contaminated and flood-damaged building materials and contents must be properly disposed of. Contaminated sediment must be removed from buildings, yards, and properties. In addition, severe erosion is likely; such erosion can negatively impact local ecosystems.

The effects of a levee failure are exacerbated when the failure occurs abruptly or with little warning and if it results in deep, fast-moving water through highly developed areas. The worst-case scenario for a levee failure in Armstrong County would be the complete failure of the Kittanning Borough levee. If this occurred during a flood with a 1-percent annual chance of occurrence, the failure would lead to effects consistent with those described in Section 4.3.5, Flood, Flash Flood, and Ice Jams Hazard Profile.

4.3.8.3 Past Occurrence

No known levee failures have been recorded in Armstrong County. There have been no FEMA declarations associated with levee failure in Armstrong County or the Commonwealth of Pennsylvania.

4.3.8.4 Future Occurrence

A complete levee failure is rather infrequent and typically coincides with events that cause them such as heavy rainfall, storm surge, or hurricanes. Additionally, future climate change may impact storm patterns, increasing the probability of more frequent, intense storms with varying duration. Because levee failure is often caused by excessive rainfall, it is appropriate to relate the future vulnerability of levees directly with the potential for increased rainfall in Armstrong County.

In Section 4.4, the identified hazards of concern for Armstrong County were ranked for relative risk. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and reference to the Pennsylvania State HMP, the probability of occurrence for levee failure events in Armstrong County is considered *unlikely*. Section 4.4 includes further information on PEMA's risk factor methodology and the risk factors used to determine each hazard's risk ranking.

4.3.8.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets exposed and/or vulnerable within the identified hazard area. For the levee hazard, the area protected by the Kittanning Levee, as depicted in Figure 4.3.8-1 above, is examined. This section evaluates and estimates the potential impact of flooding in Armstrong County in the following subsections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) the economy; (5) the environment; and (6) future growth and development
- Effects of climate change on vulnerability

Overview of Vulnerability

As discussed above, the USACE's NLD indicates that Armstrong County has one levee. The Kittanning Levee, located in Kittanning Borough, is 0.87 mile in length and protects approximately 0.1 square mile of land. Figure 4.3.8-1 illustrates the levee location and levee-protected area boundary.

Data and Methodology

Information from USACE regarding the levee-protected area of the Kittanning Levee was used to estimate exposure. Levee-protected areas are typically protected from flooding but can becoming inundated in the event of a levee failure event.

Impact on Life, Health, and Safety

Impacts of levee failure on life, health, and safety depend on several factors, including severity of the event, protection level of the level, and whether or not adequate warning time is provided to residents. Assumedly, the population living in or near floodplain areas and in the levee-protected area could be impacted by a failure event. To estimate the population exposed to the levee failure hazard, the levee-protected area boundary was overlaid on the 2010 U.S. Census population data in using geographic information system (GIS) technology (U.S. Census 2010). The U.S. Census blocks do not follow the boundaries of the levee-protected area data. When utilizing the centroids or intersects of the U.S. Census blocks with the levee failure hazard area, the population exposed may be grossly overestimated or underestimated. The limitations of these analyses are recognized, and as such the results are used only to provide a general estimate. More information on the impact on life, health, and safety is included in Section 4.3.5, Flood, Flash Flood, and Ice Jam Hazard Profile. According to the analysis, approximately 357 residents in Kittanning Borough (8.8 percent of total Borough population) are located within the levee-protected area.

Impact on General Building Stock

After consideration of the population exposed, the built environment was evaluated. Similar to the population, the building stock data are presented by U.S. Census block. To estimate the number of buildings and value of building stock exposed to the levee failure hazard, the levee protected area boundary was overlaid on the Hazards U.S.—Multi-hazard (HAZUS-MH) building stock data in GIS. Using the HAZUS-MH default general building stock, the replacement cost values of the Census blocks with their centroids in the area were totaled. Approximately $55 million worth of buildings and their contents are exposed to the hazard area in Kittanning Borough in Armstrong County. This represents approximately 5.9 percent of the Borough's total general building stock replacement value inventory ($933 million). To estimate the number of structures exposed to the levee failure hazard, the County's spatial layer of structures was overlaid with the hazard area. In total, 185 structures, or 11.5 percent of the Kittanning Borough's building stock, are located in the levee-protected area. As described above, the U.S. Census blocks do not follow hazard area boundaries and these estimates should only be used for planning purposes

Impact on Critical Facilities

In addition to considering general building stock at risk, the hazard risk for critical facilities, utilities, and user-defined facilities was evaluated. There are no critical facilities in Kittanning Borough located within the hazard area.

Impact on the Economy

Section 4.3.5, Flood, Flash Flood, and Ice Jams Hazard Profile, includes more information regarding the impact of levee failure and flooding on the economy in Armstrong County.

Impact on the Environment

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 wastewater 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 (PEMA 2018).

Future Growth and Development

As discussed in Section 4.4, areas targeted for future growth and development have been identified across the Armstrong County. Any areas of growth could be impacted by the flood hazard if the areas are within identified hazard areas. The County intends to discourage development in vulnerable areas, or to encourage higher regulatory standards on the local level.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation, but also by the type, frequency, and intensity of weather events. Both globally and at the local level, climate change can alter the prevalence and severity of extremes such as flood events. While predicting changes of flood events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment (U.S. Environmental Protection Agency [EPA] 2006).

Pennsylvania Department of Environmental Protection (PADEP) was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of potential impacts of global climate change on the Commonwealth. The June

2009 Pennsylvania Climate Impact Assessment's main findings indicate that Pennsylvania is very likely to undergo increased temperatures in the 21st century. An increase in variability of temperature and precipitation may lead to increased frequency and/or severity of storm events. Summer floods and general stream flow variability are projected to increase due to increased precipitation. Even with the anticipated increase in winter precipitation occurring as rain rather than snow, increased winter temperatures and a reduced snowpack may decrease rain-on-snow events and thus affect major flooding events in Pennsylvania. This conclusion regarding trends toward increased temperatures, however, remains speculative until further studies can validate it. Future improvements in modeling smaller-scale climatic processes are expected, and will lead to improved understanding of the ways in which the changing climate will alter temperature, precipitation, storms, and flood events in Pennsylvania (Shortle et al. 2009).

Additional Next Steps

For future plan updates, levee failure inundation areas may be used to estimate potential impacts to life, buildings, and critical assets.

4.3.9 Pandemic Disease

This section describes the location and extent, range of magnitude, past occurrence, future occurrence, and vulnerability assessment for the pandemic disease hazard for Armstrong County.

Pandemics are large-scale disease outbreaks defined by the way a disease spreads rather than by the number of fatalities associated with the disease. A pandemic outbreak has several recognizable characteristics, including rapid, large-scale (potentially global) spread that causes overloaded healthcare systems; inadequate medical supplies; medical supply shortages; and a disrupted economy and society (Flu.gov 2015). Pandemics typically result from infectious diseases. An infectious disease, as defined by the World Health Organization (WHO), is caused by pathogenic organisms (e.g., bacteria, viruses, fungus, or parasites) that spread from one person to another, whether through direct or indirect contact. Zoonotic disease, a type of infectious disease, occurs when animals transmit a disease to humans (WHO 2015). Although any infectious disease can reach pandemic levels, influenza (flu) has the greatest likelihood of causing the next pandemic.

The risk of a global influenza pandemic has increased over the last several years. This disease can claim thousands of lives and adversely affect critical infrastructure and key resources. An influenza pandemic has the ability to reduce the health, safety, and welfare of the essential services workforce; prevent core infrastructure from operating normally, such as hospitals (essential personnel becoming ill and unable to work); and induce fiscal instability.

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

At the national level, the Centers for Disease Control and Prevention's (CDC) Influenza Division has a long history of supporting the WHO and its global network of National Influenza Centers (NIC). With limited resources, most international assistance provided in the early years was through hands-on laboratory training of in-country staff, the annual provision of WHO reagent kits (produced and distributed by CDC), and technical consultations for vaccine strain selections. The Influenza Division also conducts epidemiologic research, including vaccine studies and serologic assays, and provides international outbreak investigation assistance (CDC 2011). Influenza most frequently spreads through the air or by touch; when an infected person coughs, infected droplets go into the air or onto their hands, facilitating transmission of the disease to other people (WHO 2015).

4.3.9.1 Location and Extent

Pandemic events cover a wide geographic area and can affect large populations, which can include multiple countries or continents. The size and extent of an infected population depends on how easily the illness is spread, mode of transmission, and amount of contact between infected and uninfected individuals. Locations with higher density populations are more susceptible to pandemic outbreaks, as the disease can be transmitted more easily. Additionally, vulnerable populations, especially the young and the elderly (who have weaker immune systems), are at greater risk for both contracting a disease and suffering fatal or severe consequences.

When a pandemic or disease outbreak occurs, WHO and other public health institutions begin tracking the disease outbreak, treatment, and more. Ebola was a significant pandemic concern for American public health officials in 2014; however, the disease has primarily remained in Africa to date. Should a pandemic take hold in the United States, the Centers for Disease Control and Prevention (CDC) and the National Institutes of Health (NIH) would be actively involved in managing the outbreak and treatment of the disease.

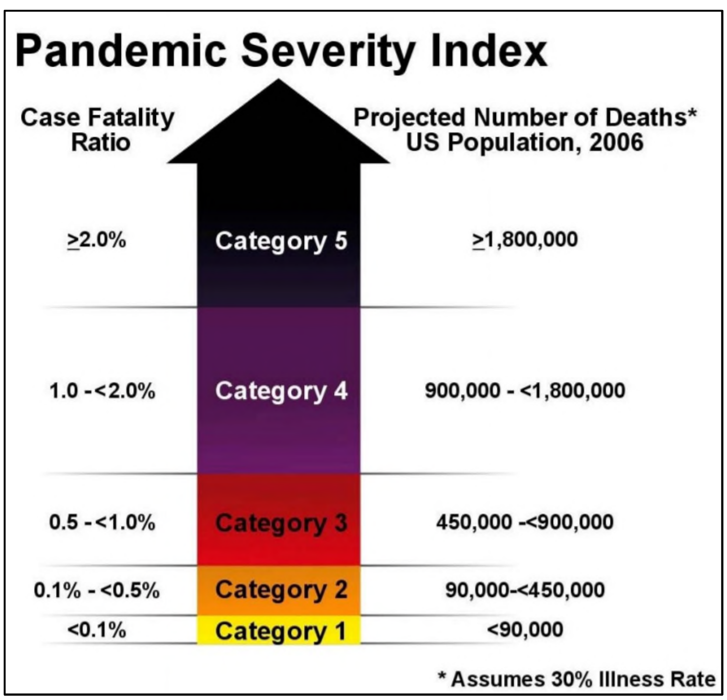
Although Ebola is still recognized as a global health threat, Armstrong County is primarily concerned with the possibility of a pandemic influenza outbreak. Influenza viruses with the potential to reach pandemic levels include the avian influenza A (H5N1) and avian influenza H7N9 (CDC 2015). In 2009, the swine influenza (H1N1) was of particular concern. H1N1 was first detected in people in the United States in April 2009. On June 11, 2009, WHO signaled that a pandemic of 2009 H1N1 influenza was underway (CDC 2009).

4.3.9.2 Range of Magnitude

The severity of a pandemic depends on a number of factors, as indicated above. These include aggressiveness of the disease, ease of transmission, and factors associated with the impacted community (e.g., access to medical care, demographic data, and population density). Advancements in medical technologies have greatly reduced the number of deaths caused by influenza, the disease most likely to reach pandemic scale in Pennsylvania. Consequently, global effects of various influenza outbreaks have declined over the past century. High-risk populations considered more vulnerable to various pandemic diseases are described in the vulnerability assessment.

The CDC and Prevention Community Strategy for Pandemic Influenza Mitigation guidance introduced a Pandemic Severity Index (PSI), which uses the case fatality ratio as the critical driver for categorizing the severity of a pandemic. The index is designed to estimate the severity of a pandemic on a population to allow better forecasting of the impact of a pandemic, and to enable recommendations on the use of mitigation interventions that are matched to the severity of influenza pandemic. Pandemics are assigned to one of five discrete categories of increasing severity (Category 1 to Category 5) (CDC 2018). Figure 4.3.9-1 illustrates the five categories of the PSI.

Figure 4.3.9-1. Pandemic Severity Index



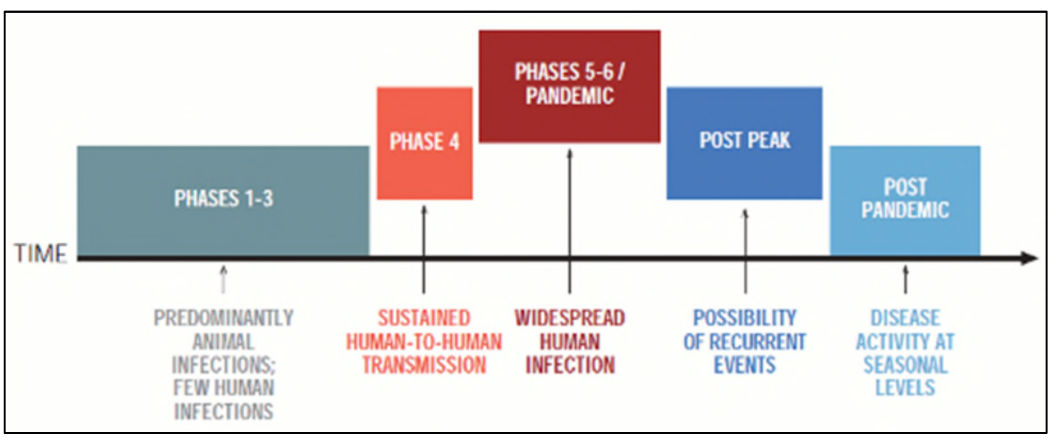
Source: CDC 2018

The WHO described a series of pandemic phases in 1999 and revised these in 2005 and 2009 to provide a global framework and aid in pandemic preparedness and response planning. In addition to facilitating implementation of preparedness recommendations, the phases also help provide greater understanding of when an event is considered to have reached pandemic levels. The six phases are shown on Figure 4.3.9-2 below and are described as follows:

- Phase 1: No viruses circulating among animals have been reported among humans.
- Phase 2: An animal influenza virus circulating among domesticated or wild animals has caused known infection in humans and is now considered a potential pandemic threat.
- Phase 3: An animal or human-animal influenza reassortment virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks. Limited human-to-human transmission may occur under some circumstances, such as close contact between an infected person and an unprotected caregiver.
- Phase 4: Verified human-to-human transmission of an animal or human-animal influenza reassortment virus is able to cause "community-level outbreaks." The ability to cause sustained disease outbreaks in a community marks a significant upwards shift in the risk of a pandemic. Any country that suspects or has verified such an event should urgently consult with WHO so that the situation can be jointly assessed, and a decision made by the affected country if implementation of a rapid pandemic containment operation is warranted. Phase 4 indicates a significant increase in risk of a pandemic but does not necessarily mean that a pandemic is a forgone conclusion.
- Phase 5: There has been human-to-human spread of the virus into at least two countries in one WHO region. While most countries will not be affected at this stage, the declaration of Phase 5 is a strong signal that a pandemic is imminent, and that the time to finalize the organization, communication, and implementation of the planned mitigation measures is short.
- Phase 6: The pandemic phase is characterized by community-level outbreaks in at least one other country in a different WHO region, in addition to the criteria defined in Phase 5. Phase 6 indicates a global pandemic is underway.

The conclusion of Phase 6 leads to the post-peak period, wherein pandemic levels decrease in most countries with surveillance capabilities. Despite a decrease in activity, countries still must be prepared for additional waves of the pandemic. Pandemic waves can be separated by a period of months, leading to a long recovery time to guarantee entry of the pandemic into the post-pandemic phase (WHO 2009).

Figure 4.3.9-2. Pandemic Influenza Phases



Source: World Health Organization 2009

Pandemic influenza should not be confused with seasonal influenza. Seasonal influenza is a less severe concern because of its regularity of occurrence and predictability. Table 4.3.9-1 lists key differences between pandemic influenza and seasonal influenza.

Table 4.3.9-1. Seasonal Influenza vs. Pandemic Influenza

Pandemic Influenza	**Seasonal** Influenza
Rarely happens (three times in 20th century).	Happens annually and usually peaks in January or February.
People have little or no immunity because they have no previous exposure to the virus.	Usually some immunity built up from previous exposure.
Healthy people may be at increased risk for serious complications.	Usually only people at high risk, not healthy adults, are at risk of serious complications.
Healthcare providers and hospitals may be overwhelmed.	Healthcare providers and hospitals can usually meet public and patient needs.
Vaccine probably would not be available in the early stages of a pandemic.	Vaccine available for annual influenza season.
Effective antivirals may be in limited supply	Adequate supplies of antivirals are usually available.
Number of deaths could be high (U.S. death toll during the 1918 pandemic was approximately 675,000).	Seasonal influenza-associated deaths in the U.S. over 30 years ending in 2007 have ranged from about 3,000 per season to about 49,000 per season.
Symptoms may be more severe	Symptoms include fever, cough, runny nose, and muscle pain.
May cause major impact on the general public, such as widespread travel restrictions and school or business closings.	Usually causes minor impact on the general public; some schools may close, and sick people are encouraged to stay home.
Potential for severe impact on domestic and world economy.	Manageable impact on domestic and world economy.

Source: Flu.gov 2015

4.3.9.3 Past Occurrence

Several pandemic influenza outbreaks have occurred over the past 100 years. A list of worldwide pandemic events appears in Table 4.3.9-2. Deaths occurred in the United States as a result of Spanish influenza, Asian influenza, and Hong Kong influenza outbreaks. Spanish influenza (1918-1920) claimed 500,000 lives in the United States, with 350,000 cases reported in Pennsylvania. Most deaths resulting from Asian influenza occurred between September 1957 and March 1958; within the United States, approximately 70,000 people died, and approximately 15 percent of the population of Pennsylvania was affected. The first cases of Hong Kong influenza in the United States were detected in September 1968, with deaths peaking between December 1968 and January 1969 (Global Security, 2009). As of August 2010, H1N1 was in a post-pandemic period.

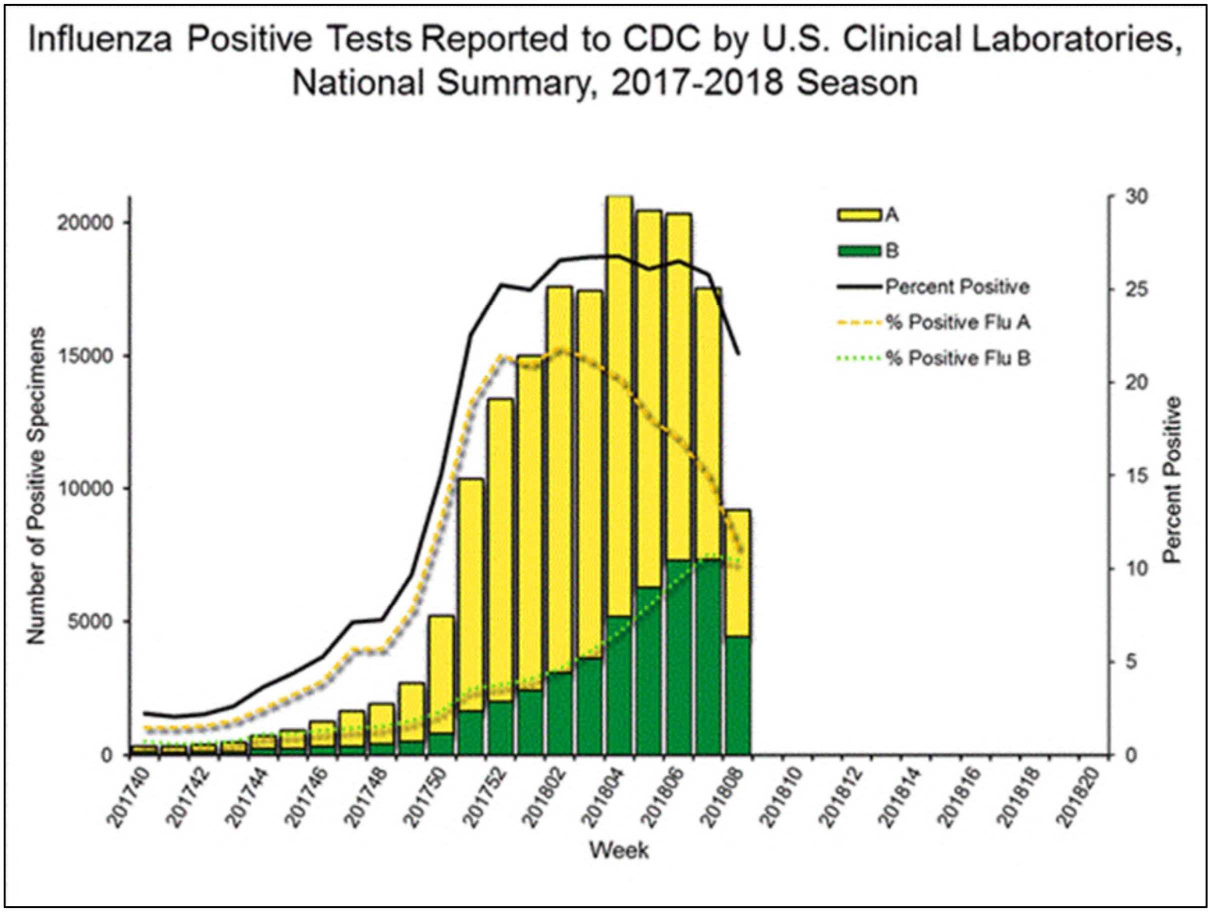
Table 4.3.9-2. Previous Pandemic Outbreaks

Date	Pandemic/Subtype	Worldwide Deaths (Approx.)
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/H1N1	> 18,000

Source: CDC 2010

Epidemiologists and public health officials consistently track the rate of influenza or influenza-like illnesses (ILI) to monitor potential pandemic threats. This also allows them to provide annual data on ILI seasonal outbreaks. Figure 4.3.9-3 below shows the biweekly national number of cases of ILI during the 2017–2018 season, distinguishing each type of ILI by a unique color.

Figure 4.3.9-3. ILI Cases in Pennsylvania, 2017–2018 Season



Source: PA Department of Health 2017

The Pennsylvania Department of Health tracks positive influenza tests. Table 4.3.9-3 shows the numbers of positive ILI tests in Armstrong County in recent years.

Table 4.3.9-3. Positive ILI tests in Armstrong County

Year	Influenza Type A	Influenza Type B	Influenza Type U	Total
2005/2006	N/A	N/A	N/A	51
2006/2007	N/A	N/A	N/A	32
2007/2008	N/A	N/A	N/A	228
2008/2009	N/A	N/A	N/A	81
2009/2010	N/A	N/A	N/A	139
2010/2011	N/A	N/A	N/A	146
2011/2012	N/A	N/A	N/A	12
2012/2013	N/A	N/A	N/A	219
2013/2014	153	15	0	168
2014/2015	264	56	1	321
2015/2016	126	40	3	169
2016/2017	226	86	0	312

Year	Influenza Type A	Influenza Type B	Influenza Type U	Total
2017/2018	303	102	0	405

Source: PA Department of Health 2017
Note: Influenza type not available prior to 2013/2014

4.3.9.4 Future Occurrence

Predicting the future occurrences of pandemics is difficult. Although any infectious disease can reach pandemic levels, influenza has the greatest likelihood of causing the next pandemic. Based on the history of occurrences in Armstrong County, it is likely that the County will be impacted by certain diseases in the future. Additionally, an increase in population and population density in Armstrong County may increase resident exposure and susceptibility to outbreaks. Infected mosquitos and ticks will continue to inhabit and impact Armstrong County.

Based on previous occurrences of the various diseases, pandemics, and outbreaks of the different diseases will continue to occur. However, the future of these diseases and their impacts on Armstrong County is uncertain. Future pandemics may also emerge from other diseases, especially invasive pathogens to which residents of Armstrong County do not have natural immunity.

In Section 4.4, the identified hazards of concern for Armstrong County were ranked for relative risk. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and reference to the Pennsylvania State HMP, the probability of occurrence for pandemic events in Armstrong County is considered *possible*. Please refer to Section 4.4 for further information on the Pennsylvania Emergency Management Agency's (PEMA) risk factor methodology and the risk factors used to determine each hazard's risk rank.

4.3.9.5 Vulnerability Assessment

To understand risk, a community must evaluate what assets are exposed and potentially vulnerable to the identified hazard. For the pandemic hazard, the entire County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities, and lifelines), as described in the Community Profile (Section 2), are exposed and potentially vulnerable. The following text evaluates and estimates the potential impact of a pandemic event on Armstrong County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, health and safety, (2) general building stock, (3) critical facilities, (4) economy, (5) environment, and (6) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will assist understanding of this hazard over time

Overview of Vulnerability

Depending on characteristics of the disease or virus, certain population groups can be at higher risk of infection than others. Regarding seasonal influenza, about 60 percent of hospitalizations and 90 percent of influenza-related deaths occur among people 65 and older. However, during the H1N1 pandemic, 90 percent of hospitalizations and 87 percent of H1N1-related deaths occurred in people younger than 65. As with seasonal influenza, people with underlying health conditions faced a much higher probability of contracting H1N1. Schools, convalescent centers, and other institutions are highly conducive to faster transmission of pandemic diseases (CDC 2010).

Data and Methodology

A qualitative assessment was conducted to evaluate the assets exposed and the potential impacts associated with this hazard.

Impact on Life, Health, and Safety

The entire population of Armstrong County is vulnerable to a pandemic event. According to the 2016 American Community Survey 5-Year Population Estimate, the County's population was 67,512. The elderly population and individuals with suppressed immune systems may be more susceptible to effects of diseases such as influenza. Table 4.3.9-4 shows the demographic change in children and the elderly from 2000 through 2016. There are fewer individuals under 65 years of age, but more individuals over 65 years of age in the County. Therefore, Armstrong County is more vulnerable to seasonal influenza but less vulnerable to pandemic influenza such as the H1N1 pandemic.

Table 4.3.9-4. Demographic Trends for Vulnerable Populations

Vulnerable Population	2000 Census	2010 Census	2016 Census Estimate	2000 to 2016 Change
Children under 5 years	3,913	3,605	3,429	-484
Under 18 years	16,574	14,189	13,204	-3,370
65 years and over	13,053	12,687	13,666	673

Source: U.S. Census Bureau 2017

Impact on General Building Stock and Critical Facilities

No structures are anticipated to be directly affected by a pandemic event.

Impact on the Economy

The impact pandemic events can have on the economy and estimated dollar losses are difficult to measure and quantify because the exact rates of absenteeism and costs of treating widespread disease will depend on the virus or bacterium in question, the availability of vaccinations or treatments, and the severity of symptoms. Costs associated with the activities and programs implemented to conduct surveillance and address pandemic events have not been quantified in available documentation.

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 (PEMA 2018).

Impact on the Environment

There are no true environmental impacts of pandemic and infectious disease threats, but there will be significant economic and social costs beyond the possibility of disease-related death (see the Impact on the Economy subsection) (PEMA 2018). However, there are environmental factors that can influence the spread of diseases that are prone to lead to pandemics. These include: water supply, sanitation facilities, food, and climate. A lack of safe water, inadequate sanitation facilities, poor hygiene, and unsafe food can all lead to additional impacts to those already suffering. Climate can affect disease transmission in numerous ways. The distribution and population size of disease vectors can be heavily affected by local climate. Flooding after heavy rains can result in sewage overflow and widespread water contamination leading to illness (WHO 2018).

Future Growth and Development

Areas targeted for potential future growth and development in the next five to ten years have been identified across Armstrong County (further discussed in Section 4.4 of this HMP). It is anticipated that any new development and new residents will be exposed to the pandemic hazard.

Effect of Climate Change on Vulnerability

An increase in temperature and humidity may lead to a larger number of influenza outbreaks. Studies have shown that warmer winters led to an increase in influenza cases. During warm winters, fewer people contract influenza, causing many people to remain vulnerable into the next season and leading to an early and strong occurrence of the virus (Spross 2013).

Additional Data and Next Steps

For the HMP update, any additional information regarding localized concerns and past impacts will be collected and analyzed. This data will be developed to support future revisions to the plan. Future mitigation efforts could include building on existing Pennsylvania, Armstrong County, and local efforts.

4.3.10 Radon Exposure

This section describes the location and extent, range of magnitude, past occurrence, future occurrence, and vulnerability assessment for the radon exposure hazard for the Armstrong County Hazard Mitigation Plan (HMP).

Radon is a natural gas that cannot be seen, smelled, or tasted. It is a noble gas that originates from natural radioactive decay of uranium and thorium. Radon is a large component of the natural radiation to which humans are exposed, and can pose a serious threat to public health when it accumulates in poorly ventilated residential and occupation settings. According to the U.S. Environmental Protection Agency (EPA), (EPA 402-R-03-003: EPA Assessment), radon is estimated to cause approximately 21,000 lung cancer deaths per year, making it second only to smoking as the leading cause of lung cancer (EPA 2013). An estimated 40 percent of the homes in Pennsylvania are believed to have elevated radon levels (Pennsylvania Department of Environmental Protection [PADEP] 2014).

4.3.10.1 Location and Extent

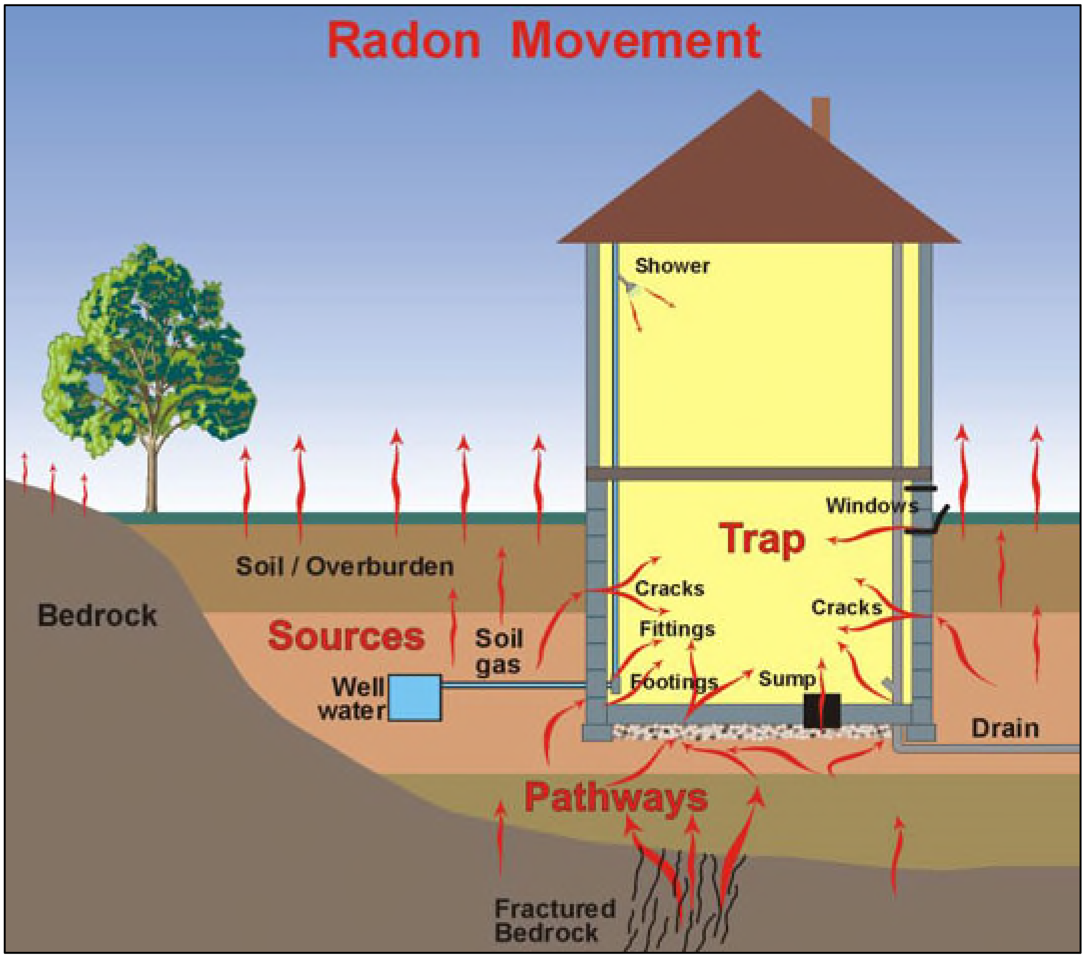
Radioactivity caused by airborne radon has been recognized for many years as an important component in the natural background radioactivity exposure of humans. However, the wide geographic distribution of elevated values in houses and the possibility of extremely high radon values in houses was not recognized until the 1980s. In 1984, routine monitoring of employees leaving the Limerick nuclear power plant near Reading, PA, revealed interesting results. Readings collected from employee 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 pico Curies per Liter (pCi/L), much higher than the EPA guideline of 4 pCi/L or even the 67 pCi/L limit for uranium miners (PEMA 2018).

Radon (Rn-222), which has a half-life of 3.8 days, is a widespread hazard. The distribution of radon correlates with the distribution of radium (Ra-226), its immediate radioactive parent, and with uranium, its original ancestor. Because of the short half-life of radon, the distance radon atoms travel from their parent before they decay is generally limited to extents of feet or tens of feet.

Figure 4.3.10-1 illustrates radon entry points into a home. The following three sources of radon in houses are now recognized:

- Radon in soil air flows into the house
- Radon dissolved in water from private wells and exsolved during water usage (This source is rarely a problem in Pennsylvania.)
- Radon emanating from uranium-rich building materials, such as concrete blocks or gypsum wallboard (This source also is not known to be a problem in Pennsylvania.) (PEMA 2018)

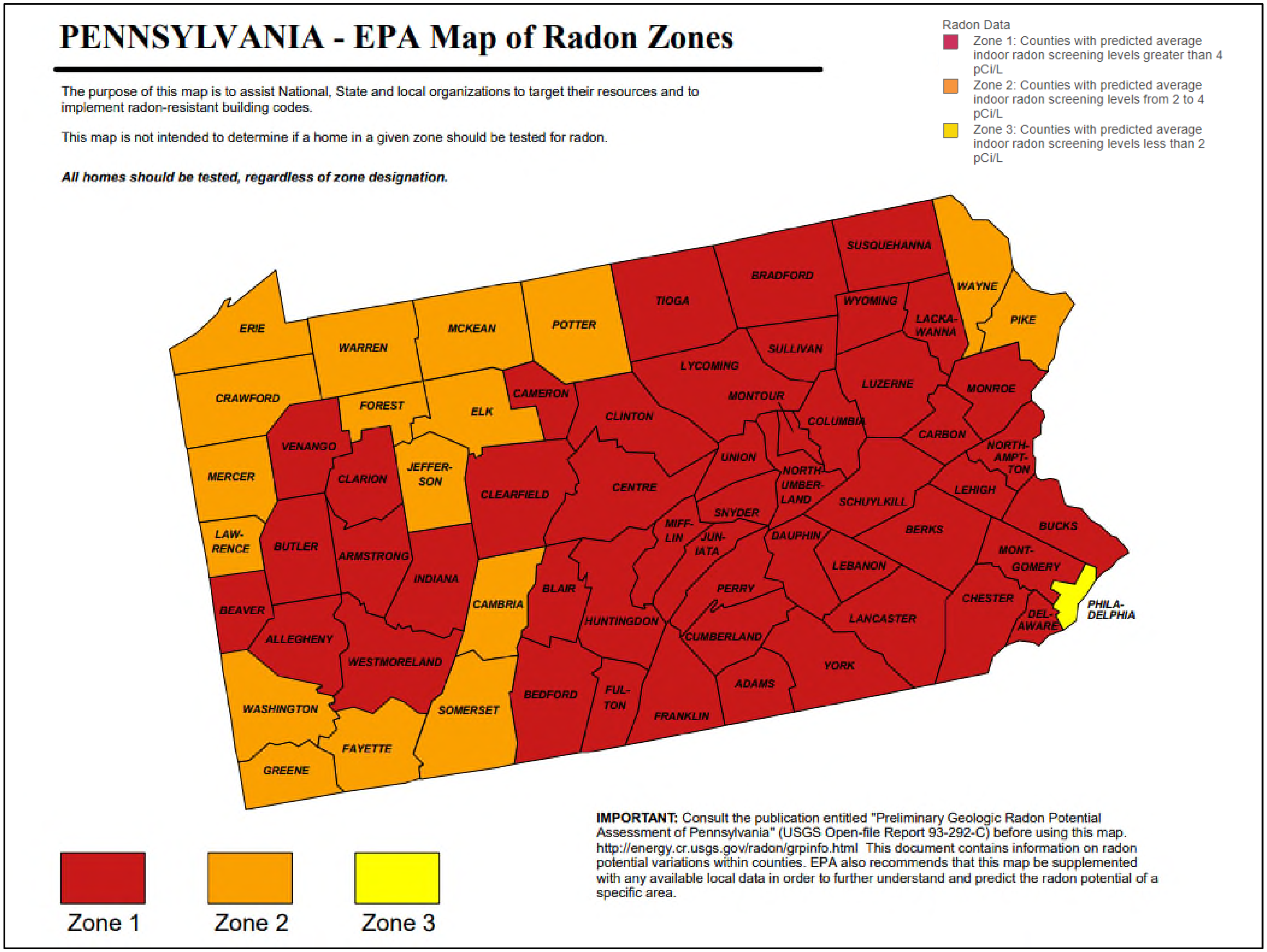
Figure 4.3.10-1. Sketch of Radon Entry Points into a House



Sources: PEMA 2013

Each county in Pennsylvania is classified as having a low, moderate, or high radon hazard potential. A majority of counties across the Commonwealth, particularly counties in eastern Pennsylvania, have a high hazard potential. Western Pennsylvania counties, however, are not completely immune from the threat of radon, as high potential for radon exposure exists within nine western counties. The average indoor radon screening level within high-exposure counties exceeds 4 pCi/L. Armstrong County is in Zone 1 – High Radon Potential, as noted on Figure 4.3.10-2 below.

Figure 4.3.10-2. Radon Hazard Zones in Pennsylvania



Sources: EPA 2018

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 (PEMA 2018).

The radon concentration of soil gas depends upon a number of soil properties, the importance of which is still being evaluated. In general, 10 to 50 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 (PEMA 2018).

Areas where houses have high levels of radon can be divided into the following three groups in terms of uranium content in rock and soil:

- Areas of very elevated uranium content (>50 parts per million [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 shale. 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 the black shale 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 values 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 (PEMA 2018).

4.3.10.2 Range of Magnitude

Exposure to radon is the second-leading cause of lung cancer after smoking, and is the number one cause of lung cancer among nonsmokers. Radon is responsible for approximately 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, no evidence indicates that children are at greater risk of lung cancer than adults. The main hazard is actually from radon-daughter products (polonium-218, lead-214, bismuth-214), which may become attached to lung tissue and induce lung cancer by their radioactive decay. Table 4.3.10-1 lists the following information for smokers and nonsmokers: (1) cancer risks from exposure to radon at various levels, (2) comparisons of lung cancer risks from radon exposure to comparable cancer risks from other hazards, and (3) action thresholds (PEMA 2018).

Table 4.3.10-1. Radon Risk for Smokers and Non-Smokers

Radon Level (picoCuries per liter [pCi/L])	Cancer Rate per 1,000 People with Lifetime Exposure	Comparative Cancer Risk of Radon Exposure	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	
8	About 120 people could get lung cancer	30 times the risk of dying in a fall	
4	About 62 people could get lung cancer	5 times the risk of dying in a car crash	
2	About 32 people could get lung cancer	6 times the risk of dying from poison	Consider fixing structure 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	
8	About 15 people could get lung cancer	4 times the risk of dying in a fall	
4	About 7 people could get lung cancer	The risk of dying in a car crash	
2	About 4 people could get lung cancer	The risk of dying from poison	Consider fixing structure between 2 and 4 pCi/L
1.3	About 2 people could get lung cancer	(Average indoor radon level)	Reducing radon levels below 2pCi/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.			

Source: EPA 2016

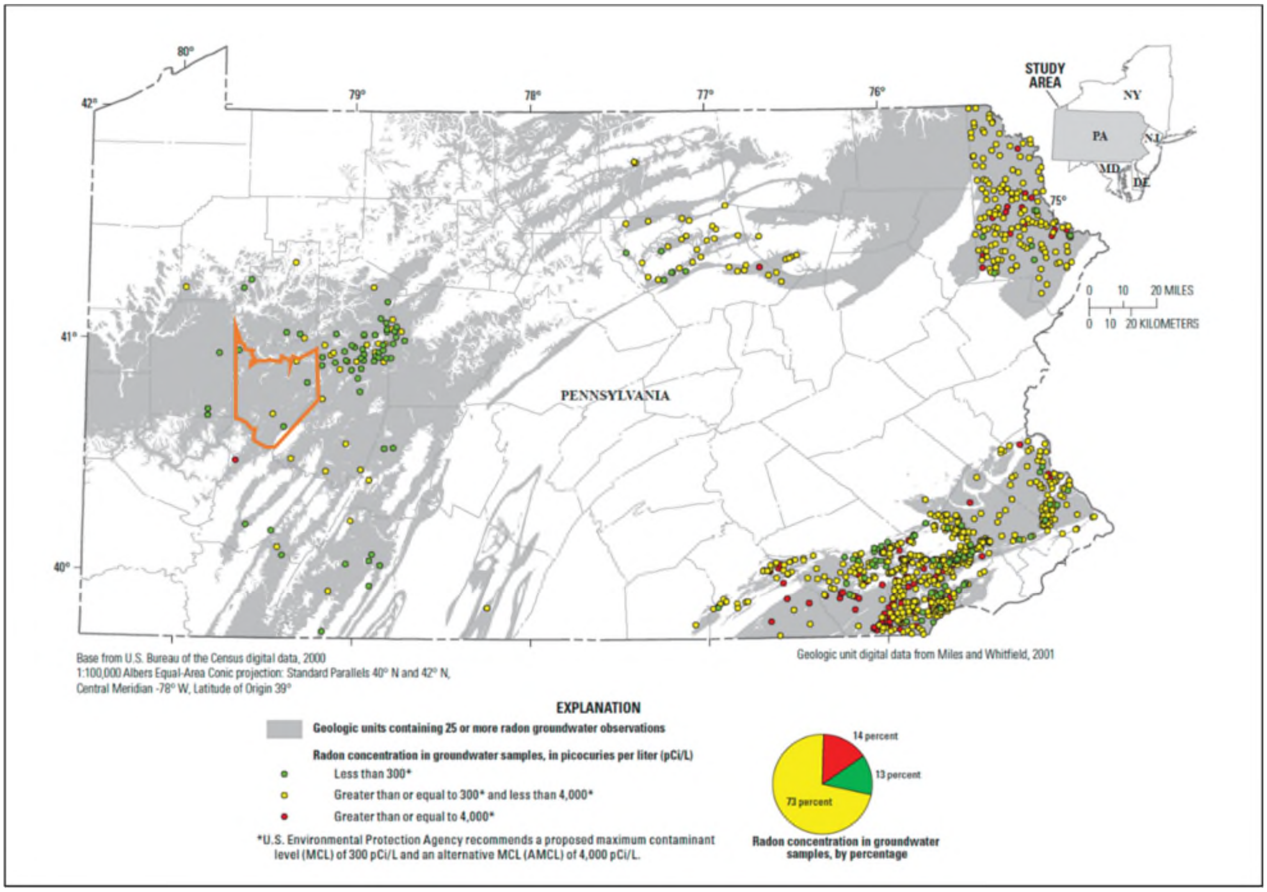
The worst-case scenario for radon exposure would be a large area of tightly sealed homes inducing high levels of exposure to residents over a prolonged period of time, without awareness of this by the residents. This worst-case scenario exposure then could lead to a large number of people contracting cancer attributed to the radon exposure (PEMA 2013). The most likely scenario is a single household exposed to a very low concentration of radon, with no adverse health effects.

4.3.10.3 Past Occurrence

Current data on abundance and distribution of radon as it affects individual houses in the Commonwealth of Pennsylvania in general are considered incomplete and potentially biased (PEMA 2018). Armstrong County is not an exception. EPA has estimated that the national average indoor radon concentration is 1.3 pCi/L and the level for action is 4.0 pCi/L; however, they have estimated that the average indoor concentration in Pennsylvania basements is about 7.1 pCi/L, and 3.6 pCi/L on the first floor (PADEP 2016).

The U.S. Geological Survey (USGS), in cooperation with the Pennsylvania Departments of Health and Environmental Protection, examined 1,041 well water samples and found that 14 percent had radon levels at or above the EPA's proposed alternative maximum contaminant level of 4,000 pCi/L. While the EPA does not currently regulate radon in drinking water, it has proposed this alternative limit for public water supplies in states like Pennsylvania, which has an EPA-approved radon indoor air quality program. For states without an approved program, EPA has proposed a lower, more protective, maximum contaminant level of 300 pCi/L. Figure 4.3.10-3 indicates that several wells in Armstrong County had radon detected in drinking water.

Figure 4.3.10-3. Radon Concentrations of Water Samples in Pennsylvania.



Source: USGS 2017

In Armstrong County, ten zip codes had sufficient tests submitted to the PA DEP Bureau of Radiation Protection to report their findings, which are shown in Table 4.3.10-2 below. The PADEP Radon Division recommends that *all* homeowners test for radon, regardless of the zip code result. Even when a zip code result shows a low average, many homes within that zip code can have elevated radon results. Air Chek, Inc., a company that provides home radon testing kits and manages the Radon.com website, lists the average indoor radon levels of Armstrong County to be 9.3 pCi/L, as determined by radon test results from Air Chek, Inc. (Air Check 2018).

Table 4.3.10-2. Radon Level Tests and Results by Armstrong County Zip Codes

Zip Code	Area in Home	Number of Tests	Maximum Result (pCi/L)	Average Result (pCi/L)
16201	Basement	606	173.0	9.6
	First Floor	45	16.2	4.5

Zip Code	Area in Home	Number of Tests	Maximum Result (pCi/L)	Average Result (pCi/L)
16226	Basement	217	111.0	7.6
	First Floor	Insufficient Data	Insufficient Data	Insufficient Data
16229	Basement	323	198.0	11.5
	First Floor	Insufficient Data	Insufficient Data	Insufficient Data
15656	Basement	491	172.1	7.2
	First Floor	36	66.0	11.7
16262	Basement	65	51.1	9.8
	First Floor	Insufficient Data	Insufficient Data	Insufficient Data
16049	Basement	40	69.4	7.2
	First Floor	Insufficient Data	Insufficient Data	Insufficient Data
16222	Basement	31	67.6	11.7
	First Floor	Insufficient Data	Insufficient Data	Insufficient Data
16249	Basement	36	52.5	8.0
	First Floor	Insufficient Data	Insufficient Data	Insufficient Data
15686	Basement	74	276.4	22.8
	First Floor	Insufficient Data	Insufficient Data	Insufficient Data
16218	Basement	30	144.1	13.9
	First Floor	Insufficient Data		

Source: PADEP 2018

4.3.10.4 Future Occurrence

Radon exposure is inevitable given present soil, geologic, and geomorphic factors in Armstrong County. Residents who live in developments within areas where radon levels were once found to be 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 by conducting proper testing within both existing and future developments, and implementing appropriate mitigation measures (PEMA 2013). As part of a 2014 initiative to raise awareness, EPA implemented the radon action campaign "Test, Fix, Save a Life" to highlight radon testing and mitigation as a simple and affordable step to significantly reduce the risk of lung cancer. Through this initiative, the "Test, Fix, Save a Life" mantra specifies activities and facts for the public regarding radon poisoning, as indicated below:

- Test: All homes with or without basements should be tested for radon. Affordable do-it-yourself radon test kits are available online and at home improvement and hardware stores, or you can hire a qualified radon tester.
- Fix: EPA recommends taking corrective action to fix radon levels at or above 4 pCi/L and contacting a qualified radon-reduction contractor. In most cases, a system with a vent pipe and fan is used to reduce radon. Addressing high radon levels often costs the same as other minor home repairs.
- Save a Life: More than 20,000 Americans die from radon-related lung cancer each year. By decreasing elevated levels in the home, residents can help prevent lung cancer while creating a healthier home (EPA 2013).

Based on available data and the fact that radon is present across Armstrong County, future occurrences of radon exposure can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (further discussed in Section 4.4).

4.3.10.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable within the identified hazard area. This section evaluates and estimates the potential impact of the radon exposure hazard on Armstrong County in the following sections:

- Overview of vulnerability
- Data and methodology used for the evaluation

- Impacts on (1) life, health, and safety; (2) general building stock and critical facilities; (3) the economy; (4) the environment; and (5) future growth and development
- Further data collections that will assist in understanding this hazard over time

Overview of Vulnerability

Radon exposure is of particular concern in Armstrong County because of the County's location within a high potential (Level 1) EPA radon zone. While structural factors (such as building construction and engineered mitigation measures) can influence the level of radon exposure, all residents and structures within Armstrong County are vulnerable to radon exposure.

Data and Methodology

The 2010 U.S. Census data and the Hazards U.S.–Multi-Hazard (HAZUS-MH) building inventory for Armstrong County were referenced to support an evaluation of assets exposed to this hazard and potential impacts associated with this hazard. In accordance with the 2013 Pennsylvania State HMP, an average radon mitigation system cost of $1,200 was applied to 20 percent of the building stock to evaluate economic vulnerability (PEMA 2013).

Impact on Life, Health, and Safety

For the purposes of this plan, the entire population of Armstrong County is assumed to be at risk of radon exposure. Radon is responsible for more than 20,000 of lung cancer deaths every year. Lung cancer is the only known effect on human health from exposure to radon in air, and thus far, no evidence indicates that children are at greater risk of lung cancer than are adults (EPA 2013). Excess human cancer risk posed by radon exposure at this elevated level is identified in Table 4.3.10-1.

Impact on General Building Stock and Critical Facilities

While the entire general building stock and critical facility inventory in Armstrong County is exposed to radon, radon does not result in direct damage to structures and facilities. Rather, engineering methods installed to mitigate human exposure to radon in structures results in economic costs described in the following subsection. Additionally, the 2018 State HMP Update indicates that a total of 32,065 buildings are present in areas with high radon test results (PEMA 2018).

Impact on the Economy

EPA has concluded that an average radon mitigation system costs $1,200. EPA also states that current State surveys indicate one home in five has elevated radon levels. Based on this information, radon loss estimation is factored by assuming that 20 percent of the residential buildings within high potential (Level 1) counties have elevated radon levels, and each would require a radon mitigation system installed at the EPA-estimated average of $1,200. Therefore, estimated radon mitigation costs for residential structures in Armstrong County could exceed $7.6 million (PEMA 2018).

Impact on the Environment

Radon exposure exerts minimal environmental impacts. Because of the relatively short half-life of radon, it tends to affect only living and breathing organisms such as humans or pets that are routinely within contained areas (basement or house) where the gas is released (PEMA 2013).

Future Growth and Development

Because the entirety of Armstrong County has been determined at risk for the radon exposure hazard, any new development will be exposed to this risk. Measures to reduce human exposure to radon in structures are readily available and can be incorporated during new construction at significantly lower cost and greater effectiveness than cost and effectiveness of retrofitting existing structures to implement these measures.

Effect of Climate Change on Vulnerability

According to the EPA's *Climate Change and Indoor Air* Quality contractor report, the primary factors that influence radon entry into a home include radon content of the soil; pressure differential between the interior of the home and the soil; the air exchange rate for the home; the moisture content surrounding the home; and the presence and size of entry pathways. These factors can be affected by climate change to different degrees. Climate change may also affect the depositional environment within the home, which can result in changes to the delivered dose by radon decay products. Additionally, EPA stated that the relative concentration of radon to its decay products, and the ability to deliver dose, is impacted by numerous factors including building ventilation rate, decay product attachment to aerosols, and particle deposition rate on surface. All these factors could be impacted by housing as well as behavioral changes driven directly or indirectly by climate change. For example, the increased use of ceiling fans could increase deposition of radon-decay products and reduce the delivered radon-related doses to the lungs (EPA 2013).

Additional Data and Next Steps

The assessment above identifies human health and economic losses associated with this hazard of concern; however, these estimates are based on national epidemiological statistics and generalized estimates of costs to mitigate structures in Armstrong County. Because specific structural conditions affect human exposure to radon, direct radon measurements within facilities are necessary to properly assess the level of health risk and indicate need for specific mitigation measures. Furthermore, EPA recommends consideration of radon exposure risk and installation of mitigation measures as appropriate during all new construction.

4.3.11 Subsidence and Sinkholes

This section provides a profile and vulnerability assessment for the subsidence and sinkhole hazard for the Armstrong County Hazard Mitigation Plan (HMP).

Two common causes of subsidence in Pennsylvania that impact Armstrong County are (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, subsurface 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. Areas of the County underlain by carbonate rock may be more susceptible to sinkholes as they are common where this type of rock is below the surface. As the rock dissolves, spaces and caverns develop underground (U.S. Geological Survey [USGS] 2018).

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 (Pennsylvania Emergency Management Agency [PEMA] 2018).

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 subsurface (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 (PEMA 2018).

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 3 to 5 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 50 feet thick. A study of subsidence in the Pittsburgh area revealed that the majority of sinkholes, which constituted about 95 percent of all reported subsidence incidents, occurred on sites located less than 60 feet above mine level (PEMA 2018).

The following sections discuss the location and extent, range of magnitude, previous occurrence, future occurrence, and vulnerability assessment associated with the subsidence and sinkhole hazard for Armstrong County.

4.3.11.1 Location and Extent

Approximately 2.5 percent of Armstrong County (3.6 square miles) is underlain by carbonate bedrock. Figure 4.3.11-1 shows the distribution of carbonate rock areas in Armstrong County. The following municipalities have identified near-surface limestone:

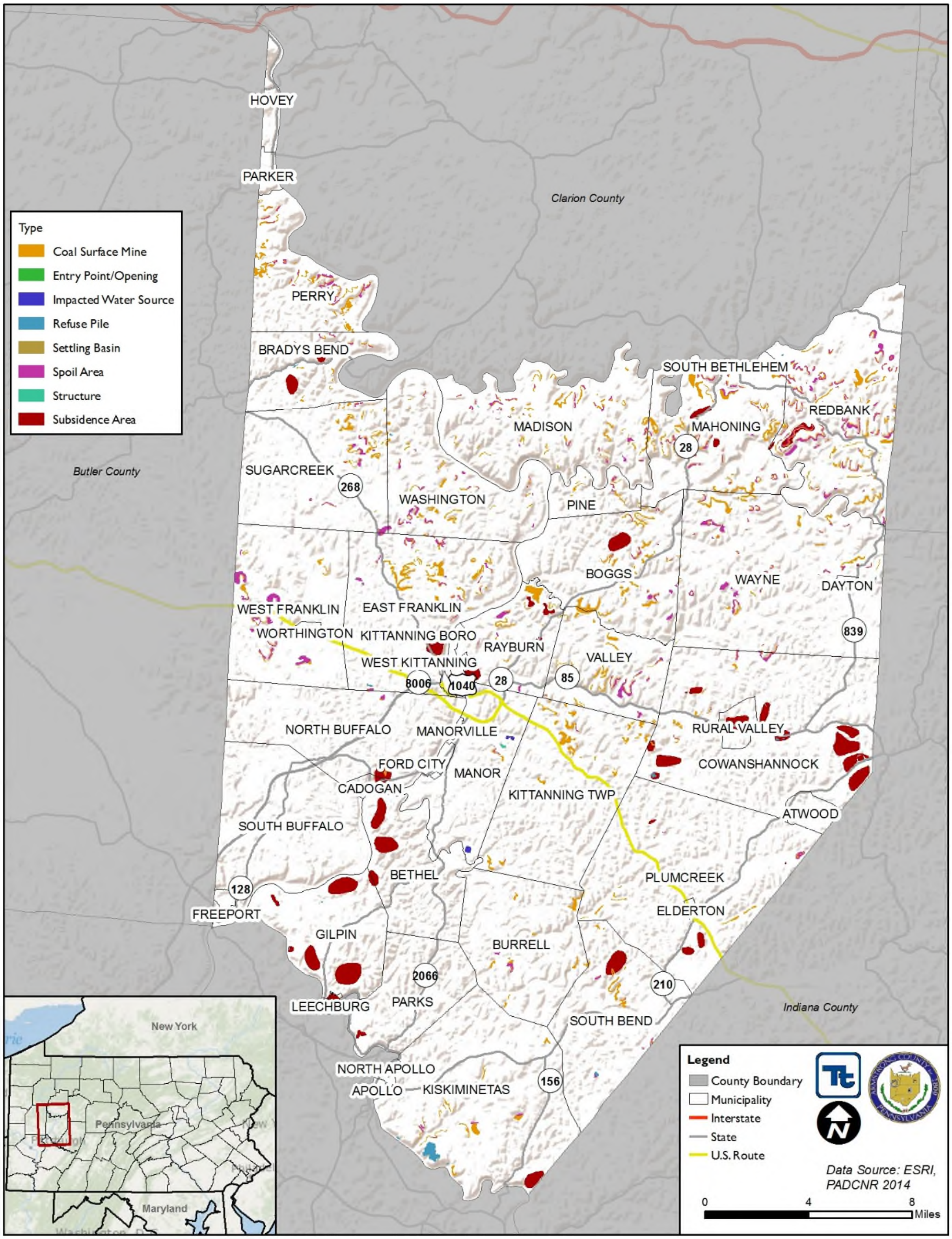
- Kiskiminetas Township
- South Bend Township

Figure 4.3.11-1. Armstrong County Carbonate Bedrock Geology

Source: Pennsylvania Bureau of Topographic and Geologic Survey 2001

Figure 4.3.11-2 shows the approximate location of abandoned mines and land hazards created by past coal mining; information is based on a subset of data contained in the Office of Surface Mining Reclamation and Enforcement (OSMRE) Abandoned Mine Land Inventory. In addition, detailed maps of abandoned mines are available for 649 mines in Armstrong County through the National Mine Map Repository (NMMR), maintained by OSMRE. The NMMR contains over 183,000 maps from the 1790s to the present day, providing information for both surface and underground mines throughout the United States (OSMRE 2018).

Figure 4.3.11-2. Abandoned Mines in Armstrong County



Source: Pennsylvania Department of Environmental Protection (PADEP) 2014

Note: Red areas indicate abandoned mines that have been identified as subsidence areas.

4.3.11.2 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. 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 (PEMA 2018). Damage from mine subsidence can impact structures, surface water and groundwater, and wells and springs (PADEP 2001).

4.3.11.3 Past Occurrence

According to the USGS, Pennsylvania is one of the top seven states most likely to receive damage from sinkholes. The other states include Florida, Texas, Alabama, Missouri, Kentucky, and Tennessee. Neither the Pennsylvania Department of Conservation and Natural Resources (PA DCNR) (PA DCNR 2018) nor the 2018 Pennsylvania State HMP (PEMA 2018) show any sinkholes in Armstrong County.

4.3.11.4 Future Occurrence

Although sinkhole occurrence will continue to be a possibility in Armstrong County, the probability of a sinkhole or subsidence event is difficult to predict because of the low number of previous events. Areas to monitor for future sinkhole and subsidence events based on their geologic bedrock are listed above in Section 4.3.11.1.

The identified hazards of concern for Armstrong County were ranked for relative risk in Section 4.4 of the HMP. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and reference to the Pennsylvania State Hazard Mitigation Plan, the probability of occurrence for subsidence and sinkhole events in the County is considered *possible*. Section 4.4 includes further information on PEMA's risk factor methodology and the risk factors used to determine each hazard's risk rank.

4.3.11.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable in the identified hazard area. This section discusses the potential impact of the subsidence and sinkhole hazard on Armstrong County in the following subsections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) economy; (5) the environment; and (6) future growth and development
- Effects of climate change on vulnerability

Overview of Vulnerability

Table 4.3.11-1 summarizes the municipalities that are potentially vulnerable to sinkholes and subsidence events based on the presence of limestone bedrock and/or abandoned mines.

Table 4.3.11-1. Municipalities Vulnerable to Sinkholes and Subsidence Events

Municipality	Carbonate Rock	Abandoned Mine	Abandoned Mine noted as "Subsidence Area"
Apollo Borough			
Applewold Borough			
Atwood Borough			
Bethel Township		X	X
Boggs Township		X	X
Bradys Bend Township		X	X
Burrell Township		X	
Cadogan Township		X	X
Cowanshannock Township		X	X
Dayton Borough			
East Franklin Township		X	X
Elderton Borough			
Ford City Borough			
Ford Cliff Borough			
Freeport Borough			
Gilpin Township		X	X
Hovey Township		X	
Kiskiminetas Township	X	X	X
Kittanning Borough		X	X
Kittanning Township		X	X
Leechburg Borough		X	X
Madison Township		X	X
Mahoning Township		X	X
Manor Township		X	X
Manorville Borough			
North Apollo Borough		X	X
North Buffalo Township		X	X
Parker City			
Parks Township		X	X
Perry Township		X	X
Pine Township		X	
Plumcreek Township		X	X
Rayburn Township		X	X
Redbank Township		X	X
Rural Valley Borough		X	X
South Bend Township	X	X	X
South Bethlehem Borough			
South Buffalo Township			
Sugarcreek Township		X	
Valley Township		X	

Municipality	Carbonate Rock	Abandoned Mine	Abandoned Mine noted as "Subsidence Area"
Washington Township		X	X
Wayne Township		X	X
West Franklin Township		X	
West Kittanning Borough			
Worthington Borough			

Source: Pennsylvania Bureau of Topographic and Geologic Survey 2001; PADEP 2014

Data and Methodology

Unlike the flood, wind, and earthquake hazards, no standard loss estimation models or methodologies exist for the subsidence and sinkhole hazard. To estimate the County's vulnerability, the portion of the region underlain by limestone bedrock is considered exposed to natural subsidence and sink holes. To determine the assets that are exposed to this hazard, available and appropriate bedrock geology spatial data generated by the Pennsylvania Bureau of Topographic and Geologic Survey were overlaid upon the assets. The limitations of this analysis are recognized and are only used to provide a general estimate. Over time, additional data will be collected to allow better analysis for this hazard. Available information reviewed and a preliminary assessment are provided in the sections below.

Impact on Life, Health, and Safety

To estimate the population exposed to the hazard, the approximate hazard area (limestone bedrock) was overlaid upon the 2010 U.S. Census population data. The Census blocks with their center (centroid) within the boundary were used to calculate the estimated population exposed to this hazard. Please note U.S. Census blocks do not align with the limestone bedrock polygon in the spatial data, and these estimates are for planning purposes only. Only two municipalities have populations exposed to the limestone; 30 people in Kiskiminetas Township (less than 1 percent of the total population) and 22 people in South Bend Township (approximately 1.9 percent of the total population) are exposed to the hazard area.

Impact on General Building Stock

As noted above, no standard loss estimation models exist for the subsidence and sinkhole hazard. In general, the built environment located on limestone is exposed to this hazard. In an attempt to estimate the general building stock potentially vulnerable to this hazard, the associated building replacement values (buildings and contents) were determined for the identified Census blocks within the approximate hazard area. The County-provided spatial layer for building structures was also used to determine the number of structures located within the hazard area. In Kiskiminetas Township, approximately six buildings with an associated replacement cost value of $3.3 million are exposed to the hazard area (less than 1 percent of the total building stock). In South Bend Township, approximately seven buildings with an associated replacement cost value of $2.9 million are exposed to the hazard area (approximately 1.3 percent of the total building count and approximately 2.5 percent of the total replacement cost value).

Impact on Critical Facilities

There are no critical facilities exposed to the subsidence and sinkhole hazard in Armstrong County.

Impact on the Economy

Subsidence and sinkholes can severely impact roads and infrastructure. As noted earlier, limestone formations underlie approximately 2.5 percent of the County. However, there are no major roadways in the County located above limestone bedrock. It is not possible to estimate potential future economic losses caused by subsidence and sinkhole events at this time.

Impact on the Environment

Sinkholes can have negative effects on local groundwater. Groundwater in limestone and other similar carbonate rock formations can be easily polluted, because water moves readily from the earth's surface down through solution cavities and fractures, thus undergoing very little filtration. Sinkholes have the potential to cause damage to chemical infrastructure such as pipelines and facilities that store or transport hazardous materials. The result from a breach of one of these systems may result in a hazardous materials release and damage the environment. Contaminants such as sewage, fertilizers, herbicides, pesticides, or industrial products are of concern. Vegetation is usually damaged during abrupt subsidence events. However, regrowth takes place over time (PEMA 2013).

Future Growth and Development

Areas targeted for potential future growth and development in the next 5 to 10 years have been identified across the County at the municipal level and are described in Section 4.4 of this Plan. New development occurring within the identified hazard areas may be exposed to risks associated with the subsidence and sinkhole hazard.

Effect of Climate Change on Vulnerability

Climate change factors such as an extended growing season, higher temperatures, and the possibility of more intense, less frequent summer rainfall may lead to changes in water resource availability. Sinkholes are caused by changes to the water balance of an area including over-withdrawal of groundwater, diverting surface water from a large area and concentrating it in a single point, artificially creating ponds of surface water, and drilling new water wells will cause sinkholes. These actions can also serve to accelerate the natural processes of bedrock degradation, which can have a direct impact on sinkhole creation.

The climate of Pennsylvania is already changing and will continue to change over the course of this century. Since 1900, temperatures in the northeastern United States have increased an average of 1.5 °F. The majority of this warming has occurred since 1970. In terms of winter temperatures, the northeastern United States has seen an increase in the average temperature by 4 °F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). The projection in the increase of average temperatures may lead to an increase in the frequency of droughts. Sinkhole activity intensifies in some karst areas and increases during periods of drought. With an increase in drought periods, the number of sinkholes can increase (Linares et al. 2016).

The potential effects of climate change on Armstrong County's vulnerability to subsidence and sinkhole events will need to be considered as a greater understanding of regional climate change impacts develop.

4.3.12 Terrorism

This section describes the location and extent, range of magnitude, past occurrence, future occurrence, and vulnerability assessment for the terrorism hazard for Armstrong County.

A universal definition for terrorism has yet to be identified and agreed upon, either internationally or nationally within the United States. The Federal Bureau of Investigation 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," while the Department of State defines it as, "premeditated, politically-motivated violence perpetrated against non-combatant targets by sub-national groups or clandestine agents, usually intended to influence an audience."

Although the definition of terrorism is interpreted in many ways, the term typically refers to intentional, criminal, and malicious acts designed to intimidate. A subcategory of terrorism is agriterrorism, which is the direct, intentional, generally covert contamination of food supplies or the introduction of pests and/or disease agents to crops and livestock (FEMA 2002). The ultimate target of this terrorist act is the local or regional economy and population. Because the County is primarily a rural area, it is more prone to an occurrence of agriterrorism than the more traditional instances of terrorism, such as bombs, lone shooters, etc.

4.3.12.1 Location and Extent

Acts of terrorism can occur anywhere in the world, although the most well-known instances are typically in urban locations. The National Consortium for the Study of Terrorism and Responses to Terrorism (START) issued a report in January 2012 that identifies hot spots for terrorism and other crimes in the U.S., based on data collected from 1970 to 2008. The report found that terrorism is widely dispersed, although there remains evidence of a higher concentration of attacks in specific counties. A total of 65 counties were labeled as terrorist hot spot areas, including urban city centers (like Manhattan, Los Angeles, San Francisco, and D.C.) and small rural counties (like Maricopa County, AZ; Middlesex County, MA; and Harris County, TX). Philadelphia, PA, is the only hot spot in Pennsylvania identified by START. The START report notes that acts of terrorism are not limited to high-crime areas, although they are more likely to occur in those locations. Additionally, residential stability and language diversity are significant predictors of the location of terrorist attacks (Armstrong County HMP 2013).

An important consideration in evaluating terrorism is the existence of facilities, landmarks, or other buildings of international, national, or regional importance. While Armstrong County has many notable landmarks, there are no sites which are considered significant landmarks in terms of national or international importance. Nonetheless, terrorism can take many forms, and terrorists have a wide range of personal, political, or cultural agendas. Therefore, there is no location that is not a potential terrorist target.

4.3.12.2 Range of Magnitude

The range of magnitude can vary greatly and is dependent upon the method of attack. An attack involving diseases or pests could impact a wide expanse of land, whereas food contamination will likely only impact a small population.

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.

The National Terrorism Advisory System (NTAS) communicates information about terrorist threats by providing detailed information to the public, government agencies, first responders, airports and other transportation hubs, and the private sector. When a threat arises, the Secretary of Homeland Security announces an NTAS Alert and shares the news with the public. The alert may include specific information about the nature of the threat, including the geographic region, mode of transportation, or critical infrastructure potentially affected, as well as steps that individuals and communities can take to protect themselves and help prevent, mitigate, or respond to the threat. The alert indicates whether the threat is elevated or imminent. Elevated threats are those that include no specific information about the timing or location. Imminent threats are threats believed to be impending or occurring very soon. The alerts will be posted on-line on multiple government websites (which websites may vary dependent on the threat) and released to the news media for distribution. U.S. Department of Homeland Security (DHS) will also distribute alerts through its social media channels (DHS 2015).

4.3.12.3 Past Occurrence

Armstrong County has never suffered an international terrorist attack. However, in July 2013, an Armstrong County resident was sentenced to 8 ½ years in prison for soliciting terrorist attacks against the U.S. on an anti-American jihadist web forum between 2008 and 2010. Armstrong County has occasionally experienced domestic terror threats, such as bomb threats, suspicious packages, and suspicious devices.

4.3.12.4 Future Occurrence

Based on historical events, Armstrong County can expect to experience several terrorist threats or suspicious activities each year; however, few will result in an actual terrorist incident. Therefore, the future occurrence of terrorist acts is unlikely based on current risk assessment methodology, barring substantial economic or population changes.

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 (PEMA 2018).

4.3.12.5 Vulnerability Assessment

The probability of the County becoming a terrorist target should remain relatively low. In fact, the County is more likely to experience the secondary effects of a nearby area being attacked than to experience a direct terrorist attack. Pittsburgh is a major metropolitan center located only about an hour drive away from the County. In the event of a terrorist incident in Pittsburgh, the County would experience potential issues with people from the surrounding areas evacuating/migrating to or through the region to areas with a lower threat risk. This influx of population in these critical situations would stress the rural facilities of the County and its municipalities.

Because terrorism cannot be quantified in the same way as that of many natural hazards, it is not possible to assess vulnerability only in terms of potential occurrence. Instead, vulnerability is also assessed in terms of specific assets. By identifying potentially at-risk terrorist targets in a community, planning efforts can be put in place to reduce the risk of attack. All communities in the County are vulnerable on some level, directly or indirectly, to a terrorist attack. However, communities where cropland or livestock are more concentrated or abundant should be considered more vulnerable to agriterrorism incidents. Site-specific assessments should be based on the relative importance of a particular crop, food storage site, or stretch of farmland to the surrounding community or population to help lessen the impact of a terrorist event in the County.

Regarding the environment, impacts of terrorism can vary in severity from nominal to catastrophic and are contingent upon the method of the attack, the amount 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. Significant damage to ecosystems can occur with contamination associated with certain terror attacks. 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 and 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 (PEMA 2018).

4.3.13 Tornado, Windstorm

Wind begins with differences in air pressures and occurs through rough horizontal movement of air caused by uneven heating of the earth's surface. Wind occurs at all scales, from local breezes lasting a few minutes to global winds resulting from solar heating of the earth. There are different types of damaging winds: straight-line wind, downdraft, downburst, microburst, gust front, derecho, bow echo, and hook echo. Additionally, high winds are often associated with other severe weather events such as derechos, tornadoes, Nor'Easters, hurricanes, and tropical storms. This section provides a profile and vulnerability assessment for the tornado and windstorm hazard.

Tornadoes

A tornado appears as a rotating, funnel-shaped cloud that extends from a thunderstorm to the ground with whirling winds that can reach 250 miles per hour (mph). Damage paths can be greater than 1 mile wide and 50 miles long. Tornadoes typically develop from either a severe thunderstorm or hurricane as cool air rapidly overrides a layer of warm air. Tornadoes typically move at speeds between 30 and 125 mph and can generate combined wind speeds (forward motion and speed of the whirling winds) exceeding 300 mph. The lifespan of a tornado rarely is longer than 30 minutes (FEMA 1997). Tornadoes can occur at any time of the year, with peak seasons at different times for different states (National Severe Storms Laboratory [NSSL] 2013).

Windstorms

Straight-line winds and windstorms occur on a region-wide scale (Pennsylvania Emergency Management Agency [PEMA] 2013). Damaging winds are often called "straight-line" winds to differentiate wind damage from tornadoes. Windstorms are generally defined with sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration. They occur in all parts of the United States.

Extreme windstorm events are associated with extra-tropical and tropical cyclones, winter cyclones, severe thunderstorms, and accompanying mesoscale offspring such as tornadoes and downbursts. Wind speeds vary from 0 mph at ground level to 200 mph in the upper atmospheric jet stream 6 to 8 miles above the earth's surface (FEMA 1997).

A derecho is type of windstorm that can occur during a rapidly moving thunderstorm. A derecho is a long-lived windstorm associated with a moving squall line of thunderstorms. It produces straight-line winds gusts of at least 58 mph and often has isolated gusts exceeding 75 mph. As a result, trees generally fall and debris is blown in one direction. To be considered a derecho, these conditions must continue along a path of at least 240 miles. Derechos are more common in the Great Lakes and Midwest regions of the United States, though, on occasion, can persist into the mid-Atlantic and northeast United States (Office of the New Jersey State Climatologist [ONJSC] Rutgers University 2013).

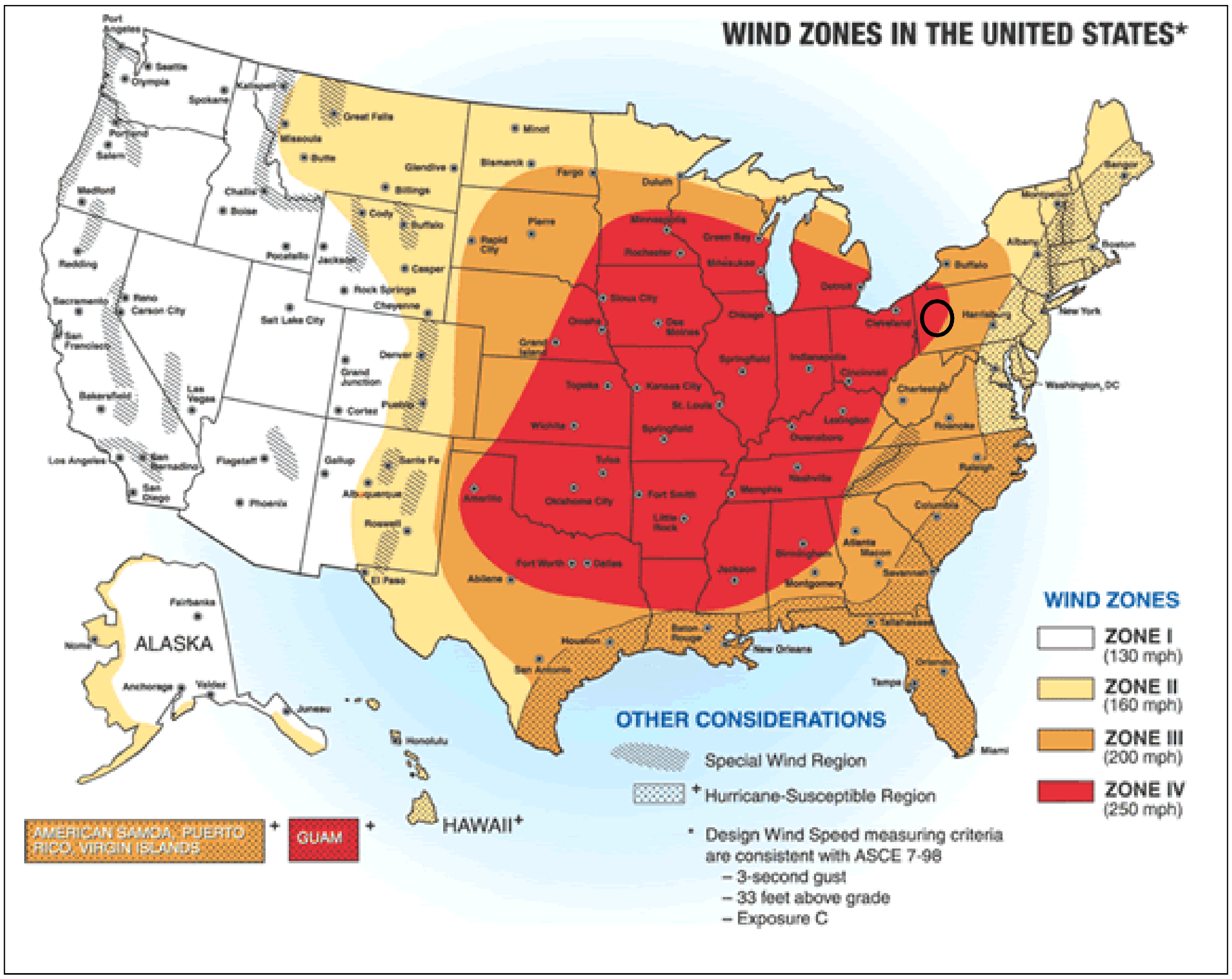
4.3.13.1 Location and Extent

Tornadoes and windstorms can occur throughout Armstrong County, though incidents 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 are 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. The forward motion of the tornado path can be a few hundred yards or several hundred miles in length. The width of a tornado can vary greatly, but generally ranges in size from less than 100 feet to over a mile. 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 more region-wide scale. While such winds usually accompany tornadoes, straight-line 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 as having sustained wind speeds of 40 mph or greater lasting for 1 hour or longer, or winds of 58 mph or greater for any duration.

Figure 4.3.13-1 illustrates the ways in which the frequency and strength of windstorms affect the United States, and the general location of the most wind activity. This figure is based on 40 years of tornado history and 100 years of hurricane history collected by FEMA. States located in Wind Zone IV have undergone the greatest number of tornados and the strongest tornados (FEMA 2009). Armstrong County is within Wind Zone IV, where wind speeds can be as high as 250 mph.

Figure 4.3.13-1. Wind Zones in the United States



Source: FEMA 2012

Note: The black circle indicates the approximate location of Armstrong County. The figure shows that the County is located in Zone IV.

4.3.13.2 Range of Magnitude

The following provides details regarding the range of magnitude for tornadoes and windstorms.

Tornado

Each year, tornadoes account for $1.1 billion in damage and cause over 80 deaths nationally. 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 (PEMA 2018).

Damage 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 damage to structures of light construction such as mobile homes (PEMA 2018).

The magnitude or severity of a tornado is categorized using the Enhanced Fujita Tornado Intensity Scale (EF Scale). Figure 4.3.13-2 illustrates the relationship between EF ratings, wind speed, and expected tornado damage.

Figure 4.3.13-2. Enhanced Fujita Tornado Intensity Scale Ratings, Wind Speeds, and Expected Damage

EF Rating	Wind Speeds	Expected Damage	
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.	
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.	
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.	
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.	
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.	
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.	

Source: National Weather Service 2018

Tornado watches and warning are issued by the local National Weather Service (NWS) office. A tornado watch is released when tornadoes are possible in an area. A tornado warning means a tornado has been sighted or indicated by weather radar. The current average lead time for tornado warnings is 13 minutes. Occasionally, tornadoes develop so rapidly, that little, if any, advance warning is possible (NOAA 2011).

Windstorms

Windstorms are generally defined as sustained wind speeds of 40 mph or greater, lasting for 1 hour or longer, or winds of 58 mph or greater for any duration. Table 4.3.13-1 describes wind classifications used by the NWS.

Table 4.3.13-1. NWS Wind Descriptions

Descriptive Term	Sustained Wind Speed (mph)
Strong, dangerous, high, damaging (high wind warning criteria	≥40
Very windy	30-40
Windy	20-30
Breezy (mild weather) brisk or blustery (cold weather)	15-25
None	5-15 or 10-20
Light/light and variable wind	0-5

Source: NWS 2011
mph Miles per hour

NWS issues site-specific high wind advisories, watches, and warnings when wind speeds may pose a hazard or may be life threatening. The criterion for each of these varies from state to state. Wind warnings and advisories for Pennsylvania are as follows:

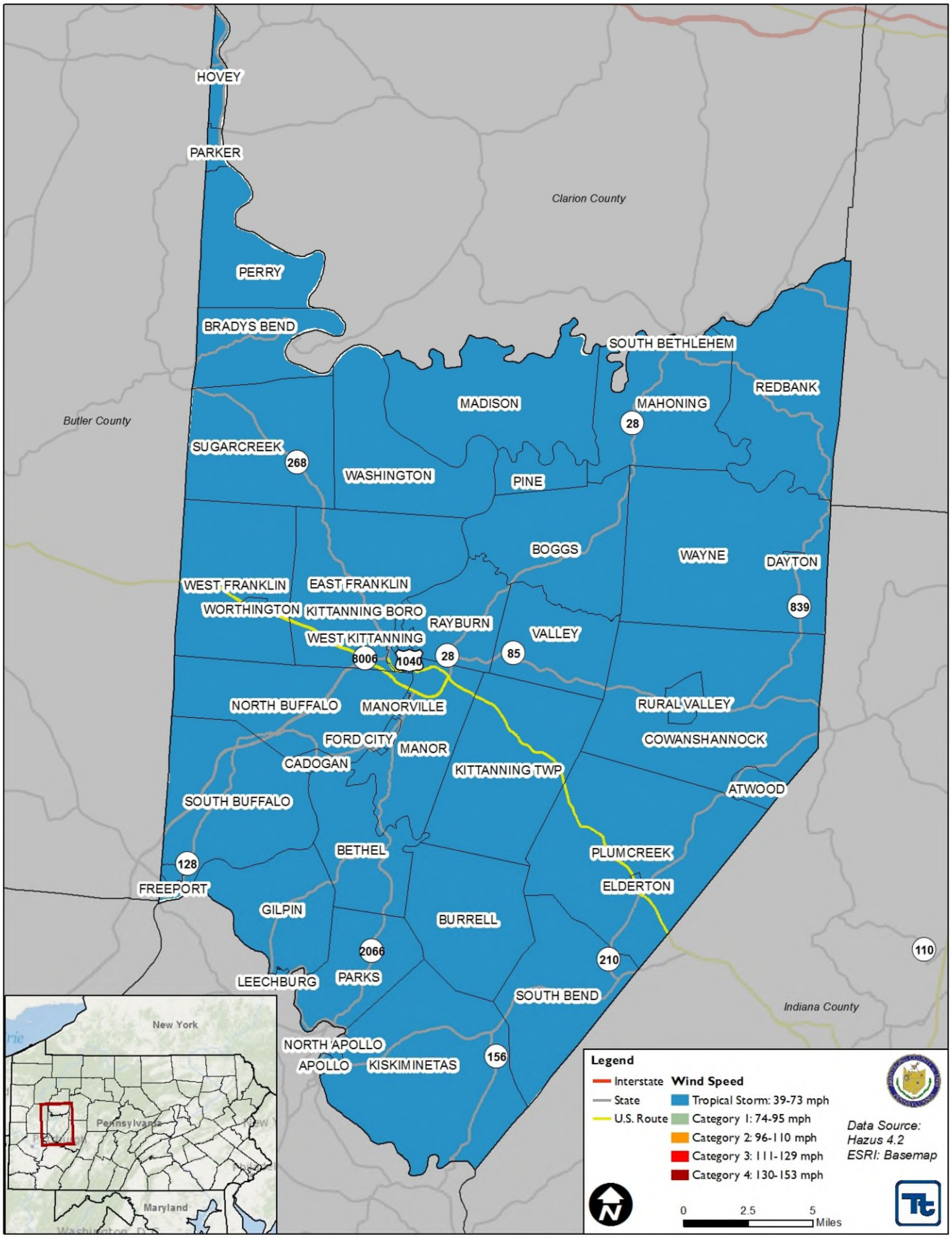
- *High Wind Warnings* are issued when sustained winds of 40 mph or greater are forecast for 1 hour or longer, or wind gusts of 58 mph or greater are forecast for any duration.
- *Wind Advisories* are issued when sustained winds of 30 to 39 mph are forecast for 1 hour or longer, or wind gusts of 46 to 57 mph are forecast for any duration (NWS 2015).

Mean Return Period

In evaluating the potential for hazard events of a given magnitude, a mean return period (MRP) is often used. The MRP provides an estimate of the magnitude of an event that may occur within any given year based on past recorded events. MRP is the average period of time, in years, between occurrences of a particular hazard event, equal to the inverse of the annual frequency of exceedance (Dinicola 2009).

Figure 4.3.13-3 shows the estimated maximum 3-second gust wind speeds that can be anticipated in the County when associated with the 500-year MRP event. These peak wind speed projections were generated using Hazards U.S. Multi-Hazard (HAZUS-MH) model runs. HAZUS-MH 4.2 estimated the maximum 3-second gust wind speeds for Armstrong County to be below 39 mph for the 100-year MRP event and not strong enough to be considered a tropical storm. The maximum 3-second gust wind speeds for Armstrong County range from 56 to 60 mph for the 500-year MRP event (tropical storm). The associated impacts and losses from these 100-year and 500-year MRP wind event model runs are reported in the Vulnerability Assessment.

Figure 4.3.13-3. Wind Speeds for the 500-Year Mean Return Period Event



Source: HAZUS-MH 4.2

4.3.13.3 Past Occurrence

Many sources provided historical information regarding previous occurrences and losses associated with tornadoes and windstorms throughout the Commonwealth of Pennsylvania and Armstrong County. With so many sources reviewed for this plan, loss and impact information varies depending on the source. Therefore, the accuracy of monetary figures discussed is based only on the available information identified during research for this HMP.

Between 1954 and 2017, FEMA issued a disaster (DR) or emergency (EM) declaration for the Commonwealth of Pennsylvania for 21 wind-related events, classified as one or a combination of the following disaster types: tropical storm, high winds, flash flood, severe storm, tornado, hurricane, tropical depression, and flooding. Of those events, Armstrong County has been included in six declarations related to tornadoes, tropical storms, hurricanes, and winds (FEMA 2018). Table 4.3.13-2 lists FEMA DR and EM declarations from 1954 to 2017 for this HMP.

Table 4.3.13-2. FEMA DR and EM Declarations for Armstrong County

FEMA Declaration Number	Date(s) of Event	Event Type
DR-340	June 23, 1972	Tropical Storm Agnes
EM-3081	June 13, 1980	Severe Storms & Tornadoes
DR-1130	July 19, 1996	Severe Storms, Flooding, And Tornadoes
DR-1555	September 8-9, 2004	Severe Storms and Flooding Associated with Tropical Depression Frances
DR-1557	September 17-October 1, 2004	Tropical Depression Ivan
EM-3356	October 26-November 8, 2012	Hurricane Sandy

Source: FEMA 2018

Known tornado and windstorm events, including FEMA disaster declarations, that affected Armstrong County are listed in Table 4.3.13-3. Notably, not all events in Armstrong County are included because of the amount of documentation available and possibility that not all sources were identified or researched. Loss and impact information could vary depending on source. Therefore, accuracy of monetary figures discussed is based only on available information identified during research for this HMP update.

Table 4.3.13-3. Previous Occurrences of Tornadoes and Windstorms in Armstrong County

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
June 27, 1951	Tornado (F2)	N/A	N/A	$2,500 in property damage
April 23, 1966	Tornado (F2)	N/A	N/A	$5,000 – $50,000
June 23, 1972	Tropical Storm Agnes	DR-340	Yes	No damage and/or losses reported.
July 23, 1978	Tornado	N/A	N/A	Two injuries; $250,000 in property damage
June 3, 1980	Tornado (F4)	EM-3081	Yes	120 injuries; $250 million in property damage
July 20, 1983	Tornado (F1)	N/A	N/A	$250,000 in property damage
September 23, 1986	Tornado (F2)	N/A	N/A	1 injury; $2.5 million in property damage

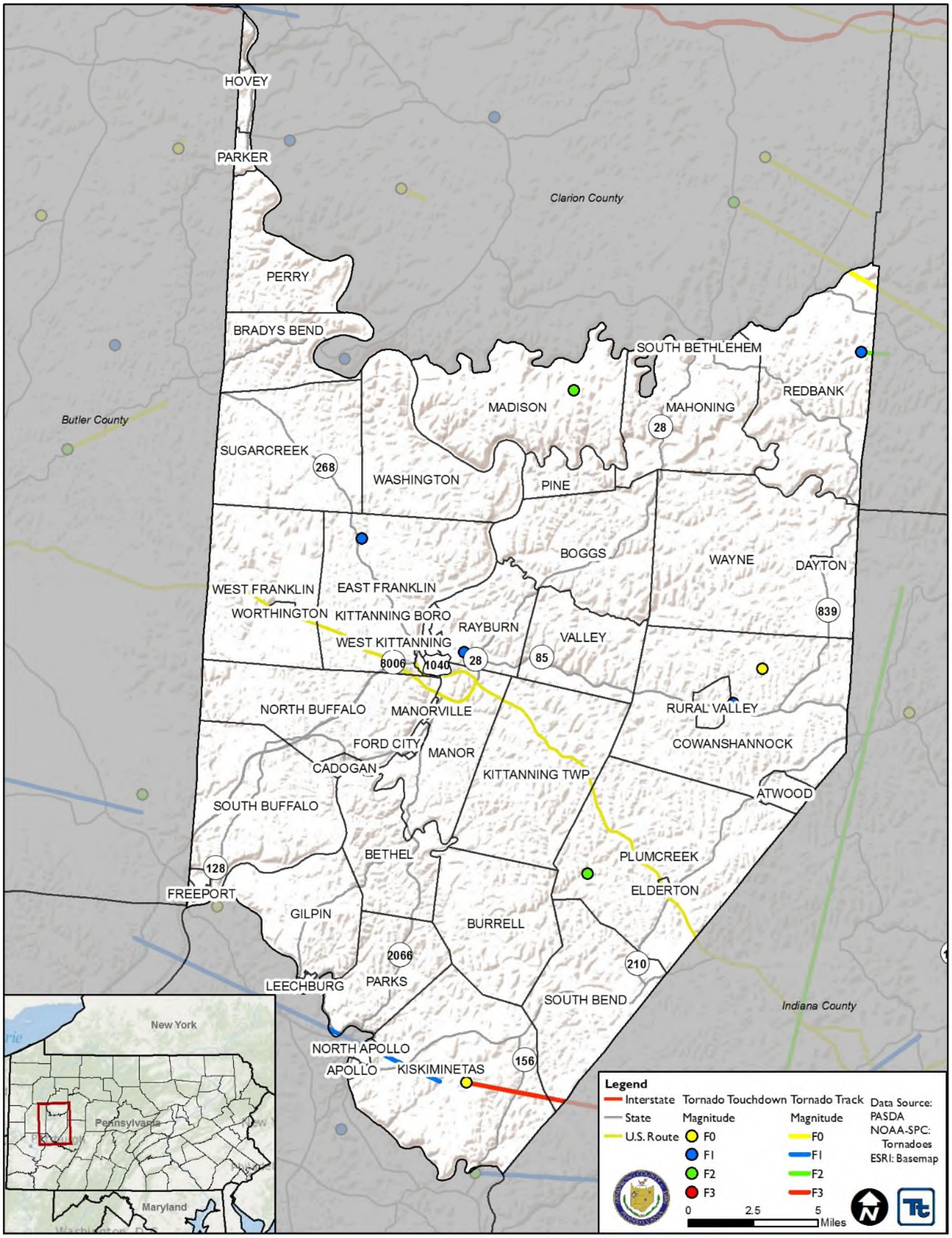
Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
May 1, 1994	Thunderstorm Winds	N/A	N/A	Strong winds from a thunderstorm downed 12 trees and damaged two homes in Freeport. One house was damaged by a fallen tree. The other home had siding and shingles blown off. Approximately $50,000 in property damage.
July 22, 1994	Thunderstorm Winds	N/A	N/A	Trees and powerlines were downed from Kittanning through South Buffalo along Route 28 due to strong winds from a thunderstorm. At Kittanning, a tree fell on two parked cars. Between Slate Lick and Boggsville, a 300- to 400-foot area of trees were downed. Part of a roof and a shed were damaged. Approximately $50,000 in property damage.
July 19, 1996	Tornado (F2)	DR-1130	Yes	No losses and/or damage reported.
June 2, 1998	Tornado (F1)	N/A	N/A	No losses and/or damage reported.
June 2, 1999	Thunderstorm Wind	N/A	N/A	A microburst with winds estimated to around 100 MPH blew a 3-mile long swath across the Elderton area. One house was completely destroyed, with one person receiving minor injuries. Four other homes suffered structural damage, and another ten homes in the area received minor damage. Two cars were also damaged. Most of the affected homes were in the area off Route 210 just northeast of Elderton, near the Keystone Dam. A few homes on the outskirts of Atwood also reported minor damage. Numerous trees in the area were blown down, either uprooted or snapped off. The County had approximately $250,000 in property damage.
April 28, 2002	Tornado (F0)	N/A	N/A	An F0 touched down at approximately 2:45 PM just south of the town of Spring Church. It traveled east about 3 miles before crossing into Indiana County approximately 1 mile east of Maysville at 2:52 PM. This tornado continued traveling to the east for another mile, finally dissipating near the community of Iselin at around 2:55 PM. The maximum estimated winds with this tornado were about 70 MPH. Damage from this tornado included numerous trees which were toppled or snapped. A small steeple was toppled, and a swimming pool was destroyed. There were several trees toppled onto houses, and some houses suffered minor wind damage. A garage was damaged, and a house under construction was lifted off the foundation. Total damage in the County were approximately $150,000.
September 8-9, 2004	Severe Storms and Flooding Associated with Tropical Depression Frances	DR-1555	Yes	No losses and/or damage reported.
August 31, 2005	Thunderstorm Wind	N/A	N/A	A stronger microburst struck Sugarcreek and West Franklin townships, near Cowansville. Numerous trees were toppled, and large branches snapped off. Several buildings had structural damage. At a construction company, two cinder block walls were blown down. Part of a roof was blown off another building. Minor damage occurred to several houses near the construction company.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
				Several sheds were destroyed. A camper was overturned. Microburst was 300 yards wide and 3/4 mile long. Maximum wind was estimated at 90 mph. The County had approximately $100,000 in property damage.
September 14, 2008	High Wind (Remnants of Hurricane Ike)	N/A	N/A	Remnants of Hurricane Ike produced very strong winds across eastern Ohio, northern West Virginia, and western Pennsylvania. Widespread damage to trees and power lines were reported across the region with power outages and damage to structures from fallen trees. Power was not restored for one week in rural areas. Damage in Armstrong County were estimated at $500,000.
April 25, 2011	Thunderstorm Wind	N/A	N/A	Scattered thunderstorms brought strong winds across the County. In Templeton, emergency management reported 13 structures with some damage as well as numerous downed trees. The County had approximately $100,000 in property damage.
October 26-November 8, 2012	Hurricane Sandy	EM-3356	Yes	The remnants of Hurricane Sandy brought a variety of weather impacts to western Pennsylvania, eastern Ohio, northern West Virginia, and Garrett County, Maryland, as the storm made landfall and interacted with a cold front essentially right over the region. Heavy rain and strong winds combined to cause downed trees and power-lines in the lower elevations. Meanwhile, the higher elevations experienced blizzard conditions, with snow amounts in excess of 2 1/2 feet reported at elevations above 2,500 feet. In general, rainfall from the front and remnants of Sandy averaged 2 inches across much of eastern Ohio, northern West Virginia, and western Pennsylvania. There were several reports of downed trees and power outages across the lower elevations. In Armstrong County, there were reports of downed trees. Approximately $10,000 in damage.

Sources: FEMA 2018; NOAA-NCEI 2018; PEMA 2018
DR Major Disaster Declaration (FEMA)
EM Emergency Declaration (FEMA)
FEMA Federal Emergency Management Agency
HMP Hazard Mitigation Plan
Mph Miles per hour
N/A Not applicable
PEMA Pennsylvania Emergency Management Agency

Figure 4.3.13-4 shows the locations of tornadoes that have touched down in Armstrong County.

Figure 4.3.13-4. Tornado History in Armstrong County from 1950 to 2017



4.3.13.4 Future Occurrence

Armstrong County experiences strong winds on a frequent basis, and when those winds occur, they can result in significant property damage, downed trees, and utility outages. It can be reasonably assumed that future tornadoes will be similar in nature to those that have affected Armstrong County in the past. It is estimated that Armstrong County will continue to experience direct and indirect impacts of annual windstorms and tornadoes that may induce secondary hazards, such as infrastructure deterioration or failure; utility failures; power outages; water quality and supply concerns; and transportation delays, accidents, and inconveniences.

The most up-to-date data was collected to calculate the probability of future occurrence of tornado and windstorm events, of all intensities, for Armstrong County. Information from NOAA-NCEI storm events database and the Storm Prediction Center (SPC) were used to identify the number of tornado and wind events that occurred between 1950 and 2018. The table below shows these statistics, as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100 percent chance of a windstorm event, and a 13 percent chance of a tornado event occurring in any given year in Armstrong County.

Table 4.3.13-4. Probability of Future Tornado and Windstorm Events in Armstrong County

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Tornado (all scales)	9	0.13	7.56	0.13	13.24%
Wind (30 knots and stronger)	163	2.43	0.42	2.40	100%

Sources: NOAA-NCEI 2018; FEMA 2018; SPC 2018

In Section 4.4, the hazards of concern identified for Armstrong County are ranked according to relative risk. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. The probability of occurrence for strong wind events in Armstrong County is considered *highly likely* (100-percent annual probability) as defined by the Risk Factor Methodology probability criteria (Section 4.4).

4.3.13.5 Vulnerability Assessment

To understand risk, a community must evaluate which assets are exposed and vulnerable in the identified hazard. The entire County has been identified as the hazard area for tornado and other windstorm events. Therefore, all assets in the County (population, structures, critical facilities, and lifelines), as described in the County Profile (Section 2), are potentially vulnerable. The following text evaluates and estimates the potential impact of strong winds on the County, including:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on: (1) life, safety and health of residents, (2) general building stock, (3) critical facilities, (4) economy, and (5) future growth and development
- Effect of climate change on vulnerability

Overview of Vulnerability

The high winds and air speeds of a severe windstorm event, including winds in a tornado, can result in power outages, disruptions to transportation corridors and equipment, loss of workplace access, significant property damage, injuries and loss of life, and the need to shelter and care for individuals affected by the events. A large amount of damage can be inflicted by trees, branches, and other objects that fall onto power lines, buildings, roads, vehicles, and, in some cases, people. The risk assessment for tornadoes and windstorms evaluates available data for a range of storms included in this hazard category.

The entire inventory of the County is at risk of being damaged or lost through the impacts of tornadoes and windstorms. Certain areas, infrastructure, and types of buildings are at greater risk than others because of their proximity to falling hazards or their manner of construction. Potential losses associated with high wind events were calculated for two probabilistic hurricane events: the 100-year and 500-year MRP hurricane events. The impacts on population, existing structures, critical facilities, and the economy are presented below, after a summary of the data and methodology used. Although the estimate is based on a hurricane event, the data can also be used to estimate potential damage from other windstorm events.

Data and Methodology

After historical data had been reviewed, the HAZUS-MH methodology and model were used to analyze windstorms for Armstrong County. Data used to assess this hazard include data available in the HAZUS-MH v4.2 wind model and professional knowledge.

HAZUS-MH v4.2 contains data on historical hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support modeling of wind force across various types of land surfaces. Hurricane and inventory data available in HAZUS-MH v4.2 were used to evaluate potential losses from the 100- and 500-year MRP events (severe wind impacts). Other than updated data for the general building stock and critical facility inventories, the default data in HAZUS-MH v4.2 were the best available for use in this evaluation.

Impact on Life, Health, and Safety

The impact of a tornado or windstorm on life, health, and safety depends on several factors, including the severity of the event and whether adequate warning time was provided to residents. It is assumed that the entire population of Armstrong County, estimated at more than 67,000 people, is exposed to this hazard (US Census 2017).

Residents may be displaced or require temporary to long-term sheltering. In addition, downed trees, damaged buildings, and debris carried by high winds can lead to injury or loss of life. Socially vulnerable populations are most susceptible, based on a number of factors, including their physical and financial ability to react or respond during a hazard and the location and construction quality of their housing. HAZUS-MH v4.2 estimates there will be zero people displaced and zero people who may require temporary shelter as a result of the 100- and 500-year MRP events.

Economically disadvantaged populations are more vulnerable because they are likely to evaluate their risk and make decisions based on the major economic impact to their family and may not have funds to evacuate. The population over the age of 65 is also more vulnerable and, physically, they may have more difficulty evacuating. The elderly are considered most vulnerable because they require extra time or outside assistance during evacuations and are more likely to seek or need medical attention that may not be available due to isolation during a storm event. Section 2 presents the statistical information regarding these populations in the County.

Impact on General Building Stock

Damage to buildings is dependent upon several factors including wind speed, storm duration, path of the storm track or tornado, distance from the tornado funnel and building construction. Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Generally, wood and masonry buildings, regardless of their occupancy class, tend to experience more damage than concrete or steel buildings. High-rise buildings are also very vulnerable structures. Mobile homes are the most vulnerable to damage, even if tied down, and offer little protection to people inside.

The U.S. Census Bureau defines manufactured homes as "movable dwellings, 8 feet or wider and 40 feet or more long, designed to be towed on its own chassis, with transportation gear integral to the unit when it leaves the factory, and without need of a permanent foundation (Census, 2010)." They can include multi-wides and expandable manufactured homes but exclude travel trailers, motor homes, and modular housing. Due to their light-weight and often unanchored design, manufactured housing is extremely vulnerable to high winds and will generally sustain the most damage.

Table 4.3.13-5 displays the number of manufactured housing units per municipality in Armstrong County. Total counts based on mobile/manufactured homes were included in the updated general building stock. As noted, Kiskiminetas Township has the greatest number of manufactured homes.

Table 4.3.13-5. Manufactured Housing Units per Municipality in Armstrong County

Municipality	Number of Manufactured Homes	Municipality	Number of Manufactured Homes
Apollo Borough	0	Manor Township	93
Applewold Borough	0	Manorville Borough	0
Atwood Borough	0	North Apollo Borough	0
Bethel Township	0	North Buffalo Township	21
Boggs Township	0	Parker City	8
Bradys Bend Township	24	Parks Township	21
Burrell Township	0	Perry Township	0
Cadogan Township	0	Pine Township	0
Cowanshannock Township	17	Plumcreek Township	38
Dayton Borough	0	Rayburn Township	28
East Franklin Township	31	Redbank Township	6
Elderton Borough	0	Rural Valley Borough	0
Ford City Borough	0	South Bend Township	11
Ford Cliff Borough	0	South Bethlehem Borough	0
Freeport Borough	12	South Buffalo Township	0
Gilpin Township	6	Sugarcreek Township	0
Hovey Township	0	Valley Township	0
Kiskiminetas Township	246	Washington Township	0
Kittanning Borough	10	Wayne Township	0
Kittanning Township	12	West Franklin Township	59
Leechburg Borough	0	West Kittanning Borough	0

Municipality	Number of Manufactured Homes	Municipality	Number of Manufactured Homes
Madison Township	0	Worthington Borough	0
Mahoning Township	0		
		Armstrong County (Total)	**643**

Source: Armstrong County

According to HAZUS-MH's wind model, direct wind-induced damage (wind pressures and windborne debris) to buildings is dependent upon the performance of components and cladding, including roof covering (shingles, tiles, membrane), roof sheathing (wood frame construction only), windows, and doors and is modeled as such. Structural wall failures can occur for masonry and wood frame walls and uplift of whole roof systems due to failure at the roof/wall connections. Foundation failures (i.e., sliding, overturning and uplift) can potentially take place in manufactured homes.

After the population exposed to the tornado or windstorm hazard has been considered, the general building stock replacement value exposed to and damaged by 100- and 500-year MRP events was examined. Wind-only impacts are reported based on the probabilistic hurricane runs using HAZUS-MH v4.2. Potential damage is the modeled loss that could occur to the exposed inventory, including damage to structural and content value based on the wind-only impacts associated with a hurricane (using the methodology described in Section 4.4). Although the estimate is based on a hurricane event, the data can also be used to estimate potential damage from other windstorm events.

It is assumed that the entire County's general building stock is exposed to the wind hazard (greater than $3.4 billion for structures only). Expected building damage was evaluated by HAZUS-MH v4.2 across the following wind damage categories: no damage/very minor damage, minor damage, moderate damage, severe damage, and total destruction.

Table 4.3.13-6 summarizes the definitions of the damage categories.

Table 4.3.13-6. Description of Damage Categories

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
No Damage or Very Minor Damage Little or no visible damage from the outside. No broken windows, or failed roof deck. Minimal loss of roof over, with no or very limited water penetration.	≤ 2%	No	No	No	No	No
Minor Damage Maximum of one broken window, door, or garage door. Moderate roof cover loss that can be covered to prevent additional water entering the building. Marks or dents on walls requiring painting or patching for repair.	> 2% and ≤ 15%	One window, door, or garage door failure	No	< 5 Impacts	No	No

Qualitative Damage Description	Roof Cover Failure	Window Door Failures	Roof Deck	Missile Impacts on Walls	Roof Structure Failure	Wall Structure Failure
Moderate Damage Major roof cover damage, moderate window breakage. Minor roof sheathing failure. Some resulting damage to interior of building from water.	> 15% and ≤ 50%	> the larger of 20% & 3 and ≤ 50%	1 to 3 Panels	Typically 5 to 10 Impacts	No	No
Severe Damage Major window damage or roof sheathing loss. Major roof cover loss. Extensive damage to interior from water.	> 50%	> one and ≤ the larger of 20% & 3	> 3 and ≤ 25%	Typically 10 to 20 Impacts	No	No
Destruction Complete roof failure or failure of wall frame. Loss of more than 50 percent of roof sheathing.	Typically > 50%	> 50%	> 25%	Typically > 20 Impacts	Yes	Yes

Source: FEMA 2013

As noted earlier in the profile, HAZUS-MH v4.2 estimates the 100-year MRP peak gust wind speeds for Armstrong County to be less than 39 mph with no associated building stock damage. HAZUS-MH v4.2 estimates the 500-year MRP peak gust wind speeds for Armstrong County to range from 56 to 60 mph. This wind speed equates to a *Tropical Storm* and approximately $526,000 in damage to the general building stock (structure only). This amount is less than 1 percent of the County's building inventory. Table 4.3.13-7 summarizes the building value (structure only) damage estimated for the 500-year MRP wind-only event by occupancy class.

Table 4.3.13-7. Estimated Building Replacement Value (Structure Only) Damaged by the 500-Year Mean Return Period Winds for All Occupancy Classes

Municipality	Total Building Replacement Value (Structure Only)	Total Building Damage (All Occupancies)	Residential Buildings	Commercial Buildings
		Probable Loss	Probable Loss	Probable Loss
Apollo Borough	$251,670,000	$16,578	$16,578	$0
Applewold Borough	$74,252,000	$3,301	$3,301	$0
Atwood Borough	$10,050,000	$670	<$1,000	$0
Bethel Township	$128,949,000	$8,417	$8,417	$0
Boggs Township	$76,331,000	$5,115	$5,115	$0
Bradys Bend Township	$131,764,000	$229	<$1,000	$0
Burrell Township	$73,172,000	$4,260	$4,260	$0
Cadogan Township	$65,238,000	$3,614	$3,614	$0
Cowanshannock Township	$303,507,000	$17,027	$17,027	$0
Dayton Borough	$84,832,000	$3,173	$3,173	$0

Municipality	Total Building Replacement Value (Structure Only)	Total Building Damage (All Occupancies)	Residential Buildings	Commercial Buildings
		Probable Loss	Probable Loss	Probable Loss
East Franklin Township	$1,027,803,000	$30,703	$30,703	$0
Elderton Borough	$75,474,000	$3,703	$3,703	$0
Ford City Borough	$538,129,000	$36,287	$36,287	$0
Ford Cliff Borough	$42,367,000	$4,809	$4,809	$0
Freeport Borough	$314,661,000	$22,392	$22,392	$0
Gilpin Township	$375,439,000	$28,829	$28,829	$0
Hovey Township	$25,518,000	$226	<$1,000	$0
Kiskiminetas Township	$529,524,000	$32,097	$32,097	$0
Kittanning Borough	$933,567,000	$28,151	$28,151	$0
Kittanning Township	$224,824,000	$13,224	$13,224	$0
Leechburg Borough	$490,357,000	$22,186	$22,186	$0
Madison Township	$176,372,000	$1,169	$1,169	$0
Mahoning Township	$155,073,000	$3,076	$3,076	$0
Manor Township	$578,870,000	$45,951	$45,951	$0
Manorville Borough	$40,861,000	$4,414	$4,414	$0
North Apollo Borough	$163,435,000	$11,531	$11,531	$0
North Buffalo Township	$364,294,000	$26,363	$26,363	$0
Parker City	$83,797,000	$3,511	$3,511	$0
Parks Township	$502,517,000	$23,105	$23,105	$0
Perry Township	$72,571,000	<$1,000	<$1,000	$0
Pine Township	$51,655,000	$1,375	$1,375	$0
Plumcreek Township	$219,089,000	$16,350	$16,350	$0
Rayburn Township	$225,689,000	$12,872	$12,872	$0
Redbank Township	$211,247,000	$4,121	$4,121	$0
Rural Valley Borough	$154,259,000	$5,794	$5,794	$0
South Bend Township	$116,754,000	$7,793	$7,793	$0
South Bethlehem Borough	$132,137,000	$1,048	$1,048	$0
South Buffalo Township	$454,112,000	$31,652	$31,643	<$1,000
Sugarcreek Township	$190,498,000	$2,675	$2,675	$0
Valley Township	$88,371,000	$4,521	$4,521	$0
Washington Township	$111,171,000	<$1,000	<$1,000	$0
Wayne Township	$108,168,000	$2,021	$2,021	$0
West Franklin Township	$347,597,000	$17,707	$17,707	<$1,000
West Kittanning Borough	$412,394,000	$8,792	$8,792	$0

Municipality	Total Building Replacement Value (Structure Only)	Total Building Damage (All Occupancies)	Residential Buildings	Commercial Buildings
		Probable Loss	Probable Loss	Probable Loss
Worthington Borough	$144,717,000	$5,027	$5,018	<$1,000
Armstrong County (Total)	**$10,883,076,000**	**$526,747**	**$526,730**	**<$1,000**

Source: HAZUS-MH v4.2

Because of differences in building construction, residential structures are generally more susceptible to wind damage than commercial and industrial structures. Wood and masonry buildings, regardless of their occupancy class, usually experience more damage than concrete or steel buildings. The damage counts include buildings damaged at all severity levels from minor damage to total destruction. Total damage dollar amounts reflect the overall impact to buildings at an aggregate level.

Of the more than $4.5 billion in total residential replacement value (structure) for the entire County, an estimated over $526,000 in residential building damage can be anticipated for the 500-year event. Residential building damage accounts for nearly 100-percent of total damage for the 500-year wind-only event. This information illustrates residential structures are the most vulnerable to the wind hazard.

Annualized losses were also examined for Armstrong County. A total of more than $6,000 is estimated as the annualized loss for the entire County; however, annualized loss does not predict which losses will occur in any particular year.

Impact on Critical Facilities

HAZUS-MH v4.2 estimates the probability that critical facilities (medical facilities, fire/emergency medical services, police, emergency operation centers, schools, and user-defined facilities such as shelters and municipal buildings) may sustain damage as a result of 100-year and 500-year MRP wind-only events. Additionally, HAZUS-MH estimates the loss of use for each facility in number of days. HAZUS-MH v4.2 estimates that there will be no structural losses to critical facilities in Armstrong County; and continuity of operations at these facilities will not be interrupted (loss of use is estimated to be 0 days) as a result of the 100- and 500-year MRP events.

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

Utility structures could suffer damage associated with falling tree limbs or other debris, resulting in the loss of power, which can impair business operations and can affect heating or cooling provision to citizens (including the young and elderly, who are particularly vulnerable to temperature-related health impacts).

Impact on Economy

Tornadoes and windstorms also affect the economy, including loss of business function (for example, to tourism and recreation), damage to inventory, relocation costs, wage loss, and rental loss from repair or replacement of buildings. HAZUS-MH v4.2 estimates the total economic loss associated with each storm scenario (direct building losses and business interruption losses). Business interruption losses are associated with the inability to operate a business because of the wind damage sustained during the storm or the temporary living expenses for those displaced from their home because of the event.

HAZUS-MH v4.2 estimates no business interruption losses for Armstrong County for the 100-year MRP event. HAZUS-MH v4.2 estimates less than $1,000 in business interruption losses for Armstrong County for the 500-year MRP wind only event, which includes loss of income, relocation costs, rental costs, and lost wages.

Debris management can be costly and may also impact the local economy. HAZUS-MH v4.2 also estimates the amount of debris that may be produced a result of the 100- and 500-year MRP wind events. This estimate is likely conservative; it may be higher if multiple impacts occur or if the event occurs in conjunction with rain or other hazards, because the estimated amount of debris produced does not include flooding. According to the HAZUS-MH Hurricane User Manual, estimates of weight and volume of eligible tree debris are those of downed trees that would likely be collected and disposed of at public expense. Refer to the User Manual for additional details regarding these estimates. HAZUS-MH v4.2 estimates no debris will be generated as a result of the 100-year MRP wind event. Table 4.3.13-8 summarizes the debris produced for Armstrong County during a 500-year MRP wind event.

Table 4.3.13-8. Estimated Debris Production for 500-Year Mean Return Period Hurricane-Related Winds

Municipality	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
Apollo Borough	0	0	43.1	21.4
Applewold Borough	0	0	3.5	3.5
Atwood Borough	0	0	0.0	0.0
Bethel Township	0	0	7.7	5.0
Boggs Township	0	0	40.4	13.5
Bradys Bend Township	0	0	9.9	1.3
Burrell Township	0	0	27.4	9.1
Cadogan Township	0	0	46.7	11.0
Cowanshannock Township	0	0	487.9	95.7
Dayton Borough	0	0	0.0	0.0
East Franklin Township	0	0	709.1	143.3
Elderton Borough	0	0	17.7	13.8
Ford City Borough	0	0	21.3	7.7
Ford Cliff Borough	0	0	2.4	2.4
Freeport Borough	0	0	61.5	45.1
Gilpin Township	0	0	137.2	42.1
Hovey Township	0	0	0.0	0.0
Kiskiminetas Township	0	0	366.0	97.6
Kittanning Borough	0	0	24.5	21.8
Kittanning Township	0	0	31.1	9.8
Leechburg Borough	0	0	45.0	33.4
Madison Township	0	0	21.8	2.5
Mahoning Township	0	0	0.0	0.0
Manor Township	0	0	231.2	132.7
Manorville Borough	0	0	6.8	6.5
North Apollo Borough	0	0	11.9	9.5
North Buffalo Township	0	0	590.7	89.8

Municipality	Brick and Wood (tons)	Concrete and Steel (tons)	Tree (tons)	Eligible Tree Volume (cubic yards)
Parker City	0	0	0.0	0.0
Parks Township	0	0	86.0	37.1
Perry Township	0	0	0.0	0.0
Pine Township	0	0	0.0	0.0
Plumcreek Township	0	0	312.4	60.2
Rayburn Township	0	0	36.4	17.6
Redbank Township	0	0	1.0	0.9
Rural Valley Borough	0	0	33.0	13.0
South Bend Township	0	0	626.7	57.6
South Bethlehem Borough	0	0	2.8	2.8
South Buffalo Township	0	0	291.7	75.5
Sugarcreek Township	0	0	7.2	3.3
Valley Township	0	0	0.0	0.0
Washington Township	0	0	7.6	3.7
Wayne Township	0	0	22.5	10.2
West Franklin Township	0	0	1,151.0	108.3
West Kittanning Borough	0	0	18.3	16.5
Worthington Borough	0	0	15.0	13.9
Armstrong County (Total)	**0**	**0**	**5,556.7**	**1,239.0**

Source: HAZUS-MH v4.2

Future Growth and Development

As discussed and illustrated in Section 4.4, areas targeted for future growth and development have been identified across Armstrong County. Any areas of growth could be affected by the tornado and windstorm hazard because the entire County is exposed and vulnerable to the wind hazard, particularly when associated with severe storms.

Effect of Climate Change on Vulnerability

Climate is defined not simply as average temperature and precipitation but also by the type, frequency, and intensity of weather events. Both globally and at the local scale, climate change has the potential to alter the prevalence and severity of events, such as hurricanes. While predicting changes to the prevalence or intensity of a wind event and its effects is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society and the environment (U.S. Environmental Protection Agency [EPA] 2006).

Major clusters of summertime thunderstorms in North America will grow larger, more intense, and more frequent later this century in a changing climate, unleashing far more rain and posing a greater threat of flooding across wide areas (UCAR 2017). At century's end, the number of summertime storms that produce extreme downpours could increase by more than 400 percent across parts of the United States, including sections of the Gulf Coast, Atlantic Coast, and the Southwest. In addition, the intensity of individual extreme rainfall events could increase by as much as 70 percent in some areas (UCAR 2016).

Thunderstorms and other heavy rainfall events are estimated to cause more than $20 billion of economic losses annually in the United States. Particularly damaging, and often deadly, are mesoscale convective systems (MSCs): clusters of thunderstorms that can extend for many dozens of miles and last for hours, producing flash floods, debris flows, landslides, high winds, and/or hail. The persistent storms over Houston in the wake of Hurricane Harvey were an example of an unusually powerful and long-lived MCSs.

Storms have become more intense in recent decades, and a number of scientific studies have shown that this trend is likely to continue as temperatures continue to warm. The reason, in large part, is that the atmosphere can hold more water as it gets warmer, thereby generating heavier rain.

Modeling has found that the number of severe MCSs in North America more than tripled by the end of the 20th century. Moreover, maximum rainfall rates became 15 to 40 percent heavier, and intense rainfall reached farther from the storm's center. As a result, severe MCSs increased throughout North America, particularly in the northeastern and mid-Atlantic states, as well as parts of Canada, where they are currently uncommon.

4.3.14 Transportation Accident

This section describes the location and extent, range of magnitude, past occurrence, future occurrence, and vulnerability assessment for the transportation accident hazard.

Transportation accidents are defined as accidents involving air, rail, and roadway travel resulting in death or serious injury or extensive property loss or damage. Accidents related to hazardous materials are considered under the Hazardous Materials section of this document (refer to Section 4.3.4). These types of transportation accidents are defined below.

- *Vehicular Accidents*: A vehicular accident is a road traffic incident that usually involves one vehicle colliding with another vehicle or other road user, such as an animal, stationary roadside object, or cyclist/pedestrian. A vehicular accident may result in injury, property damage, or possible fatalities. Many factors contribute to vehicular accidents, including equipment failure, poor road conditions, weather, traffic volume, and driver behavior.
- *Aviation Accidents*: According to the International Civil Aviation Organization, an aviation accident occurs during operation of an aircraft between the time a person boards the aircraft with intent to fly to a destination to the time the person has disembarked the aircraft. Three different situations qualify as an aviation accident: (1) a person is fatally or seriously injured; (2) the aircraft sustains damage or structural failure; or (3) the aircraft is missing or inaccessible. An aviation incident is an occurrence, other than an accident, associated with operation of an aircraft that affects or could affect the safety of operation. Aviation accidents and incidents have the potential to occur while the plane is over County airspace, not only directly on airport property.
- *Railway Accidents*: Railway accidents involve one or more trains. They can involve a train derailment or one train impacting another train, vehicle, pedestrian, or cyclist.

4.3.14.1 Location and Extent

Vehicular Accidents

The County road network is a vital element in the transportation system since it serves vehicular traffic, which comprises the majority of existing and anticipated future transportation demand. The roadway network will continue to be the primary means of transportation through and within the County. Armstrong County is serviced by the following major highway networks:

Table 4.3.14-1. Armstrong County Highway Network

Road	Classification	Description	Jurisdiction
Route 28	Freeway/Expressway	Multi-Lane Highway & Fully Controlled Access Highway	State
Route 422	Principal Arterial Highway & Freeway / Expressway	Fully Controlled Access Highway	Federal
Route 66	Minor Arterial	Traffic Route	State
Alt. Route 66	Minor Arterial	Traffic Route	State
Route 85	Minor Arterial	Traffic Route	State
Route 268	Minor Arterial & Principal Arterial	Traffic Route	State
Route 68	Minor Arterial	Traffic Route	State
Route 128	Minor Arterial	Traffic Route	State
Route 56	Minor Arterial	Traffic Route	State
Route 156	Minor Arterial	Traffic Route	State

Road	Classification	Description	Jurisdiction
Route 210	Minor Arterial & Rural Major Collector	Traffic Route	State
Route 839	Rural Major Collector	Traffic Route	State

Source: Armstrong County Comprehensive Plan 2005

Figure 4.3.14-1 shows major roadways running throughout Armstrong County. There are 1,820 linear miles of roads in Armstrong County.

Table 4.3.14-2. Armstrong County Transportation Network

Category	Miles
Interstate Highway	0.0
Freeways/Expressways	11.0
Principal Arterials	48.7
Minor Arterials	117.0
Major Collectors	179.8
Minor Collectors	147.5
Local Roads	1,316
TOTAL:	**1,820**

Source: Pennsylvania Department of transportation (PennDOT) 2016

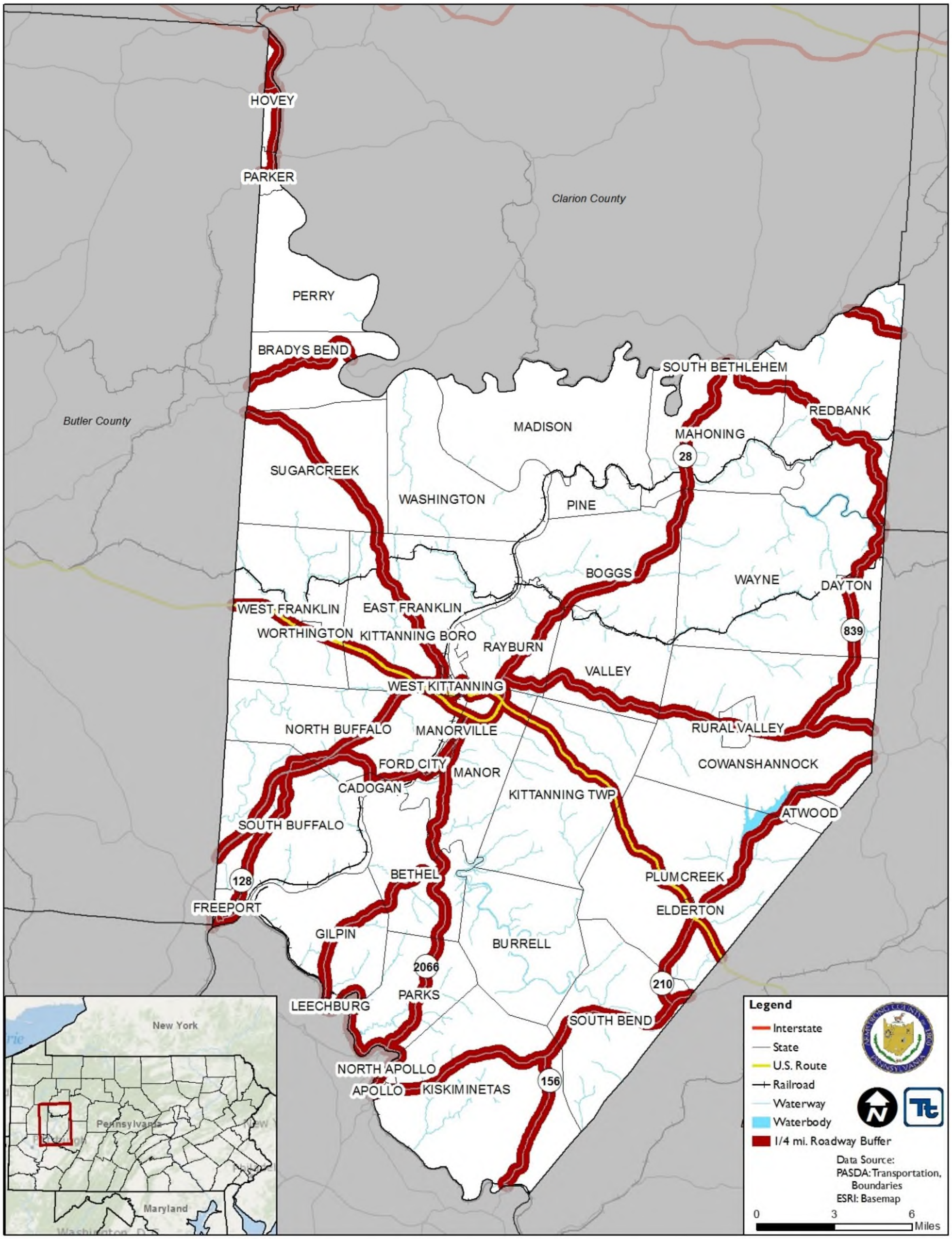
In response to the collapse of the I-35W Bridge in Minneapolis in August 2007, PennDOT assessed the structural integrity of all bridges in the Commonwealth. Table 4.3.14-3 lists the total number of bridges on state roads and local roads in Armstrong County as well as the number of those in poor condition (bridges that have deterioration to one or more of its major components).

Table 4.3.14-3. Bridges in Armstrong County

Number of Bridges on State Roads	Number in Poor Condition	Number of Bridges on Local Roads	Number in Poor Condition
369	53	66	10

Source: PennDOT 2016

Figure 4.3.14-1. Major Transportation Routes in Armstrong County



Source:

Railway Accidents

There are six active rail lines operating in Armstrong County. The longest line is the Pittsburgh & Shawmut Rail line, which enters the County around Freeport, travels north to Reesedale where it crosses the Allegheny River, and travels east toward McWilliams where it exits the County. The six active lines are:

- Bessemer & Lake Erie Railroad
- Pittsburgh & Shawmut
- Buffalo & Pittsburgh
- Kiski Junction
- Norfolk Southern (track rights over Pittsburgh & Shawmut and Buffalo)
- Pittsburgh)
- CSXT (track rights over Buffalo & Pittsburgh)

There are four sites located along regional and short line rail lines in Armstrong County that have the potential to be rail served. These properties were identified by PennDOT and are described in the following table:

Table 4.3.14-4. Regional and Short Rail Lines in Armstrong County

Location	Servicing Railroad	Size (acres)	All Public Utilities
Murphy's Flat, South Buffalo Township	Pittsburgh & Shawmut Railroad, Inc.	153	No
Schenley Industrial Park, Gilpin Township	Kiski Junction Railroad	5	Yes
Snyder Industrial Site, North Buffalo Township & East Franklin Township	Pittsburgh & Shawmut Railroad, Inc.	53	Yes
Windon Acres, Washington Township	Pittsburgh & Shawmut Railroad, Inc.	105	No

Source: Armstrong County Comprehensive Plan 2005

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
- *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.) (PEMA 2018).

Aviation Accidents

There is one public airport listed in Armstrong County by the PennDOT Bureau of Aviation. The McVille Airport is located in Freeport Borough. However, this low number of airports does not exclude the County from aviation accidents. All of the counties bordering Armstrong County also are home to at least one airport. These airports include, among others, the Allegheny County Airport, the Arnold Palmer Regional Airport, the Clarion County Airport, the Dubois Regional Airport, the Greensburg-Jeanette Regional Airport, the Pittsburgh International Airport, and the Venango Regional Airport. Additionally, Armstrong County Memorial Hospital has a heliport located in Kittanning.

4.3.14.2 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 accidents are non-fatal in Pennsylvania, but PennDOT estimates that every hour, nine people are injured in a car accident, and every seven hours, someone dies as a result of a car accident. Most fatal accidents occur in May and June, but the highest number of accidents overall occur in October, November, and December (PEMA 2018).

Rail accidents can vary widely in terms of injuries, fatalities, property damage, and interruption of service, depending on the nature and severity of the accident. Aircraft accidents can vary from a single-engine aircraft having a "hard landing" and causing damage to the aircraft, to an accident of a small turboprop or jet aircraft, to an accident of a large jet aircraft (such as a Boeing 727). Other aircraft accidents could include helicopter or experimental aircraft accidents. Aviation accidents also can involve radio-controlled or drone aircraft devices, many of which are experimental and not subject to defined regulatory oversight, potentially complicating issues with and for the public that could arise if one of these devices crashes.

The worst-case transportation accident within Armstrong County would be a tractor trailer or rail car carrying an extremely hazardous substance (see Section 4.3.4) overturning and experiencing a release of its cargo on a major roadway. This incident would block traffic on County's major transportation routes and could threaten the health and safety of individuals on the roadways and in surrounding neighborhoods. In addition, a release could cause the closure of critical facilities in Armstrong County.

4.3.14.3 Past Occurrence

Major roadway accidents (such as multi-vehicle accidents, those that close roads or bridges, or those involving school buses) are reported by Armstrong County to PennDOT. Table 4.3.14-5 summarizes these accidents from 2010 to 2017. While this table lists accidents reported to the counties and Commonwealth, significantly more minor accidents are not reported.

Table 4.3.14-5. Summary of Major Roadway Accidents in Armstrong County, 2010–2017

Year	Vehicle Accidents	Railroad Incidents	Aircraft Accidents
2010	580	0	0
2011	551	0	0
2012	532	0	0
2013	625	1	0
2014	529	0	0
2015	523	0	0
2016	511	0	0
2017	545	0	0
Total	**4,396**	**1**	**0**

Source: PennDOT 2018; National Transportation Safety Board (NTSB) 2018

Note: While no aircraft incidents have occurred between 2010 and 2017, there are have been incidents prior to 2010 in Apollo, Freeport, Kittanning, and other nearby areas.

4.3.14.4 Future Occurrence

Transportation hazards are impossible to predict accurately; however, areas prone to these hazards can be located, quantified through analysis of historical records, and plotted on countywide and municipality base maps. Certain characteristics that together cause these hazards or increase vulnerability to these hazards can be identified, and areas that may be prone are identifiable.

Assuming that transportation accidents are as likely to occur in the future as they have occurred in the past, and based on the available data, Armstrong County can expect the following each year:

- Approximately 549 major vehicle accidents (the actual number of vehicle accidents in Armstrong County may be much higher; however, this figure is based on vehicle accidents captured from PennDOT)
- Zero aircraft accidents
- At least one railroad accident

For the 2019 HMP update, the most up-to-date information was used to calculate the probability of future occurrence of transportation accidents in Armstrong County. Information provided by PennDOT and NTSB were used to identify the number of transportation accident events that occurred between 2010 and 2017. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics as well as the annual average number of events and the estimated percent chance of an incident occurring in a given year. Based on these statistics, there is an estimated 100% chance of a transportation accident event occurring in any given year in Armstrong County.

Table 4.3.14-6. Probability of Future Occurrences of Transportation Accidents

Hazard Type	Number of Occurrences Between 2010 and 2017	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in Any Given Year	Percent Chance of Occurrence in Any Given Year
Transportation Accident (all types)	4,397	628.1	0	549.6	100%

In Section 4.4, the identified hazards of concern for Armstrong County were ranked for relative risk. The probability of occurrence, or likelihood of the event, is one parameter used for ranking hazards. Based on historical records and reference to the Pennsylvania State HMP, the probability of occurrence for a transportation accident in the County is considered *highly likely*. Please refer to Section 4.4 for further information on PEMA's risk factor methodology and the risk factors used to determine each hazard's risk rank.

4.3.14.5 Vulnerability Assessment

The entire County has been identified as the hazard area for transportation accidents. This section evaluates and estimates the potential impact of transportation hazards on Armstrong County in the following sections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on: (1) life, safety, and health; (2) general building stock; (3) critical facilities; (4) the economy; and (5) future growth and development
- Further data collections that will assist in understanding this hazard over time

Overview of Vulnerability

All critical infrastructure in Armstrong County is vulnerable to transportation accidents. This vulnerability is manifested either through direct damage (e.g., a vehicle striking the facility) or through operators being injured or delayed in performing their duties due to congested or closed roadways. In the case of critical transportation infrastructure (e.g., bridges, key highways), the critical infrastructure may be the only property damaged by an accident. In addition, transportation accidents that result in the release of hazardous materials (as discussed in Section 4.3.4) may cause health effects and/or fatalities, depending on the material released.

Data and Methodology

A qualitative assessment was conducted to evaluate the assets exposed and the potential impacts associated with this hazard.

Impact on Life, Health, and Safety

Transportation accidents could lead to potential losses in categories of human health and life, property, and natural resources. Vehicular accidents, flooded roadways, and other roadway impairments may result in injury or death to drivers and passengers on the road, the public in the immediate vicinity, and emergency services personnel. Likewise, additional blockages of the rail crossings in Hyndman Borough could result in the delay of emergency services to borough residents. The number of people exposed depends on population density, whether exposure occurs during day or night, and proportions of the population located indoors and outdoors.

The County and its municipalities are prepared to manage and respond to transportation hazards.

Impact on General Building Stock, Critical Facilities, Economy, and Future Development

Because of insufficient data, a full loss estimate was not completed for the transportation accident hazard. Loss of roadway use, and public transportation services would affect thousands of commuters, employment, day-to-day operations within the County, and delivery of critical municipal and emergency services. Disruption of one or more of these modes of transportation can lead to congestion of another and affect both the County and the region as a whole. As discussed in Section 4.4 of this HMP, areas targeted for future growth and development have been identified across Armstrong County. Increased development in the County and region will lead to increased road traffic.

Impact on the Environment

Similar to the range of magnitude, the environmental impacts associated with transportation crashes can vary greatly. In the case of a simple motor vehicle crash, train derailment, or aviation crash, the environmental impact is minimal. However, if the crash 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 (PEMA 2013). For a complete discussion of the environmental impacts of hazardous materials releases, refer to Section 4.3.4.

Future Growth and Development

Increased development in Armstrong County will lead to increased road traffic. Areas targeted for potential future growth and development in the next five to ten years have been identified across the County (further discussed in Section 4.4 of this HMP). Any areas of growth could be potentially impacted by the transportation accidents hazard because the entire County is exposed and potentially vulnerable.

Effects of Climate Change on Vulnerability

The 2014 National Climate Assessment notes that the national transportation system is vulnerable to climate change impacts through infrastructure damages and electricity and communication outages (U.S. Global Change Research Program 2014). Damaged infrastructure and ineffective safety systems may lead to an increased risk of transportation accidents. Continued use of transportation that uses fossil fuels also adds to the impact of climate change through the release of greenhouse gas emissions. According to the U.S. Department of

Transportation, 28% of total U.S. greenhouse gas emissions in 2012 came from the transportation sector (USDOT 2017).

Additional Data and Next Steps

Based on limited data regarding the probability and potential impact of this hazard, a quantitative loss estimate was not completed for this HMP. Over time, the County can work with appropriate agencies to collect additional data to support mitigation planning, consideration of potential risks, and prioritization of mitigation measures for this hazard.

Armstrong County recognizes it must compile and maintain data regarding specific concerns and past losses from this hazard. These data should include specific information regarding damage or loss of life, property, or infrastructure; and any data pertaining to potential or actual cost and logistics of responding to an event caused by this hazard (locations of road closures, map detours, traffic counts, durations of closures and detours, and costs to respond). These data will be included in future revisions of the HMP and can be used to support future mitigation grant efforts (benefit cost analysis).

Studying traffic and potential transportation accident patterns could provide information on vulnerability of specific road segments and nearby populations. Increased understanding of the types of hazardous materials transported through the County will also support mitigation efforts. Maintaining a record of these frequently transported materials can facilitate development of preparatory measures to respond to a release. Predicting costs to respond to a release, remediate the environment, or repair damaged infrastructure would be useful for developing mitigation options.

4.3.15 Utility Interruption

This section describes the location and extent, range of magnitude, past occurrence, future occurrence, and vulnerability assessment for the utility interruption hazard for the Armstrong County Hazard Mitigation Plan (HMP) Update.

Utility interruptions are caused primarily by electrical failures, which are commonly a secondary effect of hazards, such as severe weather and flooding. High winds, along with heavy snow, ice, and rain, can affect an electrical system's ability to function. Worker strikes at power generation facilities have also been known to cause minor power failures. Other causes of power outages include falling tree limbs, vehicular accidents, and small animals that destroy wiring. When power outages occur, they are typically on a regional scale.

4.3.15.1 Location and Extent

Utility interruptions occur throughout Armstrong County. Interruptions are possible anywhere utility services have been installed. For example, severe thunderstorms or winter storms could bring down power lines and cause widespread disruptions in electricity service. Strong heat waves may result in rolling blackouts causing loss of power for an extended period. Local outages may be caused by traffic accidents or wind damage. Some utility facilities are especially vulnerable. For instance, because water intakes and many water control facilities lie in the 1-percent annual chance floodplain, a flood of this magnitude may seriously impair water service. Utilities that employ aboveground wiring (i.e., power and data/telecommunications) are vulnerable to the effects of other hazards such as high wind, heavy snow, ice, rain, and vehicular accidents. Table 4.3.15-1 lists the utility companies that provide service to Armstrong County.

Table 4.3.15-1. Utility Providers in Armstrong County

Type of Utility/Public Works	Company Name
Electricity	West Penn Power
	First Energy
	REA
	Penelec
	Sithe Energies
Cable Television	Adelphia Cable
	Comcast
	Tri Ax Cable
Gas Companies	Baker Gas
	Bargly Gas Co.
	C & D Gas
	CNG Transmission Corporation
	Columbia Gas Co.
	Dewey Gas Co.
	Dominion Exploration
	Economy Natural Gas
	Equitable Gas Co.
	Equitrans gas Co.
	Hillwig Gas Co.
	Kaylor Gas Distribution
	Kriebel Gas Co.
	Mid-East Oil Company (gas well in Kiski Twp)
	N.E.C.I
	National Fuel
	Philips Gas Co.
	Stafanik, Lou Gas Wells (Parks Twp.)
	Valley Gas and Welding

Type of Utility/Public Works	Company Name
	U.S. Energy
	Wally Gas Company
Sewage Companies	Ford City Borough – Wastewater Treatment Plant
	Freeport Sewage Treatment Plant
	Kiski Valley Water Pollution Control Authority
	Kittanning Borough Sewage Treatment Plant
	Parker Area Authority
	Redbank Valley Municipal Authority Wastewater Treatment Plant
	West Hills Area Water Pollution Control Authority
Telephone Providers	Armstrong Telecommunications
	AT & T
	Century Link
	Consolidated Communications
	Level Communications
	Nextel Security
	Sprint
	Verizon
	Windstream (formerly Alltel)
	United Telephone Repair Service
Water Companies	Bradys Bend Water/Sewage Authority
	Buffalo Township Water Authority
	Eastern Armstrong County Municipal Authority
	Ford City Borough Water Treatment Plant
	Gilpin Township Water Authority
	Hawthorne Area Water Authority Water Treatment Plant
	Kittanning Suburban Joint Water Authority
	Manor Township Water Authority
	Parks Township Water Authority
	Pennsylvania American Water Authority
	Plumcreek – Kittanning Water Authority
	Rural Valley Borough Water Treatment Plant
	West Kittanning Water Works
	Worthington Municipal Authority – Water Treatment Plant #2
	Worthington Municipal Authority – Water Treatment Plant # 3

Source: Armstrong County Department of Public Safety 2013

Utility interruptions in Armstrong County have the potential to affect a significant number of residents. According to the 2016 estimates of the American Community Survey, at total of 28,250 housing units are occupied in the County. The survey estimates that 74.3 percent of these households use utility gas as their main heating fuel, 9.1 percent use fuel oil or kerosene, and 8.5 percent use electricity to heat their homes (U.S. Census Bureau 2018). These statistics show that should a utility interruption occur Countywide, over 25,000 households could be without heat or cooling.

4.3.15.2 Range of Magnitude

The most severe utility interruptions will be regional or widespread power and telecommunications outages. With the loss of power, electric-powered equipment and systems will not be operational. Examples may include lighting; heating, ventilation, and air conditioning (HVAC) and ancillary support equipment; communication (e.g., public-address systems, telephone, computer servers, and peripherals); ventilation systems; fire and security systems; appliances such as refrigerators, sterilizers, trash compactors, and 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 (Pennsylvania Emergency Management Agency [PEMA] 2018).

The severity of a utility interruption can be compounded with extreme weather events, especially winter weather events. Interruptions can also be more severe for populations with access and functional needs 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 (PEMA 2018).

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 (PEMA 2018).

4.3.15.3 Past Occurrence

Utility outages have been caused by winter storms, wind, vehicle accidents, and other factors. Armstrong County has not endured any localized energy emergencies. However, some County residents have experienced individual household emergencies, likely due to aging utility infrastructure. No comprehensive list of utility interruptions exists for the County. Table 4.3.15-2 summarizes past occurrences of power outages that have impacted Armstrong County.

Table 4.3.15-2. Utility Interruptions from 2003 to 2018

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 14, 2003	Power Outage	N/A	N/A	A large, multi-state power outage impacted over 840,000 customers. People in New York – Buffalo to Albany; Ontario, Canada to Pennsylvania were impacted.
May 21, 2004	Power Outage	N/A	N/A	High winds and heavy rain led to a power outage in Western Pennsylvania, Northern West Virginia, Western Maryland, Northern Virginia. It impacted over 94,000 customers.
October 24-November 2, 2005	Power Outage	N/A	N/A	Impacts from Hurricane Wilma affected Maryland, North Central West Virginia, Southwestern Pennsylvania, and Northern Pennsylvania. This resulted in a power outage that impacted over 303,000 customers.
September 26, 2007	Power Outage	N/A	N/A	Thunderstorms and strong winds downed trees and power lines in Parks and Kiskiminetas Townships, causing over $80,000 in property damage.
September 14-19, 2008	Power Outage	N/A	N/A	Wind storms led to power outages in western Pennsylvania, impacting over 124,000 customers.
September 22, 2008	Power Outage	N/A	N/A	Tropical Depression Ike led to power outages in western Pennsylvania, impacting over 160,000 customers.
February 11-16, 2009	Power Outage	N/A	N/A	Severe thunderstorms led to widespread power outages in Maryland, Virginia, West Virginia, and Pennsylvania, impacting over 374,000 customers.
June 25, 2009	Power Outage	N/A	N/A	Thunderstorms and strong winds downed trees and power lines in Apollo, causing approximately $50,000 in property damage.
February 5-11, 2010	Power Outage	DR-1898	Yes	A winter storm that impacted western Pennsylvania led to a power outage, impacting 190,000 customers. FEMA issued a major declaration for several counties in Pennsylvania as a result of this event, including Armstrong County.

Date(s) of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
August 4-7, 2010	Power Outage	N/A	N/A	Thunderstorms in western Pennsylvania led to a power outage, impacting over 11,000 customers.
September 22-24, 2010	Power Outage	N/A	N/A	Thunderstorms in western Pennsylvania led to a power outage, impacting over 82,000 customers.
May 26, 2011	Power Outage	N/A	N/A	Thunderstorms and strong winds downed trees and power lines in Dayton, causing approximately $5,000 in property damage.
July 22, 2011	Power Outage	N/A	N/A	Thunderstorms and strong winds downed trees and power lines in Boggsville, causing approximately $15,000 in property damage.
July 26-27, 2012	Power Outage	N/A	N/A	Severe weather led to a power outage in western Pennsylvania, impacting over 65,000 customers.
June 16, 2016	Power Outage	N/A	N/A	Thunderstorms and wind led to a power outage to West Penn Power customers, impacting over 26,000 customers.
August 16, 2016	Power Outage	N/A	N/A	Rain and high winds led to a power outage to West Penn Power customers, impacting over 20,000 customers.
August 28, 2016	Power Outage	N/A	N/A	Rain and high winds led to a power outage to West Penn Power customers, impacting over 13,000 customers.
October 20, 2016	Power Outage	N/A	N/A	Rain and high winds led to a power outage to West Penn Power customers, impacting over 22,000 customers.
December 17, 2016	Power Outage	N/A	N/A	Freezing rain and high winds led to a power outage to West Penn Power customers, impacting over 20,000 customers.

Sources: U.S. Energy Information Administration 2018; PEMA 2018; National Oceanic and Atmospheric Administration (NOAA)-National Centers for Environmental Information (NCEI) 2018; Federal Emergency Management Agency (FEMA) 2018

4.3.15.4 Future Occurrence

Minor power failure (in other words, short outage events) may occur several times a year for any given area in the County, while major events (long, widespread outage events) take place once every few years. Power failures often occur during severe weather; therefore, they should be expected during those events. Based on the assumption that the County will experience severe weather annually, in addition to outages from other causes, the future occurrence of utility interruptions in Armstrong County should be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (Section 4.4).

4.3.15.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed and vulnerable in the identified hazard area. This section evaluates and estimates the potential impact of the utility interruption hazard on Armstrong County in the following sections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impact on (1) life, health and safety; (2) general building stock and critical facilities; (3) economy; and (4) future growth and development
- Effects of climate change on vulnerability
- Further data collections that will assist understanding this hazard over time

Overview of Vulnerability

All of Armstrong County is vulnerable to the utility interruption hazard. Utility interruptions most severely affect individuals with access and functional needs (e.g., children, the elderly, and individuals with special medical needs). Special medical equipment will not function without power. Likewise, a loss of air conditioning during periods of extreme heat or the loss of heating during extreme cold can be especially detrimental to those with medical needs, children, and the elderly. A lack of clean, potable water has health implications for all residents. Because this hazard often occurs in conjunction with other hazards, during winter storms, hail events, and lightning strikes make the county more vulnerable to a utility interruption.

Data and Methodology

Insufficient data were available to model long-term potential impacts of a utility failure on Armstrong County. Over time, additional utility interruption data such as utility type, location, and duration throughout the County will be collected to allow better analysis of this hazard. Available information and a preliminary assessment are provided below.

Impact on Life, Health, and Safety

For the purpose of this HMP update, the entire population of Armstrong County is considered vulnerable to the utility interruption hazard. The Community Profile (Section 2) summarizes the population statistics for the County.

Utility interruptions most severely affect individuals with access and functional needs (such as children, the elderly, and individuals with special medical needs). Special medical equipment will not function without power. Likewise, a loss of air conditioning during periods of extreme heat or the loss of heating during extreme cold can be especially detrimental to those with medical needs, children, and the elderly. Table 4.3.15-3 shows the demographic statistics for more vulnerable populations. Fewer children reside in the County, resulting in lower vulnerability of this population to the effects of a utility interruption. The population over 65 years of age increased by 7.72 percent, somewhat offsetting the decrease in number of vulnerable to utility interruption. The population with special needs has decreased by 10.84 percent, resulting in a lower vulnerability to this population.

Table 4.3.15-3. Demographic Trends for Vulnerable Populations

Vulnerable Population	2010 Census	2016 Census Estimate	Change in Population
Children under 5 years	3,605	3,429	-4.88%
65 years and over	12,687	13,666	7.72%
Individuals with Access and Functional Needs	15,409	13,739	-10.84%

Source: U.S. Census Bureau 2018

Impact on General Building Stock and Critical Facilities

All buildings and facilities in Armstrong County considered to be critical infrastructure are vulnerable to utility interruptions, especially the loss of power. Some key indicators of increased vulnerability to utility interruption include the presence of ground- or basement-level utilities, reliance on electronic banking, or facilities located in isolated or wooded areas where a downed tree might cause a utility interruption. The establishment of reliable backup power at these facilities is extremely important to continue to provide for the health, safety, and well-being of Armstrong County's population.

Impact on the Economy

Utility interruptions could affect the ability of the government to function, especially if backup power generation or supply is inadequate or unavailable, which could have cascading economic impacts. Increased costs such as those related to providing shelters, and cooling and heating centers may be incurred as a result of a utility outage. Extended power outages will require officials to shelter victims who require heat and power for activities of daily living. Power interruptions can cause economic impacts stemming from lost income and spoiled food and other goods, costs to the owners or operators of the utility facilities, and costs to government and community service groups. FEMA's benefit-cost analysis (BCA) methodology measures loss of electrical service on a person-per-day-of-lost-service basis for the service area affected. For the electrical utility, the standard value is $131 per person per day (FEMA 2014).

Impact on the Environment

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. Utility pipelines carrying flammable materials also have the possibility of exploding or starting a fire (PEMA 2013). For a complete discussion on the impacts of a hazardous materials release, please see Section 4.3.4.

Future Growth and Development

Areas targeted for potential future growth and development in the next 5 to 10 years have been identified across Armstrong County (further discussed in Section 4.4 of this HMP). Any areas of growth could be potentially impacted by the utility interruption hazard because the entire County is exposed and potentially vulnerable. An increase in development and population will increase demand for power supply, which has the ability to increase the likelihood of utility interruption incidents.

Effect of Climate Change on Vulnerability

According to the 2015 Pennsylvania Climate Impacts Assessment Report, annual and seasonal average temperatures are expected to increase; with one scenario predicting almost a 7 °F increase in annual average temperature by the end of the 21st century. Some areas of the world may experience greater temperature changes than others. It is important to note that frequency estimates may not be an accurate representation of future conditions due to the unknown impacts of climate change (PEMA 2013).

The increase in average temperatures as a result of climate change makes the occurrence of extreme heat more likely. While increased average temperatures would make the occurrence of extreme cold less likely, some climatologists have suggested that warming in the Arctic could impact the position of the jet stream, allowing for more extreme cold weather events to occur. While some research supports this concept, others do not and the impact of climate change on cold weather events is not fully understood (Climate Central 2013). Extreme heat and cold result in greater strain on utilities, increasing the likelihood of utility interruption.

Climatologists expect an increase in the number and intensity of severe weather events. This will include wind events such as hurricanes, tornadoes, and wind associated with thunderstorms, among other phenomena. More storms with higher winds will increase the chance that the utility infrastructure will be impacted by these storms. Additionally, climatologists expect an increase in precipitation, which could come in the form of heavy downpours or winter weather thus causing additional utility interruptions. Increased risk of drought may also threaten water utilities.

Additional Data and Next Steps

For future plan updates, Armstrong County can track data on power outage events and obtain additional information on past and future events, particularly in terms of any injuries, deaths, shelter needs, pipe freeze incidents, and other impacts. These data will help to identify any concerns or trends for which mitigation measures should be developed or refined. In time, quantitative modeling of estimated power outage events may be feasible as data are gathered and improved.

4.3.16 Wildfire

This section provides a profile and vulnerability assessment of the wildfire hazard in Armstrong County.

A wildfire is an uncontrolled fire spreading 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. A wildland fire is a wildfire in an area where development is essentially nonexistent, except for roads, railroads, power lines, and similar facilities. A wildland-urban interface (WUI) fire is a wildfire in a geographical area where structures and other human development meet or intermingle with wildland or vegetative fuels.

Wildfires can occur at any time of the year but are most likely in Armstrong County during a drought, and can occur in fields, grass, and brush as well as in the forest itself. Under dry conditions or drought, wildfires have the potential to burn forests as well as croplands. Any small fire in a wooded area, if not quickly detected and suppressed, has the potential to burn out of control. Most wildfires, approximately 98-percent, in Pennsylvania are caused by human carelessness, negligence, and ignorance. However, some are precipitated by lightning strikes and in rare instances, spontaneous combustion. The greatest danger of wildfires in Pennsylvania is during the spring months of March, April, and May and the autumn months of October and November (Pennsylvania Department of Conservation and Natural Resources [DCNR] 2018).

There are three elements needed for a fire to occur:

- Fuel – any kind of combustible material; something which will burn (e.g., vegetation, houses, paper, etc.)
- Heat – a heat source is responsible for the initial ignition of the fire, and allows fire to spread by drying out and preheating nearby fuel (e.g., match, spark from a machine, or lightning)
- Oxygen – air contains about 21 percent oxygen and most fires require at least 16 percent to burn (Smokey Bear 2018; U.S. Bureau of Land Management 2018; DCNR 2018)

Fuel and dry conditions occur most frequently in Pennsylvania during the spring and autumn. During the spring, days become longer and warmer. The trees are bare during this time allowing the sunlight to reach the forest floor, warming the ground and drying last fall's leaves. This, combined with the fact that spring winds are often strong and dry, leads to a large amount of fuel ready to burn. In autumn, the leaves turn color and being to fall, accumulating in a deep layer that creates a fire hazard. A heat or ignition source occurs during these periods (DCNR 2018).

DCNR's Bureau of Forestry (BOF) is responsible for protecting Pennsylvania's 17 million acres of public and private wildlands from wildfire. The Bureau works with fire wardens and volunteer fire departments to promote the latest advances in fire prevention and suppression (DCNR 2018).

4.3.16.1 Location and Extent

Wildfires take place in less developed or completely undeveloped areas, spreading rapidly through vegetative fuels. They can occur any time of the year, but mostly occur during long, dry, hot spells. Any small fire can get out of control if not quickly detected and suppressed. 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 open fields, grass, dense brush, and forests.

Wildfires can occur at any time of the year but are most likely in Armstrong County during a drought, and can occur in fields, grass, and brush as well as in the forest itself. Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands. Approximately 21.4 percent of the County is agricultural land, and 66.6 percent is classified as forested. Armstrong County is part of Forest District 8: Clear Creek. Table 4.3.16-1 summarizes land use in Armstrong County.

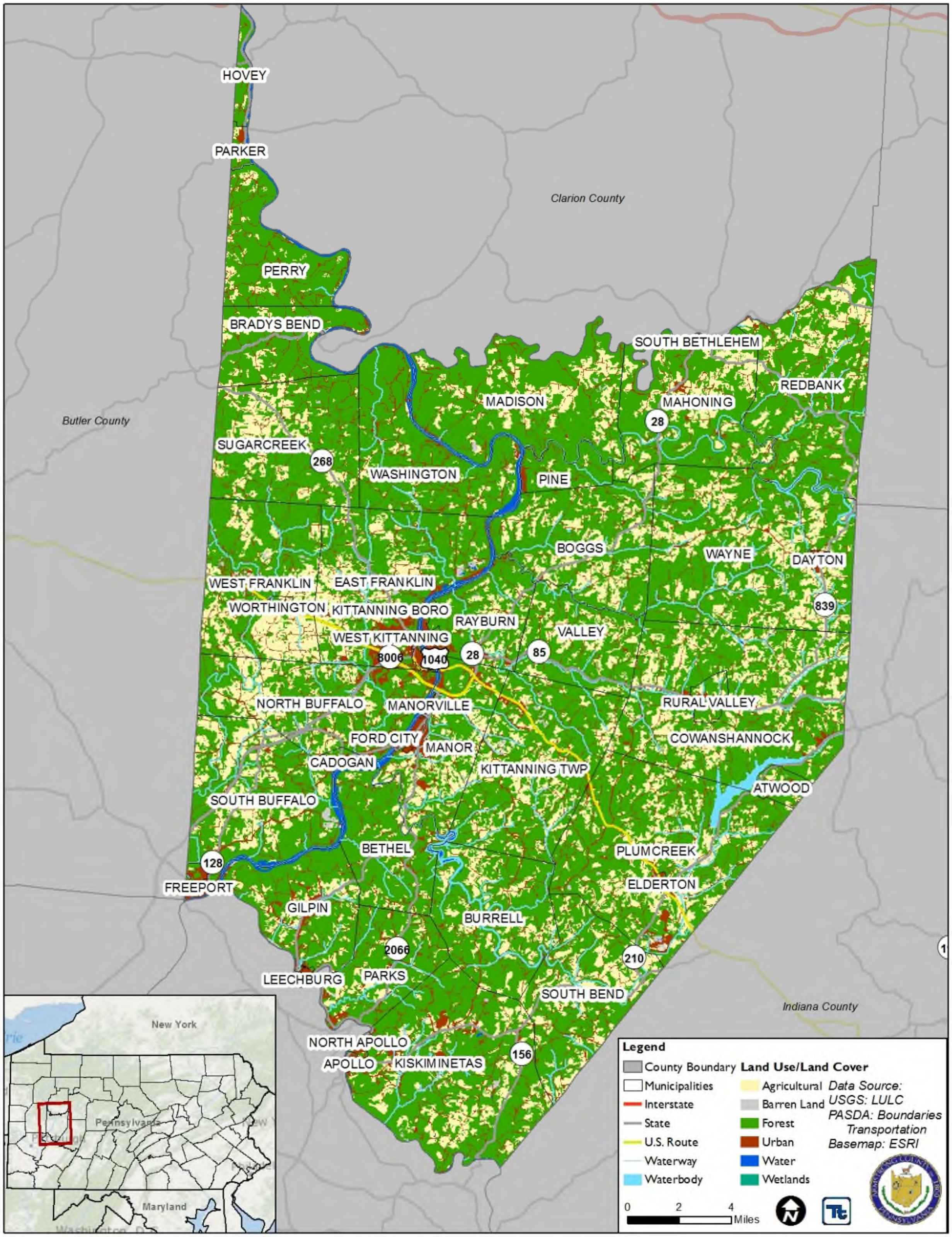
Table 4.3.16-1. Land Use Summary for Armstrong County

Land Use Category	Total Area (square miles)	Percent of Total
Agricultural	142.4	21.4%
Barren Land	3.2	<1%
Forest	443.5	66.6%
Urban	12.9	9.5%
Water	0.2	1.9%
Wetland	665.4	<1%
Total	**142.4**	**100.0%**

Source: U.S. Geological Survey (USGS) 2011

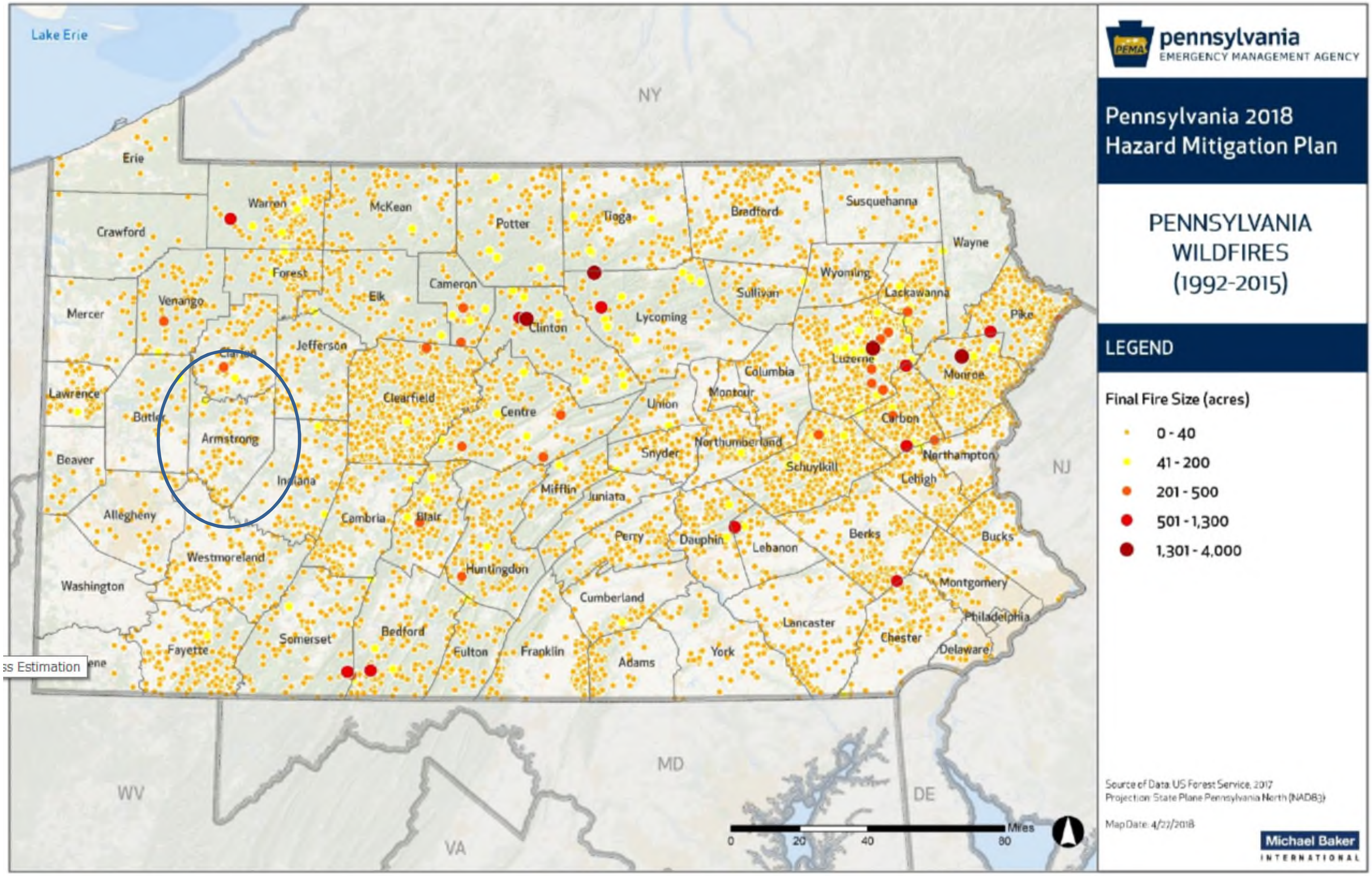
Figure 4.3.16-1 illustrates the land cover across Armstrong County. As the figure shows, forested areas are the largest land use in Armstrong County. Figure 4.3.16-2 shows the locations of wildfires throughout Pennsylvania between 1992 and 2015 as compiled by researchers at the U.S. Forest Service. The wildfire records were acquired from the reporting systems of federal, state, and local fire organizations. These data, and all the wildfire data in this section, represent the best-available data for wildfire hazards. Wildfires 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 5,000 to 10,000 wildfires occur annually in Pennsylvania. Armstrong County had 83 wildfires that burned over 274 acres (Pennsylvania Emergency Management Agency [PEMA] 2018).

Figure 4.3.16-1. Land Cover in Armstrong County



Source: USGS – National Land Cover Database (NLCD) 2011

Figure 4.3.16-2. Pennsylvania Wildfires, 1992-2015



Source: PEMA 2018

Note: Blue oval was added to highlight Armstrong County's location within Pennsylvania.

Several tools are available to estimate the potential location and extent of a fire, including (but not limited to) the Wildland/Urban Interface, Wildland Fire Assessment System, and DCNR Priority Landscape Analysis. These tools are discussed in further detail below.

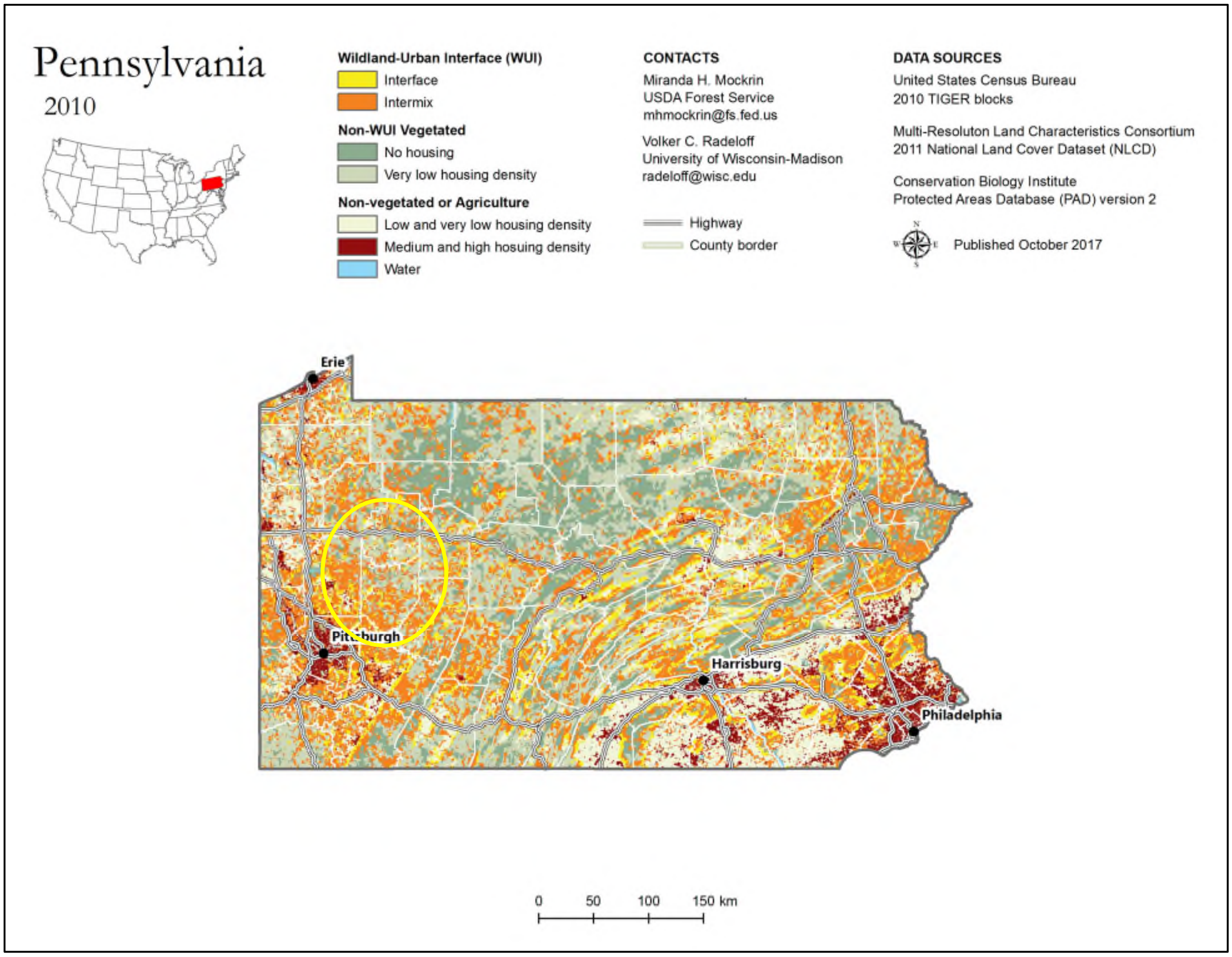
Wildland/Urban Interface (WUI)

The WUI is the area where houses and wildland vegetation coincide. The WUI is divided into two categories: intermix and interface. Intermix WUI areas are areas where housing and vegetation "intermingle." Intermix areas have more than one house per 40 acres and have more than 50 percent vegetation. Interface WUI areas are areas with housing in the vicinity of contiguous wildland vegetation. Interface areas have more than one house per 40 acres, have less than 50 percent vegetation, and are within 1.5 miles of an area larger than 1,235 acres that is more than 75 percent vegetated (Stewart et al. 2005).

The California Fire Alliance determined that areas within 1.5 miles of wildland vegetation are the approximate distance that firebrands can be carried from a wildland fire to the roof of a house. Therefore, even structures not located within the forest are at risk from wildfire. This buffer distance, along with housing density and vegetation type, were used to define the WUI (Stewart et al. 2005).

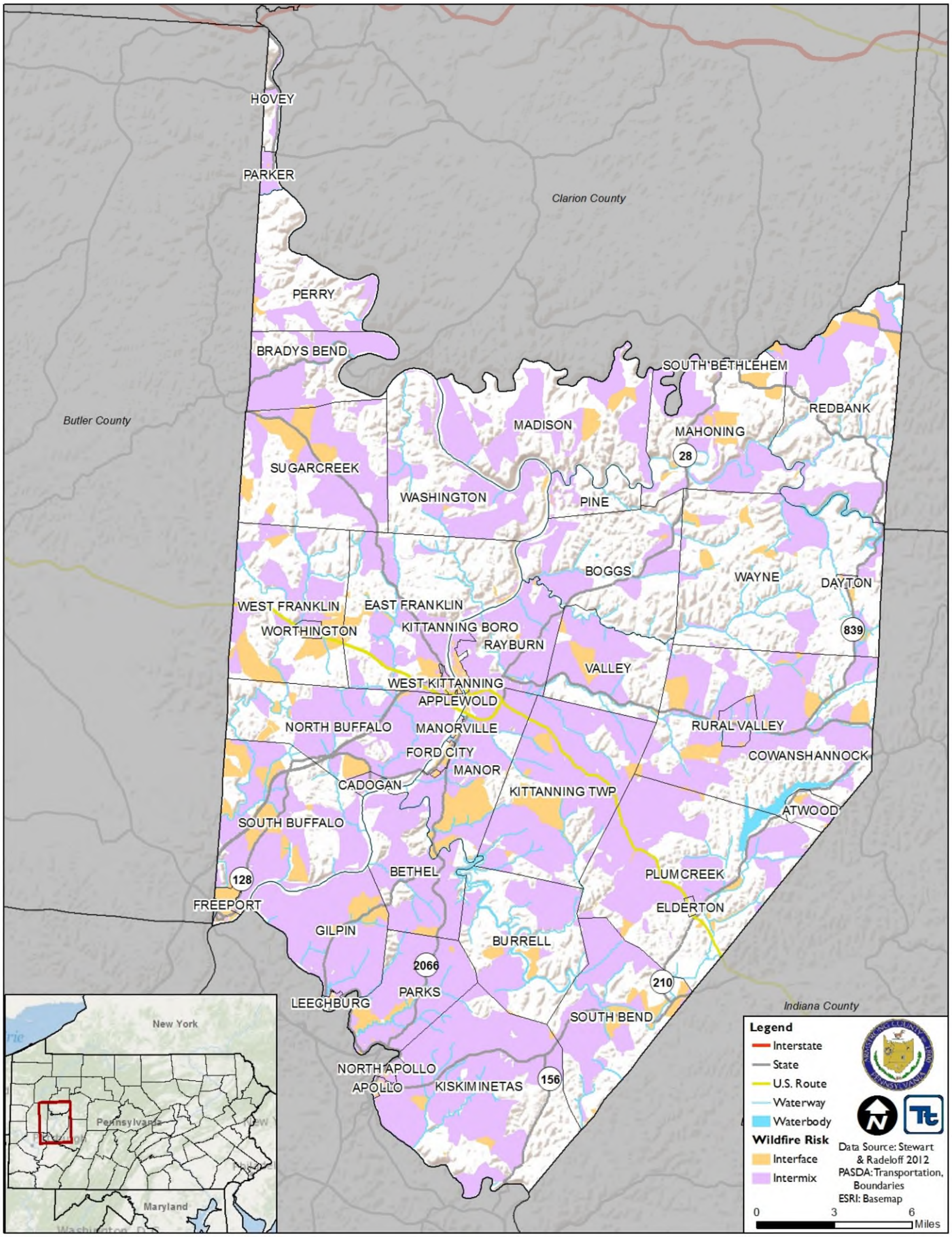
Concentrations of WUI can be seen along the east coast of the United States, including the south-central part of Pennsylvania. Armstrong County is identified as having many areas of very low-density housing (or no housing) due to the large amount of forested area. Figure 4.3.16-3 depicts the WUI areas for Pennsylvania in 2010, and Figure 4.3.16-4 illustrates the WUI areas for Armstrong County. Concentrations of WUI areas greater than 50 percent are classified as WUI (intermix or interface) in the County.

Figure 4.3.16-3. 2010 WUI for Pennsylvania



Source: SILVIS Lab 2010
Note: Yellow oval highlights Armstrong County's location within Pennsylvania.

Figure 4.3.16-4. WUI for Armstrong County



Source: Stewart and Radeloff 2012

Wildland Fire Assessment System (WFAS)

The Wildland Fire Assessment System (WFAS) is an Internet-based information system maintained at the National Interagency Fire Center (NIFC) in Boise, Idaho. The WFAS provides a national view of weather and fire potential, including national fire danger, weather maps, and satellite-derived "Greenness" maps (U.S. Forest Service [USFS] 2016). Each day during the fire season, national maps of selected fire weather and fire danger components of the National Fire Danger Rating System (NFDRS) are produced by the WFAS (WFAS 2012). The Fire Danger Rating level, described in Table 4.3.16-2 below, takes into account current and antecedent weather, fuel types, and moisture amounts for both live and dead vegetative fuel. The adjective class rating is a method of normalizing rating classes across different fuel models, indexes, and station locations. It is based primarily on a fuel model cataloged for the station, the fire danger index selected to reflect staffing levels, and climatological class breakpoints. Local station managers provide this information to USFS (USFS 2012).

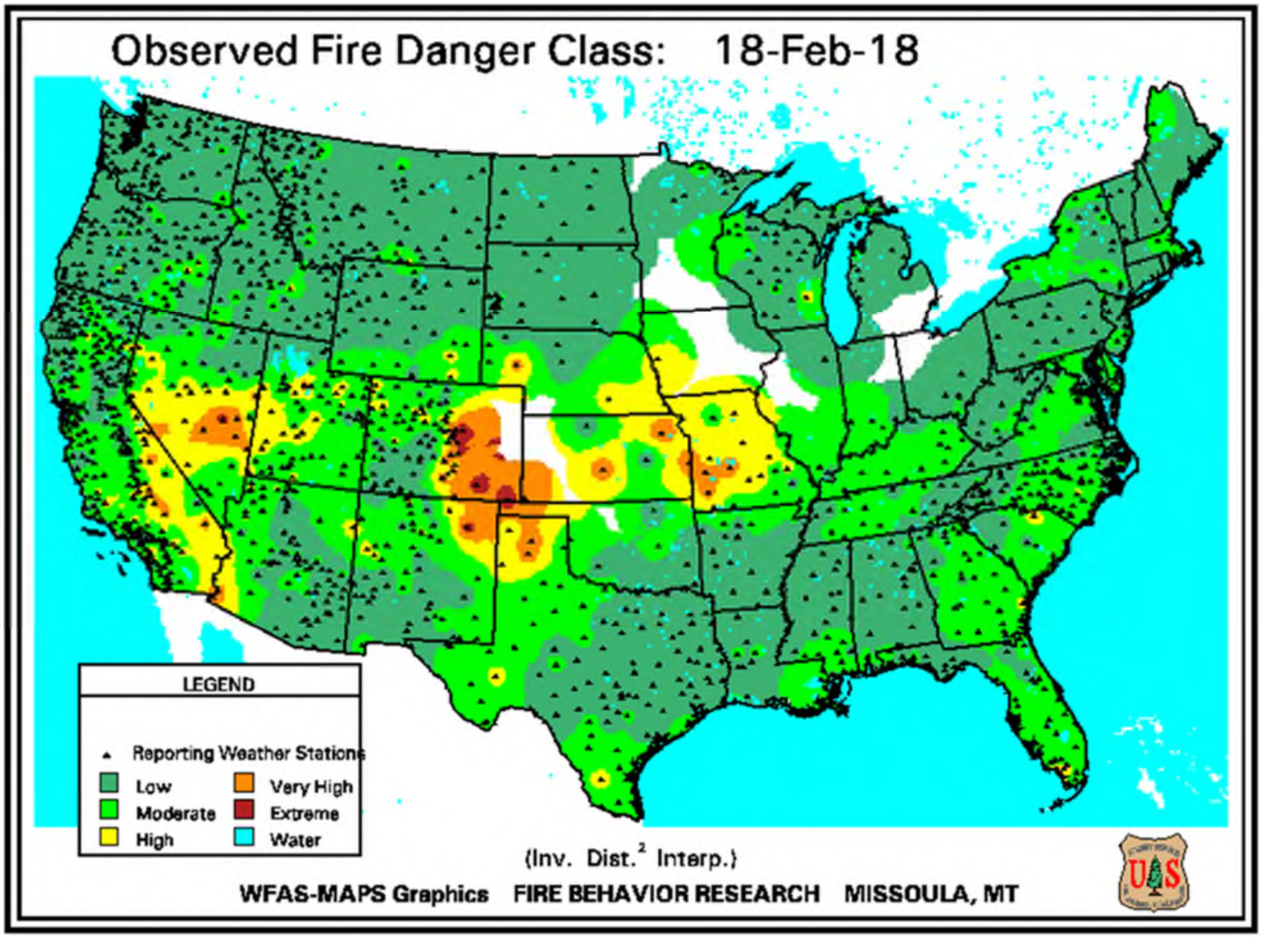
Table 4.3.16-2. Fire Danger Rating and Color Code

Fire Danger Rating and Color Code	Description
Low (L) (Dark Green)	Fuels do not ignite readily from small firebrands, although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open-cured grasslands may burn freely a few hours after rain, but woods fires spread slowly by creeping or smoldering and burning in irregular fingers. There is little danger of spotting.
Moderate (M) (Light Green or Blue)	Fires can start from most accidental causes but, with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open-cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
High (H) (Yellow)	All fine dead fuels ignite readily, and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly, and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while they are small.
Very High (VH) (Orange)	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high-intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.
Extreme (E) (Red)	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high-intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash (trunks, branches, and tree tops) or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions, the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Source: USFS 2012

The adjective class rating is a method of normalizing rating classes across different fuel models, indexes, and station locations. It is based on the primary fuel model cataloged for the station, the fire danger index selected to reflect staffing levels, and climatological class breakpoints. This information is provided by local station managers. About 90 percent use the Burning Index (BI); others use Energy Release Component (ERC). Staffing class breakpoints are set by local managers from historical fire weather climatology (USFS-WFAS 2018). Figure 4.3.16-5 illustrates an example of an observed fire danger map for February 18, 2018.

Figure 4.3.16-5. Observed Fire Danger Map (February 18, 2018)



Source: USFS 2018
Note: Dark Green (low), Light Green (moderate), Yellow (high), Orange (very high), Red (extreme)

Pennsylvania Department of Conservation and Natural Resources (DCNR) Priority Landscape Analysis

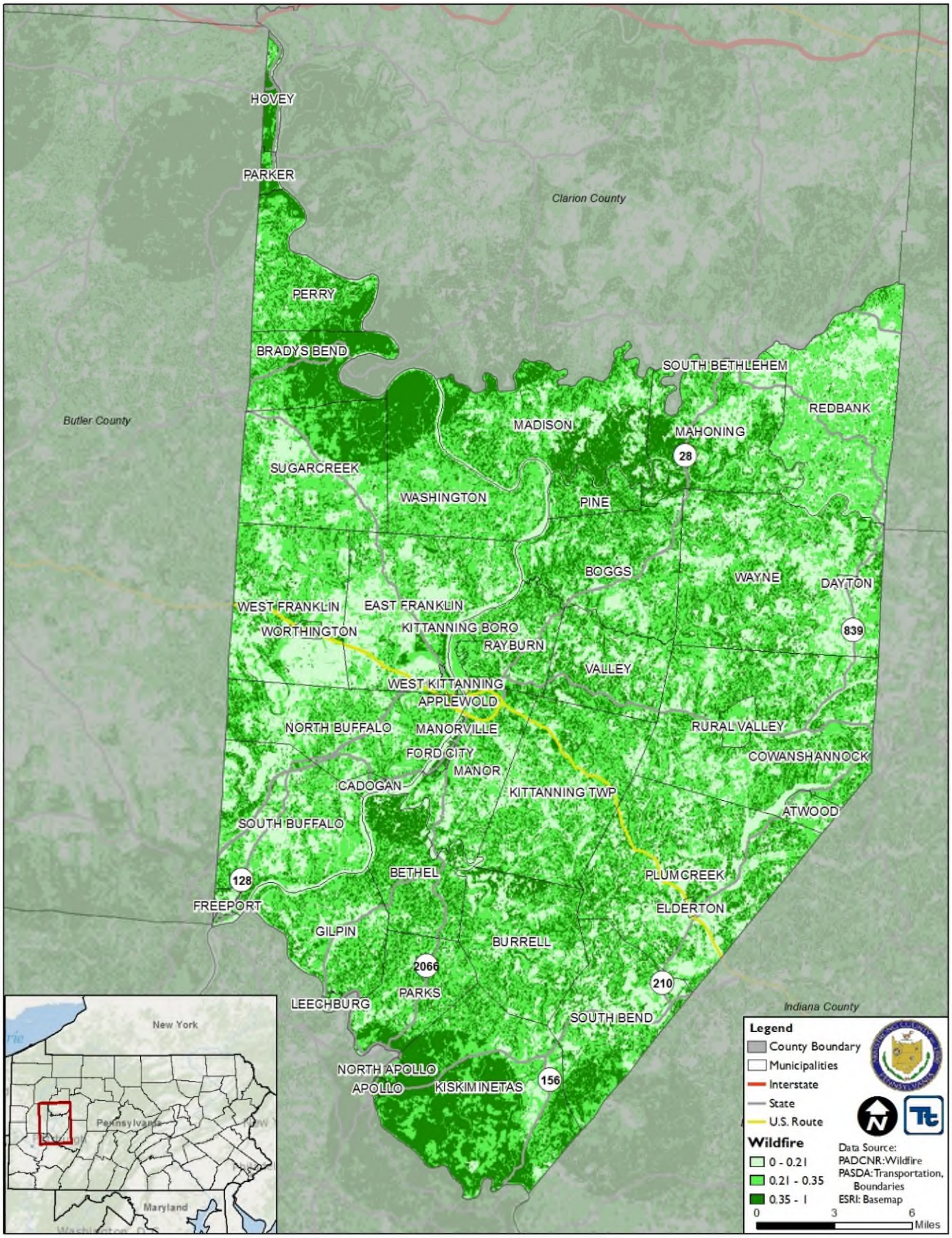
DCNR conducted a wildfire priority landscape analysis identifying areas where wildland fires are predicted to occur and become problematic. The areas are classified into high, medium, and low categories. The high classification is defined as an area prone to extreme fire behavior, with the potential to cause extensive property damage, or that could threaten the safety of the Commonwealth's citizens. The following five data sets were used for this analysis:

- 2002 WUI
- 2006 LANDFIRE
- 2002 – 2008 Pennsylvania Wildfire Point Origin Occurrences
- Percent Slope
- 2009 Local Assessment of Values, Risks, Hazards.

The WUI classifies areas where homes and other human development meet or intermingle with undeveloped land. LANDFIRE characterizes the land's vegetation into fuel models that predict various fire behavior intensities. The Pennsylvania wildfire Point Origin Occurrences consist of records of wildland fire origins that have been reported. Percent slope aids in predicting fire behavior from the terrain. The local assessment of values, risks, and hazards is a municipality-based rating system; this assessment has been made by local wildland fire managers (DCNR Date Unknown). Figure 4.3.16-6 illustrates the output for the wildfire priority landscapes model for Armstrong County.

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 (PEMA 2018).

Figure 4.3.16-6. Wildfire Priority Landscapes in Armstrong County



Source: DCNR Date Unknown

Notes: Low Priority = 0–0.21 (light green); Medium Priority = 0.21–0.35 (medium green); High Priority = 0.35–1 (dark green)

4.3.16.2 Range of Magnitude

Wildfire events in Armstrong County can range from small fires that can be managed by local firefighters to large fires burning 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; and to destroy property, valuable timber, forage, and recreational and scenic resources.

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 include 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 (PEMA 2018).

While some fires are not human-caused and are part of natural succession processes, a wildfire can kill people, livestock, fish, and wildlife. They often destroy property, valuable timber, forage, and recreational and scenic values. 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. Wildfire can also have a positive environmental impact in that they burn dead trees, leaves, and grasses to allow more open spaces for new vegetation to grow and receive sunlight. Another positive effect is that it stimulates the growth of new shoots on trees and shrubs and its heat can open pine cones and other seed pods.

The worst-case scenario for Armstrong County would occur if an uncontrolled wildfire spread across the northeastern or southwestern region of the County, specifically within Dayton Borough where 100 percent of the population is located in the WUI hazard area, or Gilpin Township where 100 percent of the population is located in the WUI. Additionally, in Cadogan Township, all structures in the Township, valued at $65.2 million, are exposed to the wildfire hazard. The Vulnerability Assessment portion of this section includes details regarding exposure and losses of the wildfire hazard in Armstrong County.

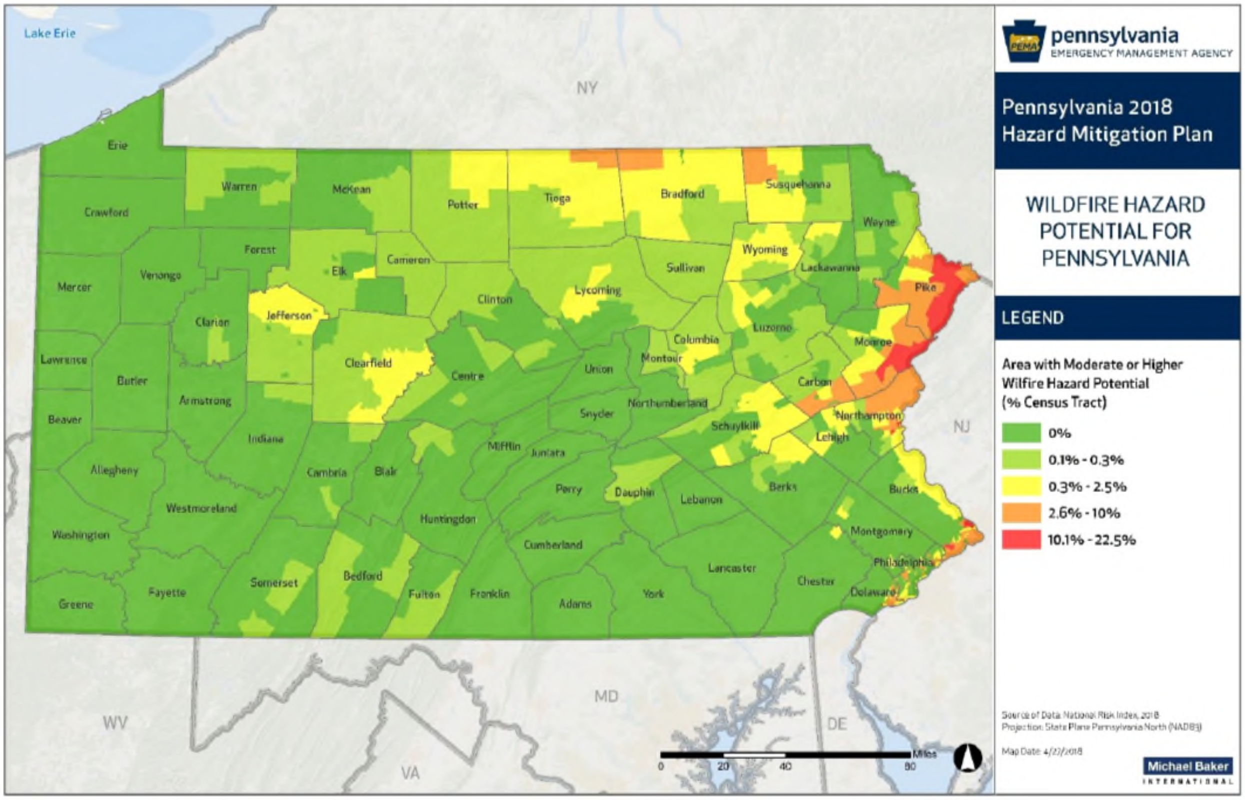
4.3.16.3 Past Occurrence

From 1992 to 2015, 83 wildfires burned 274 acres in Armstrong County; however, this number does not include wildfires that were not reported to DCNR or U.S. Forest Service, or events that were controlled solely by the volunteer fire departments in Armstrong County (PEMA 2018). Details regarding these events were not available at the time of this plan update. Between 1954 and 2017, the State of Pennsylvania has not experienced any Federal Emergency Management Agency (FEMA)-declared major disasters or emergencies related to wildfires.

4.3.16.4 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 4.3.16-7 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 (PEMA 2018). Figure 4.3.16-7 figure shows that the entire Armstrong County is not located within an area of moderate or higher wildfire hazard potential.

Figure 4.3.16-7. Wildfire Hazard Potential for Pennsylvania



Source: PEMA 2018

In Pennsylvania, wildfire events will continue to occur each year. 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 (PEMA 2018).

Based on available historical data, the future occurrence of wildfires in Armstrong County can be considered *highly likely* as defined by the Risk Factor Methodology probability criteria (described in Section 4.4). However, the overall probability of wildfires in Armstrong County is low based on the low probability of wildfires attaining significant size and intensity in the County. It should be noted that weather conditions, particularly droughts, can increase the likelihood of wildfires occurring. Any fire, without the quick response or attention of firefighters, forestry personnel, or visitors to the forest, has the potential to become a wildfire.

4.3.16.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed and vulnerable in the identified hazard area. This section evaluates and estimates the potential impact of the wildfire hazard on the County in the following sections:

- Overview of vulnerability

- Data and methodology used for the evaluation
- Impact on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) economy; and (5) future growth and development
- Effects of climate change on vulnerability
- Further data collections that will assist understanding this hazard over time.

Overview of Vulnerability

Wildfire hazards can impact significant areas of land, as evidenced by wildfires throughout the United States in recent years. Fires in urban areas have the potential to cause great damage to infrastructure, contribute to loss of life, and place severe strain on lifelines and emergency responders because of the high density of population and structures that can be affected in these areas. Wildfires, however, can spread quickly, become a huge fire complex consisting of thousands of acres, and present greater challenges for allocating resources, defending isolated structures, and coordinating multi-jurisdictional response.

Data and Methodology

Information regarding the wildfire hazard included input and data from DCNR, the University of Wisconsin-Madison, and the Steering Committee. The WUI (interface and intermix) data, obtained through the SILVIS Lab, Department of Forest Ecology and Management, University of Wisconsin-Madison, defines the wildfire hazard area. The asset data (population, building stock, and critical facilities) presented in the County Profile (Section 2) was used to support an evaluation of assets exposed and the potential impacts and losses associated with this hazard. Available and appropriate geographic information system (GIS) data were overlaid on the hazard area to identify which assets are exposed to wildfire. The limitations of this analysis are recognized, and, as such, the analysis is used only to provide a general estimate.

Impact on Life, Health, and Safety

As demonstrated by historical wildfire events, potential losses include human health and life of residents and responders. The most vulnerable populations include emergency responders and those within a short distance of the interface between the built environment and the wildland environment.

Data regarding County land within the WUI was overlaid on the 2010 Census population data to estimate the Armstrong County population vulnerable to the wildfire hazard (U.S. Census 2010). The census blocks with their center within the hazard area were used to calculate the estimated population exposed to the wildfire hazard. Table 4.3.16-3 summarizes the estimated population exposed by municipality.

Table 4.3.16-3. Estimated Population Located within the WUI in Armstrong County

Municipality	U.S. Census 2010 Population	Estimated Population Exposed	Percent of Total
Apollo (B)	1,647	1,633	99.1%
Applewood (B)	310	285	91.9%
Atwood (B)	107	83	77.6%
Bethel (T)	1,183	1,101	93.1%
Boggs (T)	936	448	47.9%
Bradys Bend (T)	773	610	78.9%
Burrell (T)	689	379	55.0%
Cadogan (T)	344	344	100.0%

Municipality	U.S. Census 2010 Population	Estimated Population Exposed	Percent of Total
Cowanshannock (T)	2,899	2,410	83.1%
Dayton (B)	553	559	101.1%
East Franklin (T)	4,082	2,758	67.6%
Elderton (B)	356	20	5.6%
Ford City (B)	2,991	2,980	99.6%
Ford Cliff (B)	371	371	100.0%
Freeport (B)	1,813	1,662	91.7%
Gilpin (T)	2,496	2,496	100.0%
Hovey (T)	97	63	64.9%
Kiskiminetas (T)	4,800	4,268	88.9%
Kittanning (B)	4,044	4,021	99.4%
Kittanning (T)	2,265	1,973	87.1%
Leechburg (B)	2,156	2,152	99.8%
Madison (T)	820	593	72.3%
Mahoning (T)	1,425	992	69.6%
Manor (T)	4,227	4,131	97.7%
Manorville (B)	410	410	100.0%
North Apollo (B)	1,297	1,271	98.0%
North Buffalo (T)	3,011	2,592	86.1%
Parker (C)	840	840	100.0%
Parks (T)	2,744	2,729	99.5%
Perry (T)	352	218	61.9%
Pine (T)	412	397	96.4%
Plumcreek (T)	2,375	1,832	77.1%
Rayburn (T)	1,907	1,850	97.0%
Redbank (T)	1,064	692	65.0%
Rural Valley (T)	876	864	98.6%
South Bend (T)	1,167	994	85.2%
South Bethlehem (B)	481	481	100.0%
South Buffalo (T)	2,636	2,227	84.5%
Sugarcreek (T)	1,539	1,304	84.7%
Valley (T)	656	558	85.1%
Washington (T)	923	704	76.3%
Wayne (T)	1,200	466	38.8%
West Franklin (T)	1,853	1,808	97.6%
West Kittanning (B)	1,175	812	69.1%
Worthington (B)	639	639	100.0%
Armstrong County	**68,941**	**60,020**	**87.1%**

Source: U.S. Census 2010, Stewart and Radeloff 2012
Note:
WUI Wildland-Urban Interface

Impact on General Building Stock

The most vulnerable structures to wildfire events are those within the WUI areas. Buildings constructed of wood or vinyl siding are generally more likely to be damaged by fire than buildings constructed of brick or concrete. The WUI was overlaid on the default building inventory in Hazards U.S. – Multi-Hazard (HAZUS-MH) to estimate the replacement cost of buildings located in the hazard area. Similarly, the County-provided spatial layer of buildings was used to estimate number of structures located in the hazard area and considered exposed to the wildfire hazard in Armstrong County. The replacement cost value (RCV) of the census blocks with their center in the WUI was totaled. Table 4.3.16-4 summarizes the estimated building stock inventory exposed by municipality.

Table 4.3.16-4. Building Stock Replacement Value and Structures Located within the WUI in Armstrong County

Municipality	Total Number of Buildings	Total RCV	WUI Hazard Area			
			Number of Buildings	% of Total	RCV	% of Total
Apollo Borough	734	$251,670,000	702	95.6%	$236,356,000	93.9%
Applewold Borough	139	$74,252,000	135	97.1%	$70,930,000	95.5%
Atwood Borough	51	$10,050,000	36	70.6%	$7,651,000	76.1%
Bethel Township	684	$128,949,000	627	91.7%	$121,676,000	94.4%
Boggs Township	458	$76,331,000	227	49.6%	$39,010,000	51.1%
Bradys Bend Township	610	$131,764,000	495	81.1%	$98,773,000	75.0%
Burrell Township	358	$73,172,000	217	60.6%	$42,802,000	58.5%
Cadogan Township	192	$65,238,000	192	100.0%	$65,238,000	100.0%
Cowanshannock Township	1,328	$303,507,000	1,080	81.3%	$258,938,000	85.3%
Dayton Borough	274	$84,832,000	267	97.4%	$78,594,000	92.6%
East Franklin Township	1,804	$1,027,803,000	1,262	70.0%	$434,754,000	42.3%
Elderton Borough	174	$75,474,000	29	16.7%	$2,251,000	3.0%
Ford City Borough	1,353	$538,129,000	1,323	97.8%	$506,922,000	94.2%
Ford Cliff Borough	182	$42,367,000	177	97.3%	$42,367,000	100.0%
Freeport Borough	601	$314,661,000	596	99.2%	$272,283,000	86.5%
Gilpin Township	1,435	$375,439,000	1,375	95.8%	$357,781,000	95.3%
Hovey Township	98	$25,518,000	89	90.8%	$7,952,000	31.2%
Kiskiminetas Township	2,269	$529,524,000	2,127	93.7%	$466,436,000	88.1%
Kittanning Borough	1,610	$933,567,000	1,523	94.6%	$815,104,000	87.3%
Kittanning Township	969	$224,824,000	884	91.2%	$170,690,000	75.9%
Leechburg Borough	1,026	$490,357,000	996	97.1%	$484,503,000	98.8%
Madison Township	584	$176,372,000	481	82.4%	$130,937,000	74.2%
Mahoning Township	703	$155,073,000	561	79.8%	$99,685,000	64.3%
Manor Township	2013	$578,870,000	1,961	97.4%	$573,656,000	99.1%
Manorville Borough	166	$40,861,000	161	97.0%	$40,765,000	99.8%
North Apollo Borough	652	$163,435,000	636	97.5%	$160,578,000	98.3%

Municipality	Total Number of Buildings	Total RCV	WUI Hazard Area			
			Number of Buildings	% of Total	RCV	% of Total
North Buffalo Township	1,333	$364,294,000	1,169	87.7%	$321,864,000	88.4%
Parker City	375	$83,797,000	367	97.9%	$82,321,000	98.2%
Parks Township	1,249	$502,517,000	1,226	98.2%	$494,092,000	98.3%
Perry Township	280	$72,571,000	183	65.4%	$48,078,000	66.2%
Pine Township	282	$51,655,000	249	88.3%	$45,906,000	88.9%
Plumcreek Township	994	$219,089,000	691	69.5%	$163,714,000	74.7%
Rayburn Township	800	$225,689,000	762	95.3%	$200,631,000	88.9%
Redbank Township	536	$211,247,000	357	66.6%	$100,452,000	47.6%
Rural Valley Borough	409	$154,259,000	405	99.0%	$153,132,000	99.3%
South Bend Township	522	$116,754,000	422	80.8%	$81,568,000	69.9%
South Bethlehem Borough	213	$132,137,000	209	98.1%	$132,137,000	100.0%
South Buffalo Township	1,264	$454,112,000	1,040	82.3%	$360,931,000	79.5%
Sugarcreek Township	617	$190,498,000	521	84.4%	$134,925,000	70.8%
Valley Township	322	$88,371,000	272	84.5%	$62,165,000	70.3%
Washington Township	729	$111,171,000	576	79.0%	$86,930,000	78.2%
Wayne Township	537	$108,168,000	214	39.9%	$45,244,000	41.8%
West Franklin Township	878	$347,597,000	682	77.7%	$163,650,000	47.1%
West Kittanning Borough	593	$412,394,000	569	96.0%	$399,202,000	96.8%
Worthington Borough	314	$144,717,000	304	96.8%	$71,522,000	49.4%
Armstrong County (Total)	**32,714**	**$10,883,076,000**	**28,377**	**86.7%**	**$8,735,096,000**	**80.3%**

Source: HAZUS-MH 4.2; Stewart and Radeloff 2012; Armstrong County 2018
Notes:
RCV Replacement cost value
WUI Wildland-Urban Interface

Impact on Critical Facilities

A number of critical facilities are located in the wildfire hazard area and are also potentially vulnerable to the threat of wildfire. Many of these facilities are also the locations with vulnerable populations (schools) and responding agencies to wildfire events (fire and police). Table 4.3.16-5 summarizes the number of critical facilities identified by the County plan participants that are located within the wildfire hazard area.

Table 4.3.16-5. Number of Critical Facilities in the WUI in Armstrong County

Municipality	Facility Types																													
	Airport	Armory	Bus	Bus Facility	Child Care	Communication Facility	Community Services	Correctional	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Oil Facility	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
Apollo (B)	0	0	0	0	2	1	0	0	0	1	0	0	0	1	1	0	1	0	0	0	0	0	1	0	1	0	0	0	1	0	0
Applewold (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atwood (B)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Bethel (T)	0	0	0	0	0	1	0	0	0	2	0	0	0	0	0	0	0	0	1	4	0	0	0	0	1	0	0	0	5	0	0
Bradys Bend (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0
Burrell (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Cadogan (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Cowanshannock (T)	0	0	0	0	1	1	0	0	0	1	0	0	1	0	0	0	0	0	1	2	0	0	0	0	2	3	0	0	4	1	0
Dayton (B)	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	1	0
East Franklin (T)	0	0	0	0	4	0	0	0	0	0	1	0	0	1	1	0	0	1	1	24	0	1	1	0	3	0	1	0	29	1	0
Elderton (B)	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
Ford City (B)	0	0	0	0	4	0	0	0	0	1	0	1	0	1	2	0	1	0	1	0	0	0	0	0	4	0	1	0	3	2	0
Ford Cliff (B)	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Freeport (B)	0	0	0	0	1	0	0	0	0	1	0	1	0	1	0	0	1	0	1	0	0	0	1	0	2	0	1	0	4	0	1
Gilpin (T)	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	1	7	0	0	1	1	2	1	1	0	12	0	0
Hovey (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Kiskiminetas (T)	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	0	0	1	0	3	1	0	0	3	4	0
Kittanning (B)	0	0	0	0	3	1	0	0	0	1	0	1	0	3	3	1	1	0	1	0	1	0	1	1	4	1	0	1	1	0	0
Kittanning (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	2	0	2	0	0	1	0	1	0	9	0	0
Leechburg (B)	0	0	0	0	0	1	0	0	0	2	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	2	0
Madison (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
Mahoning (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	1	3	0	0	0	0	1	0	0	0	4	1	1
Manor (T)	0	1	0	0	0	0	0	0	0	1	0	0	1	1	2	0	0	0	1	6	0	0	1	1	3	1	1	0	12	5	2

Municipality	Facility Types																													
	Airport	Armory	Bus	Bus Facility	Child Care	Communication Facility	Community Services	Correctional	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Oil Facility	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
Manorville (B)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0
North Apollo (B)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
North Apollo (T)	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
North Buffalo (T)	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	1	55	0	0	1	1	2	0	0	0	56	0	0
Parker (C)	0	0	0	0	0	1	0	0	0	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	2	0	1	0	3	0	1
Parks (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	0	0	1	0	3	0	1	0	2	0	0
Pine (T)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Plumcreek (T)	0	0	0	0	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	1	0	5	0	0
Rayburn (T)	0	0	0	1	1	0	1	1	0	1	0	0	3	2	0	0	0	1	1	1	0	0	1	1	1	0	2	1	8	0	0
Redbank (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	1	0	3	0	0
Rural Valley (B)	0	0	0	0	2	0	0	0	0	1	1	0	0	1	0	0	0	0	1	0	0	0	1	0	1	1	1	0	2	1	0
South Bend (T)	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	7	0	0	0	0	1	0	0	0	9	0	0
South Bethlehem (B)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
South Buffalo (T)	1	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	1	7	0	0	1	0	2	0	0	0	10	1	0
Sugarcreek (T)	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	1	0	1	1	0	0	0	0	1	1	0	0	0	1	1	0
Valley (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	2	0	0	1	0	0	0	4	0	0
Washington (T)	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	3	0	0	0	0	1	0	0	0	3	0	0
Wayne (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
West Franklin (T)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	0	1	0	6	0	0
West Kittanning (B)	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0
West Kittanning (T)	0	0	0	0	4	0	0	0	0	0	0	0	0	1	1	0	0	0	0	4	0	0	1	0	0	0	1	0	4	1	0
Worthington (B)	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0

Municipality	Facility Types																															
	Airport	Armory	Bus	Bus Facility	Child Care	Communication Facility	Community Services	Correctional	Dam	DPW	Electric Power Facility	EMS	EOC	Fire Department	Group Homes	Hospital	Library	Major Employer	Municipal	Natural Gas Facility	Nursing Home	Oil Facility	Police Department	Personal Care Homes	Polling	Post Office	Potable Water Facility	Public Health	SARA	School	Wastewater Facility
Armstrong County	1	1	1	1	26	7	1	1	3	34	6	5	6	27	12	2	6	3	35	129	1	5	14	10	54	13	16	2	205	21	5

Source: Stewart and Radeloff 2012; Armstrong County 2018

Notes:

WUI Wildland-Urban Interface

Impact on the Economy

Wildfire events can have major economic impacts on a community beginning with the initial loss of structures to the subsequent loss of revenue from destroyed businesses, followed by decreases in tourism. Wildfires can also severely damage roads and infrastructure. Portions of U.S. Route US-422 and multiple State Highways (including PA-28, PA-56, PA-58, PA-66, PA-68, PA-128, PA-156, PA-210, PA-268, PA-356, PA-368, PA-536 and PA-839) run through WUI areas. This factor should be considered when determining evacuation routes for Armstrong County residents.

Impact on the Environment

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 (PEMA 2013).

Wildfires can increase the probability of other natural disasters, specifically floods and mudflows. Wildfires, particular large-scale fires, can dramatically alter the terrain and ground conditions, making land already devastated by fire susceptible to floods. Lands impacted by wildfire increase the risk of flooding and mudflow in those areas. Normally, vegetation absorbs rainfall, reducing runoff. However, wildfires leave the ground charred, barren, and unable to absorb water; thus, creating conditions perfect for flash flooding and mudflows. Flood risk in these impacted areas remains significantly higher until vegetation is restored, which can take up to five years after a wildfire (FEMA 2013).

Future Growth and Development

Areas targeted for potential future growth and development in the next 5 to 10 years have been identified across the County at the municipal level. It is anticipated that any new development and new residents in the WUI areas will be exposed to the wildfire hazard.

Effect of Climate Change on Vulnerability

According to USFS, climate change will likely alter the atmospheric patterns that affect fire weather. Changes in fire patterns will, in turn, affect carbon cycling, forest structure, and species composition. Climate change associated with elevated greenhouse gas concentrations may create an atmospheric and fuel environment that is more conducive to large, severe fires (USFS 2011).

Fire interacts with climate and vegetation (fuel) in predictable ways. Understanding the interactions of climate, fire, and vegetation is essential for addressing issues associated with climate change that include:

- Effects on regional circulation and other atmospheric patterns that affect fire weather
- Effects of changing fire regimes on the carbon cycle, forest structure, and species composition, and
- Complications from land-use change, invasive species, and an increasing WUI area (USFS 2011)

It is projected that higher summer temperatures will likely increase the high fire risk by 10 to 30 percent. Fire occurrence and area burned could increase across the United States as a result of the increase of lightning activity; the frequency of surface pressure and associated circulation patterns conducive to surface drying; and fire weather, in general; which are all conducive to severe wildfires. Warmer temperatures will also increase the effects of drought and increase the number of days each year with flammable fuels, thereby extending fire seasons and areas burned (USFS 2011).

Pennsylvania's Department of Environmental Protection (PADEP) was directed by the Climate Change Act (Act 70 of 2008) to initiate a study of the potential impacts of global climate change on the commonwealth. The June 2009 Pennsylvania Climate Impact Assessment's main findings indicated Pennsylvania may be at increased risk for wildfires, but it was unclear as to how large an increase (Shortle and others 2009).

Future changes in fire frequency and severity are difficult to predict. Global and regional climate changes associated with elevated greenhouse gas concentrations could alter large weather patterns, thereby affecting fire-weather conditions that are conducive to extreme fire behavior (USFS 2011).

The climate of Pennsylvania is already changing and will continue to change over the course of this century. Since 1900, temperatures in the northeastern U.S. have increased an average of 1.5°F. The majority of this warming has occurred since 1970. In terms of winter temperatures, the northeastern U.S. has seen an increase in the average temperature by 4 °F since 1970 (Northeast Climate Impacts Assessment [NECIA] 2007). 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 (PEMA 2013).

A gradual change in temperatures will alter the growing environment of many tree species throughout the United States and Pennsylvania, reducing the growth of some trees and increasing the growth of others. Tree growth and regeneration may be affected more by extreme weather events and climatic conditions than by gradual changes in temperature or precipitation. Warmer temperatures may lead to longer dry seasons and multi-year droughts, creating triggers for wildfires, insects, and invasive species. Increased temperature and change in precipitation will also affect fuel moisture during wildfire season and the length of time during while wildfires can burn during a given year (U.S. Department of Agriculture [USDA] 2012). Climate change may also increase the frequency of lightning flashes. A warmer atmosphere holds more moisture which is one of the key items for triggering a lightning strike. Lightning strikes cause approximately half the wildfires in the United States. If the frequency of lightning strikes increases, the potential for wildfires from these strikes also increases (Lee 2014).

Mr. Ronald Neilson of the U.S. Forest Service's Pacific Northwest Research Station stated that climate change may bring a greater wildfire risk not just to the western United States, but to the eastern and southeastern portions of the country as well. It is in the east and southeast where these climate change risks, such as dried out vegetation, heat and drought, will grow most dramatically. Currently, forests typically dry out just as the trees are going dormant for the winter. In the future, however, forests in the east may dry long before the trees have a chance to shut down. An increasing number of eastern woodlands could become prime wildfire fuel with the combination of forests drying out and infestation (Shapley 2007). However, not enough information has been made available to support these studies or theories and too many uncertainties exist in regards to climate change and global warming to claim that wildfires will increase within the eastern United States, without further research.

As stated above, according to the temperature projections for Armstrong County, this area can expect warmer and drier conditions which may increase the frequency and intensity of wildfires. Higher temperatures are expected to increase the amount of moisture that evaporates from land and water. These changes have the potential to lead to more frequent and severe droughts, which, in turn, increases the likelihood of wildfires (U.S. Environmental Protection Agency [EPA] 2014; Northern Arizona University 2012).

Additional Data and Next Steps

As the data and resources become available, a custom building inventory can be generated to capture the construction of structures (such as roofing material, fire detection equipment, and structure age) to further refine the vulnerability analysis. As stated earlier, buildings constructed of wood or vinyl siding are generally more likely to be damaged by the fire hazard than buildings constructed of brick or concrete. The proximity of these building types to the WUI areas should be identified for further evaluation. Development and availability of these data would permit a more detailed estimate of potential vulnerabilities, including loss of life and potential structural damage.

In locations where homes are at risk for wildfires, the BOF's WUI Guidance Document is available to assist homeowners, community associations, local government, and developers in assessing and possibly mitigating the potential dangers of a wildfire. The guidance also provides information for developing an action plan in coordination with local emergency managers. Communities at risk for wildfires can adopt by local ordinance the "International Wildland-Urban Interface Code" of the Uniform Construction Code.

4.3.17 Winter Storm

This section provides a profile and vulnerability assessment of the winter storm hazard for the Armstrong County Hazard Mitigation Plan (HMP).

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 incident 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 seriously impair visibility and disrupt transportation.

The Commonwealth of Pennsylvania has a long history of severe winter weather. Winter storms in Armstrong County may include heavy snow, sleet/freezing rain, ice storms, and blizzards, which are defined below:

- Heavy Snow: According to the National Snow and Ice Data Center (NSIDC), snow is precipitation in the form of ice crystals. It originates in clouds when temperatures are below the freezing point (32 degrees Fahrenheit [°F]), when water vapor in the atmosphere condenses directly into ice without going through the liquid stage. Once an ice crystal has formed, it absorbs and freezes additional water vapor from the surrounding air, growing into snow crystals or snow pellets, which then fall to the earth. Snow falls in different forms, such as snowflakes, snow pellets, or sleet. Snowflakes are clusters of ice crystals that form from a cloud. Snow pellets are opaque ice particles in the atmosphere. They form as ice crystals fall through super-cooled cloud droplets that are below freezing but remain a liquid. The cloud droplets then freeze to the crystals. A heavy snowstorm is defined as a snowstorm with accumulations of 4 inches or more of snow in a 6-hour period, or 6 inches of snow in a 12-hour period (National Weather Service [NWS] 2009).
- Blizzard: A blizzard is a winter snowstorm with sustained or frequent wind gusts of 35 miles per hour (mph) or more, accompanied by falling or blowing snow reducing visibility to or below 0.25 mile. These conditions must be predominant over a 3-hour period to be considered a blizzard. Extremely cold temperatures are often associated with blizzard conditions, but are not a formal part of the definition. The hazard created by the combination of snow, wind, and low visibility significantly increases with temperatures below 20 °F. A severe blizzard is categorized as having temperatures near or below 10 °F, winds exceeding 45 mph, and visibility reduced by snow to near 0 miles. Storm systems powerful enough to cause blizzards usually form when the jet stream dips far to the south, allowing cold air from the north to clash with warm air from the south. Blizzard conditions often develop on the northwest side of an intense storm system. The difference between the lower pressure in the storm and the higher pressure to the west creates a tight pressure gradient, resulting in strong winds and extreme conditions caused by the blowing snow (The Weather Channel 2012).
- Sleet or Freezing Rain: Sleet is made up of drops of rain that freeze into ice as they fall. They are usually smaller than 0.30 inch in diameter (NSIDC 2013). A sleet storm involves significant accumulations of solid pellets which form from the freezing of raindrops or partially melted snowflakes causing slippery surfaces, posing a hazard to pedestrians and motorists (NWS 2009). Freezing rain occurs when rain falls into areas that are below freezing. In order for this to occur, ground level temperatures must be colder than temperatures aloft. Freezing rain can also occur when the air temperature is slightly above freezing but the surface that the rain lands upon is still below freezing from prior cold air temperatures (NWS 2009).
- Ice storm: An ice storm is an event caused by damaging accumulations of ice during freezing rain events. An ice storm involves significant accumulation of rain or drizzle freezing on objects (trees, power lines, roadways, etc.) as it strikes them, causing slippery surfaces and damage from sheer weight of ice accumulations (NWS 2009). Significant ice accumulations are typically 0.25 inch or greater (NWS 2013).

4.3.17.1 Location and Extent

Winter storms are regional incidents. Every county in the Commonwealth is subject to severe winter storms. However, the northern tier and western mountain regions tend to experience more frequent and severe winter storms, leaving Armstrong County more prone to winter storm events than other regions in Pennsylvania. On average, the County receives 21 to 30 inches of snow annually (Pennsylvania Emergency Management Agency [PEMA] 2018).

The magnitude or severity of a severe winter storm depends on several factors including a region's climatological susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, time of occurrence during the day (for example, weekday versus weekend), and time of season. While sleet accumulation is measured and tracked in a method similar to snow events, the extent or severity of freezing rain or an ice storm requires a different and sometimes more challenging process. According to NWS, ice accumulation does not coat the surface of an object evenly, as gravity typically forces rainwater to the underside of an object before it freezes. Wind can also force rainwater downward prior to freezing, resulting in a thicker coating of ice on one side of the object than the other side. Ice mass is then determined by taking the average from the thickest and thinnest portions of ice on the sample used for measurement.

The National Oceanic and Atmospheric Administration's (NOAA) National Centers for Environmental Information (NCEI) produces the Regional Snowfall Index (RSI) for significant snowstorms that impact the eastern two-thirds of the United States. The RSI ranks snowstorm impacts on a scale from Category 1 to 5, which is similar to the Fujita scale for tornadoes or the Saffir-Simpson scale for hurricanes. RSI is based on the spatial extent of the storm, the amount of snowfall, and the combination of the extent and snowfall totals with population (based on the 2000 Census). The NCEI has analyzed and assigned RSI values to over 500 storms since 1900 (NOAA-NCEI 2018). Table 4.3.17-1 lists the five RSI ranking categories.

Table 4.3.17-1. RSI Ranking Categories

Category	Description
1	Notable
2	Significant
3	Major
4	Crippling
5	Extreme

Source: NOAA-NCEI 2018
Note:
RSI Regional Snowfall Index

NWS operates a widespread network of observation systems, such as geostationary satellites, Doppler radars, and automated surface observing systems that feed into the current state-of-the-art numerical computer models to provide a look into future weather, ranging from hours to days. The models are then analyzed by NWS meteorologists who write and disseminate forecasts (NWS 2013). While winter weather is normal during the winter season for Armstrong County, the NWS uses winter weather watches, warnings, and advisories to help people anticipate what to expect in the days and hours prior to an approaching storm.

Table 4.3.17-2. NWS Winter Weather Watches, Warnings, and Advisories

Type	Description
Blizzard Watch	Conditions are favorable for a blizzard event in the next 24 to 72 hours. Sustained wind or frequent gusts greater than 35 mph will accompany falling and/or blowing snow to frequently reduce visibility to less than 0.25 mile for 3 or more hours.

Type	Description
Lake Effect Snow Watch	Conditions are favorable for a lake effect snow event to meet or exceed local lake effect snow warning criteria in the next 24 to 72 hours. Widespread or localized lake induced snow squalls or heavy snow showers which produce snowfall accumulation to 6 or more inches in 12 hours or less or 8 or more inches in 24 hours. Lake effect snow usually develops in narrow bands and impacts a limited area within a county or forecast zone. Lake Effect Snow Watch will only be issued for the 9 northern counties in Western Pennsylvania. Use "mid-point" of snowfall range to trigger a watch (i.e., 5 to 7 inches of snow = watch).
Wind Chill Watch	Conditions are favorable for wind chill temperatures to meet or exceed local wind chill warning criteria in the next 24 to 72 hours. Wind chill temperatures may reach or exceed -25 °F for 3 hours with winds greater than or equal to 5 mph for 3 hours or longer.
Winter Storm Watch	Conditions are favorable for a winter storm event (heavy sleet, heavy snow, ice storm, heavy snow and blowing snow or a combination of events) to meet or exceed local winter storm warning criteria in the next 24 to 72 hours. Criteria for snow is 6 inches or more in 12 hours or less; or 8 inches or more in 24 hours covering at least 50 percent of the zone or encompassing most of the population. Use "mid-point" of snowfall range to trigger a watch (i.e., 5 to 7 inches of snow = watch). Criteria for ice is 0.25 inch or more over at least 50 percent of the zone or encompassing most of the population.
Blizzard Warning	Blizzard event is imminent or expected in the next 12 to 36 hours. Sustained wind or frequent gusts greater than 35 mph will accompany falling and/or blowing snow to frequently reduce visibility to less than 0.25 mile.
Ice Storm Warning	An ice storm event is expected to meet or exceed local ice storm warning criteria in the next 12 to 36 hours. Criteria for ice is 0.25 inch or more over at least 50 percent of the zone or encompassing most of the population.
Lake Effect Snow Warning	A lake effect snow event is expected to meet or exceed local lake effect snow warning criteria in the next 12 to 36 hours. Widespread or localized lake induced snow squalls or heavy snow showers which produce snowfall accumulation to 6 or more inches in 12 hours or less and 8 inches or more in 24 hours. Lake effect snow usually develops in narrow bands and impacts a limited area within a county or forecast zone. Lake Effect Snow Warning will only be issued for the 9 northern counties in Western Pennsylvania. Use "mid-point" of snowfall range to trigger warning (i.e., 5 to 7 inches of snow = warning).
Wind Chill Warning	Wind chill temperatures are expected to meet or exceed local wind chill warning criteria in the next 12 to 36 hours. Wind chill temperatures will reach or exceed -25 °F for 3 hours with winds greater than or equal to 5 mph for 3 hours or longer.
Winter Storm Warning	A winter storm event (heavy sleet, heavy snow, ice storm, heavy snow and blowing snow or a combination of events) is expected to meet or exceed local winter storm warning criteria in the next 12 to 36 hours. Criteria for snow is 6 inches or more in 12 hours or less; or 8 inches or more in 24 hours covering at least 50 percent of the zone or encompassing most of the population. Use "mid-point" of snowfall range to trigger warning (i.e., 5 to 7 inches of snow = warning). Criteria for ice is 0.25 inch or more over at least 50 percent of the zone or encompassing most of the population.
Winter Weather Advisory	A winter storm event (sleet, snow, freezing rain, snow and blowing snow, or a combination of events) is expected to meet or exceed local winter weather advisory criteria in the next 12 to 36 hours but stay below warning criteria. Criteria for snow is 3 inches or more in 12 hours or less covering at least 50 percent of the zone or encompassing most of the population. Use "mid-point" of snowfall range to trigger advisory (i.e., 2 to 4 inches of snow = advisory). Criteria for ice is any ice accumulation up to 0.25 inch over at least 50 percent of the zone or encompassing most of the population.
Freezing Rain Advisory	Any accumulation of freezing rain is expected in the next 12 to 36 hours (but will remain below 0.25 inch) for at least 50 percent of the zone or encompassing most of the population.
Lake Effect Snow Advisory	A lake effect snow event is expected to meet or exceed local lake effect snow advisory criteria in the next 12 to 36 hours. Widespread or localized lake induced snow squalls or heavy snow showers which produce snowfall accumulating to 3 or more inches in 12 hours or less, but remain less than 6 inches. Lake effect snow usually develops in narrow bands and impacts a limited area within a county or forecast zone. Lake Effect Snow Advisory will only be issued for the 9 northern counties in Western Pennsylvania. Use "mid-point" of snowfall range to trigger advisory (i.e., 2 to 4 inches of snow = advisory).
Wind Chill Advisory	Wind chill temperatures are expected to meet or exceed local wind chill advisory criteria in the next 12 to 36 hours. Wind chill temperatures may reach or exceed -10 °F.

Source: NWS 2018

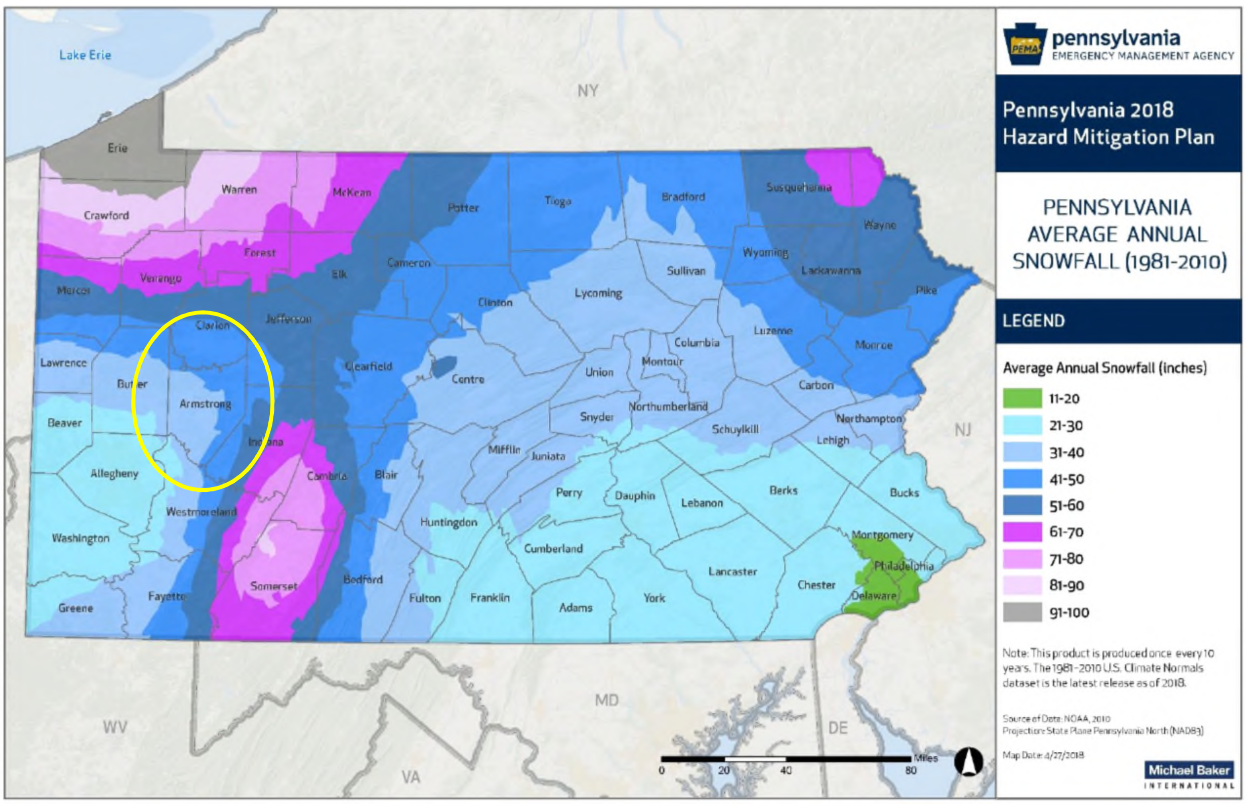
4.3.17.2 Range in Magnitude

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. Because of 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 (PEMA 2018).

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 (PEMA 2018).

Average snowfall across Pennsylvania ranges from 11 inches in the southeast to over 100 inches in the northwest. The snowfall season in the Commonwealth is November through April, and amounts are generally below 1 inch during October and May. Figure 4.3.17-1 illustrates the average annual snowfall for Pennsylvania, and shows Armstrong County as having an annual average of 31 to 50 inches of snow per year.

Figure 4.3.17-1. Pennsylvania Average Annual Snowfall, 1981 to 2010



Source: PEMA 2018

4.3.17.3 Past Occurrence

Many sources provided historical information regarding previous occurrences and losses associated with winter storm events throughout the Commonwealth of Pennsylvania and Armstrong County. With so many sources reviewed for the purpose of this Plan, loss and impact information for many events could vary depending on the source. Therefore, accuracy of monetary figures discussed is based only on available information identified during research for this Plan. Monetary figures may also have been calculated for the region as a whole based on entire storm damage, and include damage from other counties.

FEMA Major Disasters and Emergency Declarations

Between 1954 and September 2018, the Federal Emergency Management Agency (FEMA) included Pennsylvania in eight winter storm-related major disaster (DR) or emergency (EM) declarations classified as one or a combination of the following disaster types: snowstorm, severe snowfall, winter storm, and blizzard. Generally, these types of disasters can cover a wide region of the State; therefore, they may have impacted many counties. Armstrong County was included in four of these declarations (three DR and one EM), which are listed in Table 4.3.17-3.

Table 4.3.17-3. Winter Storm Related Disaster (DR) and Emergency (EM) Declarations, 1954 – September 2018

Declaration	Event Date	Event Description
EM-3105	March 13-17, 1993	Severe Snowfall and Winter Storm
DR-1015	January 4-February 25, 1994	Severe Winter Storms
DR-1085	January 6-12, 1996	Blizzard of 1996
DR-1898	February 5-11, 2010	Severe Winter Storms and Snowstorms

Source: FEMA 2018

Flood Events

Known severe winter weather events, including FEMA disaster declarations, that affected Armstrong County are listed in Table 4.3.17-4. Notably, not all events in Armstrong County are included because of the amount of documentation available and possibility that not all sources were identified or researched. Loss and impact information could vary depending on the information source. Therefore, monetary figures discussed are based only on available information identified during research for this HMP update.

Table 4.3.17-4. Major Winter Storm Events in Armstrong County

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
Winter of 1993-1994	Winter Weather	EM-3105 DR-1015	Yes	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.
March 13-14, 1993	Severe Snowfall	EM-3105	Yes	17 inches of snow reported in Ford City; 20 inches of snow reported in Putneyville
January 4-5, 1994	Winter Weather	DR-1015	Yes	Record snowfall depths in many areas of the Commonwealth, strong winds, and sleet/freezing rains. Numerous storm-related power outages were reported and as many as 600,000 residents were without electricity, in some cases for several days at a time. A ravaging ice storm followed that 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 PPL Corporation stated that this was the worst winter storm in the history of the company; related damage-repair costs exceeded $5 million. Serious power supply shortages continued through mid-January because of record cold temperatures in 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,

Dates of Event	Event Type	FEMA Declaration Number	County Designated?	Losses / Impacts
				New York, and Virginia experienced 15- to 30-minute rolling blackouts, threatening the lives of people and the safety of buildings. 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 PennDOT storage sites. In Armstrong County, 14 inches of snow were reported in Ford City.
January 14, 1994	Winter Weather	DR-1015	Yes	No losses and/or damages were reported.
February 8, 1994	Winter Weather	DR-1015	Yes	No losses and/or were damages reported.
January 5-8, 1996	Heavy Snow	DR-1085	Yes	12 inches of snow were reported in Ford City; 10 inches of snow were reported in Putneyville.
December 6, 2003	Heavy Snow	N/A	N/A	11 inches of snow were reported in Putneyville.
February 9-11, 2010	Winter Storm	DR-1898	Yes	8 inches of snow were reported in Ford City.
December 26, 2012	Heavy Snow	N/A	N/A	Over 6 inches of snow were reported in Putneyville.

Source: NOAA-NCEI 2018; FEMA 2018; Pennsylvania State Climatologist 2018

DR	Federal Disaster Declaration	NCEI	National Centers for Environmental Information
FEMA	Federal Emergency Management Agency	NOAA	National Oceanic Atmospheric Administration
N/A	Not applicable/available	PennDOT	Pennsylvania Department of Transportation

4.3.17.4 Future Occurrence

Apparently, given the history of winter storm events that have impacted Armstrong County, future winter storm events of varying degrees will occur, and thus many people and properties are at risk from the winter storm hazard in the future.

For the 2019 HMP update, the most up-to-date data were collected to calculate the probability of future occurrence of winter weather events for Armstrong County. Information from NOAA-NCEI storm events database, FEMA, and the State Climatologist were used to identify the number of winter weather events that occurred between 1950 and 2018. Using these sources ensures the most accurate probability estimates possible. The table below shows these statistics, as well as the annual average number of events and the estimate percent chance of an incident occurring in a given year. Based on these statistics, the chance of a winter weather event, of any type, occurring in any given year in Armstrong County is estimated to be 100 percent. Specific estimates of future winter weather events are presented in Table 4.3.17-5.

Table 4.3.17-5. Probability of Future Winter Weather Events

Hazard Type	Number of Occurrences Between 1950 and 2018	Rate of Occurrence or Annual Number of Events (average)	Recurrence Interval (in years) (# Years/Number of Events)	Probability of Event in any given year	Percent chance of occurrence in any given year
Blizzard	1	0.01	68.00	0.01	1.47
Heavy Snow	17	0.25	4.00	0.25	25.00
Ice Storm	10	3.33	0.40	2.50	100.00
Winter Storm	13	0.19	5.23	0.19	19.12
Winter Weather	7	0.10	9.71	0.10	10.29

Sources: FEMA 2018; NOAA-NCEI 2018

It is estimated that Armstrong County will continue to experience direct and indirect impacts of winter storm events annually that may induce secondary hazards such as utility failures, power outages, and transportation delays, accidents and inconveniences. Therefore, the future occurrence of winter weather in Armstrong County is considered *highly likely*. Section 4.4 includes further information on PEMA's risk factor methodology.

4.3.17.5 Vulnerability Assessment

To understand risk, a community must evaluate the assets that are exposed or vulnerable within the identified hazard area. Regarding winter storm events, all of Armstrong County has been identified as the hazard area. Therefore, all assets (population, structures, critical facilities and lifelines), as described in the County Profile (Section 2), are potentially vulnerable. This section evaluates and estimates the potential winter storm impacts on the County in the following sections:

- Overview of vulnerability
- Data and methodology used for the evaluation
- Impacts on (1) life, health, and safety; (2) general building stock; (3) critical facilities; (4) the economy; (5) the environment; and (6) future growth and development
- Effect of climate change on vulnerability
- Further data collections that will increase understanding of this hazard over time.

Overview of Vulnerability

In Armstrong County, winter storms are a concern because of their frequency, the direct and indirect costs associated with them, the delays they cause, and their impacts on people and facilities of the region.

Data and Methodology

National weather databases, the 2013 Pennsylvania HMP, the 2018 Pennsylvania HMP draft, and local resources were referenced to acquire information about and analyze severe winter storm impacts on Armstrong County. Information collected from the 2010 U.S. Census data and the Hazards U.S. – Multi-Hazard (HAZUS-MH) building inventory for Armstrong County supported an evaluation of exposed assets and potential impacts associated with this hazard.

Impact on Life, Health, and Safety

According to the NOAA National Severe Storms Laboratory (NSSL), winter weather indirectly and deceptively kills hundreds of people in the United States every year, primarily from automobile accidents, overexertion, and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding wind-driven snow, drifting snow, extreme cold temperatures, and dangerous wind chill. Winter storms are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm.

People can die in traffic accidents on icy roads, of heart attacks while shoveling snow, or of hypothermia from prolonged exposure to cold.

Heavy snow can immobilize a region and paralyze a city, shutting down air and rail transportation, stopping flow of supplies, and disrupting medical and emergency services. Accumulations of snow can collapse buildings and knock down trees and power lines. In rural areas, homes and farms may be isolated for days, and unprotected livestock may be lost. In the mountains, heavy snow can lead to avalanches (NSSL 2015).

Heavy accumulations of ice can bring down trees, electrical wires, telephone poles and lines, and communication towers. Communications and power can be disrupted for days while utility companies work to repair the extensive damage. Even small accumulations of ice may cause extreme hazards to motorists and pedestrians. Bridges and overpasses are particularly dangerous because they freeze before other surfaces (NSSL 2015).

For the purposes of this Plan, the entire population of Armstrong County is considered exposed to winter storm events (U.S. Census 2010). The elderly population is considered most susceptible to this hazard because of their increased risk of injuries and death from falls and overexertion, and/or hypothermia from exposure while attempting to clear snow and ice. In addition, winter storm events can reduce the ability of members of the elderly population to access emergency services. Residents with low incomes may not have access to housing, or their housing may be less able to withstand cold temperatures (e.g., homes with poor insulation and heating supply). The County Profile (Section 2) of this Plan provides population statistics regarding each participating municipality and a summary of the more vulnerable populations (over the age of 65 and individuals living below the U.S. Census poverty threshold).

Impact on General Building Stock

The entire general building stock inventory in Armstrong County is exposed and vulnerable to the winter storm hazard. In general, structural impacts include damage to roofs and building frames, rather than building content. Current modeling tools are not available to estimate specific losses from this hazard. As an alternate approach, this Plan considers percentage damages that could result from winter storm conditions. Table 4.3.17-6 below summarizes percent damages from winter storm conditions on Armstrong County's total general building stock (structure only). Given professional knowledge and currently available information, potential losses from this hazard are considered overestimated; hence, the listed values in Table 4.3.17-6 represent conservative estimates of losses associated with severe winter storm events.

Table 4.3.17-6. General Building Stock Exposure (Structure Only) and Estimated Losses from Winter Storm Events in Armstrong County

Municipality	Total GBS (Structure Only)	1% of Total	5% of Total	10% of Total
Apollo Borough	$251,670,000	$2,516,700	$12,583,500	$25,167,000
Applewold Borough	$74,252,000	$742,520	$3,712,600	$7,425,200
Atwood Borough	$10,050,000	$100,500	$502,500	$1,005,000
Bethel Township	$128,949,000	$1,289,490	$6,447,450	$12,894,900
Boggs Township	$76,331,000	$763,310	$3,816,550	$7,633,100
Bradys Bend Township	$131,764,000	$1,317,640	$6,588,200	$13,176,400
Burrell Township	$73,172,000	$731,720	$3,658,600	$7,317,200
Cadogan Township	$65,238,000	$652,380	$3,261,900	$6,523,800
Cowanshannock Township	$303,507,000	$3,035,070	$15,175,350	$30,350,700
Dayton Borough	$84,832,000	$848,320	$4,241,600	$8,483,200
East Franklin Township	$1,027,803,000	$10,278,030	$51,390,150	$102,780,300
Elderton Borough	$75,474,000	$754,740	$3,773,700	$7,547,400

Municipality	Total GBS (Structure Only)	1% of Total	5% of Total	10% of Total
Ford City Borough	$538,129,000	$5,381,290	$26,906,450	$53,812,900
Ford Cliff Borough	$42,367,000	$423,670	$2,118,350	$4,236,700
Freeport Borough	$314,661,000	$3,146,610	$15,733,050	$31,466,100
Gilpin Township	$375,439,000	$3,754,390	$18,771,950	$37,543,900
Hovey Township	$25,518,000	$255,180	$1,275,900	$2,551,800
Kiskiminetas Township	$529,524,000	$5,295,240	$26,476,200	$52,952,400
Kittanning Borough	$933,567,000	$9,335,670	$46,678,350	$93,356,700
Kittanning Township	$224,824,000	$2,248,240	$11,241,200	$22,482,400
Leechburg Borough	$490,357,000	$4,903,570	$24,517,850	$49,035,700
Madison Township	$176,372,000	$1,763,720	$8,818,600	$17,637,200
Mahoning Township	$155,073,000	$1,550,730	$7,753,650	$15,507,300
Manor Township	$578,870,000	$5,788,700	$28,943,500	$57,887,000
Manorville Borough	$40,861,000	$408,610	$2,043,050	$4,086,100
North Apollo Borough	$163,435,000	$1,634,350	$8,171,750	$16,343,500
North Buffalo Township	$364,294,000	$3,642,940	$18,214,700	$36,429,400
Parker City	$83,797,000	$837,970	$4,189,850	$8,379,700
Parks Township	$502,517,000	$5,025,170	$25,125,850	$50,251,700
Perry Township	$72,571,000	$725,710	$3,628,550	$7,257,100
Pine Township	$51,655,000	$516,550	$2,582,750	$5,165,500
Plumcreek Township	$219,089,000	$2,190,890	$10,954,450	$21,908,900
Rayburn Township	$225,689,000	$2,256,890	$11,284,450	$22,568,900
Redbank Township	$211,247,000	$2,112,470	$10,562,350	$21,124,700
Rural Valley Borough	$154,259,000	$1,542,590	$7,712,950	$15,425,900
South Bend Township	$116,754,000	$1,167,540	$5,837,700	$11,675,400
South Bethlehem Borough	$132,137,000	$1,321,370	$6,606,850	$13,213,700
South Buffalo Township	$454,112,000	$4,541,120	$22,705,600	$45,411,200
Sugarcreek Township	$190,498,000	$1,904,980	$9,524,900	$19,049,800
Valley Township	$88,371,000	$883,710	$4,418,550	$8,837,100
Washington Township	$111,171,000	$1,111,710	$5,558,550	$11,117,100
Wayne Township	$108,168,000	$1,081,680	$5,408,400	$10,816,800
West Franklin Township	$347,597,000	$3,475,970	$17,379,850	$34,759,700
West Kittanning Borough	$412,394,000	$4,123,940	$20,619,700	$41,239,400
Worthington Borough	$144,717,000	$1,447,170	$7,235,850	$14,471,700
Armstrong County (Total)	**$10,883,076,000**	**$108,830,760**	**$544,153,800**	**$1,088,307,600**

Source: HAZUS-MH 4.2
Note
GBS General building stock

Armstrong County's floodplain area is especially vulnerable to the winter storm hazard. At-risk building stock and infrastructure in floodplains are presented in the flood hazard profile (Section 4.3.5). Generally, losses from flooding associated with winter storms should be less than those associated with a 1-percent or 0.2-percent flood.

Snow and ice melt can cause both riverine and urban flooding. Estimated losses caused by riverine flooding in the County are discussed in Section 4.3.5.

Impact on Critical Facilities

Full functionality of critical facilities such as police, fire, and medical services is essential for response during and after a winter storm event. Critical facility structures are largely constructed of concrete and masonry; therefore, these should undergo only minimal structural damage from severe winter storm events. Because power interruption can occur, backup power is recommended for critical facilities and infrastructure.

Impact on the Economy

Infrastructure at risk from the winter storm hazard includes roadways that could be damaged by application of salt, and intermittent freezing and warming conditions that can damage roads over time. Costs of snow and ice removals, as well as repairs of roads undergoing freeze-and-thaw cycles, can drain local financial resources. Potential secondary impacts from winter storms also impact the local economy, including loss of utilities, interruption of transportation corridors, and loss of business function.

Impact on the Environment

Environmental impacts often include damage to trees and shrubs caused by heavy snow loading, ice build-up, and/or high winds, which can break limbs and down large trees. Indirect effects of winter storms include possible damage to surfaces and contamination of groundwater adjacent to roadway surfaces treated with salt, chemicals, and other de-icing materials (PEMA 2013).

Winter storms have a positive environmental impact; gradual melting of snow and ice recharges groundwater. However, abrupt high temperatures following a heavy snowfall can accelerate snowmelt, leading to rapid surface water runoff and severe flooding (PEMA 2013).

Future Growth and Development

Areas targeted for potential future growth and development within the next 5 to 10 years have been identified across the County at the municipal level, and are further discussed in Section 4.4 of this Plan. Because Armstrong County in its entirety has been identified as the hazard area vulnerable to the winter storm hazard, any new development will be exposed to associated risks.

Effect of Climate Change on Vulnerability

Climate is defined not just as average temperature and precipitation, but also by type, frequency, and intensity of weather events. Both globally and at the local level, climate change potentially can alter prevalence and severity of weather extremes such as winter storms. While predicting changes in winter storm events under a changing climate is difficult, understanding vulnerabilities to potential changes is a critical part of estimating future climate change impacts on human health, society, and the environment.

The climate of Pennsylvania has changed in several ways. Over the past 100 years, annual average temperatures have been rising across the Commonwealth. Warmer winters have led to a decrease in snow cover and earlier arrival of spring. Recent analyses based on the Intergovernmental Panel on Climate Change models suggest a decrease in frequency and an increase in intensity of extra-tropical winter cyclones. However, based on the methodology applied, some models show no significant change in the storm track whereas others indicate a northward displacement of the storm track in the North Atlantic. For the mid-Atlantic region, there is little indication of a change in storm activity or track over Pennsylvania. An overall increase in winter precipitation is anticipated, with decrease in snow and increase in rain during the winter months. Projections regarding future occurrences of extra-tropical cyclones in Pennsylvania are substantially uncertain. Based on available information and projections, winter storms are anticipated to continue to affect Pennsylvania in the future. Future improvements in modeling smaller-scale climatic processes can be expected, and will lead to improved understanding of ways in which changing climate will alter temperature, precipitation, and storm events in Pennsylvania (Shortle and others 2009).

Pennsylvania can expect to see warmer temperatures throughout the year, meaning less snow in the winter. Temperature is expected to increase resulting in a significant decrease in snow cover extent and duration. More precipitation will fall as rain rather than snow.

Additional Data and Next Steps

The assessment above identifies vulnerable populations and economic losses associated with the winter storm hazard of concern. Historical data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, the percent of damage assumption methodology was applied. This methodology is based on FEMA How-to Series (FEMA 386-2), Understanding Your Risks, Identifying and Estimating Losses (FEMA 2001), and FEMA's Using HAZUS-MH for Risk Assessment (FEMA 433) (FEMA 2015). Acquisition of additional or actual valuation data regarding general building stock and critical infrastructure losses would further support future estimates of potential exposure of and damage to the general building stock inventory.

4.4 HAZARD VULNERABILITY SUMMARY

This section describes the methodology and tools used to support the risk assessment process.

4.4.1 Methodology

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

- **Hazard Identification** – Use all available information to determine what types of hazards might affect a jurisdiction
- **Profile Each Hazard** – Understand each hazard in terms of:
    - Location – geographic area most affected by the hazard
    - Extent – severity of each hazard
    - Range of magnitude
    - Previous occurrences and losses
    - Probability of future hazard events
- **Assess Vulnerability**
    - **Exposure identification** – Estimate the total number of assets in the jurisdiction that are likely to experience a hazard event if it occurs by overlaying hazard maps with the asset inventories.
    - **Vulnerability identification and loss estimation** – Assess the impact of hazard events on the people, property, environment, economy, and lands of the region, including estimates of the cost of potential damage or cost that can be avoided by mitigation.

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

Asset Inventories

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

Population

As discussed in Section 2 (County Profile), research has shown that some populations are at greater risk from hazard events because of decreased resources or physical abilities. For the purposes of this planning process, vulnerable populations in Armstrong County include children, elderly, low-income, and non-English speakers.

The 2010 U.S. Census block data layers were used to estimate exposure and potential impacts to the general population. The 2010 U.S. Census demographic data available in the Federal Emergency Management Agency's (FEMA) HAZUS-MH v4.2 model was used to estimate potential impacts to the elderly (over 65 years of age) and populations with income below the poverty threshold. The 2012-2016 American Community Survey was utilized to examine residents who are non-English speaking.

U.S. Census blocks do not follow the boundaries of the hazard areas, possibly leading to gross overestimates or underestimates of exposed populations from use of centroids or intersects of Census blocks with these zones. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate.

Buildings

The default general building stock data in HAZUS-MH v4.2 based on the 2010 U.S. Census and RS Means 2016 valuations was used for the HAZUS-MH v4.2 analysis and hazard exposure analysis at the municipal level. The building inventory was used to estimate losses to the County's total replacement cost value from a hazard event. Replacement cost value is the current cost of returning an asset to its pre-damaged condition using present-day cost of labor and materials. Total replacement cost value consists of both the structural cost to replace a building and the estimated value of the contents of a building. The occupancy classes available in HAZUS-MH v4.2 were condensed into the following categories to facilitate the analysis and the presentation of results: residential, commercial, industrial, agricultural, religious, governmental, and educational. Residential loss estimates address both multi-family and single-family dwellings. To estimate the number of structures in the County exposed to the hazard areas, the County's spatial building footprint layer was utilized. Building footprints with their centroid in a hazard area were totaled to estimate exposure.

The HAZUS-MH v4.2 Census blocks do not follow the boundaries of the hazard areas, possibly leading to gross overestimates or underestimates of exposed building stock from use of centroids or intersects of Census blocks with these zones. Limitations of these analyses are recognized, and thus the results are used only to provide a general estimate.

Critical Facilities

The critical facility inventory, which includes essential facilities, utilities, transportation features, and user-defined facilities as outlined in Section 2, was updated beginning with all Geographic Information System (GIS) data provided by the Armstrong County Department of Public Safety and Information Technology – Geographic Information Systems Department. To protect individual privacy and the security of assets, information is presented in aggregate, without details about specific individual properties or facilities. The default inventory in HAZUS-MH v4.2 was updated with the critical facility inventory generated for this plan.

New Development

The 2017 American Community Survey estimates that Armstrong County has seen construction of 107 housing units from 2014 to 2017 (ACS 2017).

The County has not identified specific areas for residential development. However, residential development could be expected to take place in areas. Residential redevelopment could also take place in areas that have been identified and addressed by the Armstrong County Blight Remediation Program. The program began demolition of several vacant properties in 2018 and early 2019 within the Boroughs of Leechburg and Kittanning (Armstrong County Planning and Development 2019).

In addition to anticipated residential development, Armstrong County has over 140 acres available in 5 designated Keystone Opportunity Zones and Keystone Opportunity Expansion Zones. These zones are designated areas and zones within Pennsylvania for reduced or abated taxes for periods of up to 10 years to encourage business development and investment (Armstrong County Industrial Development Council 2019).

Methodology

To address the requirements of the DMA 2000 and better understand potential vulnerability and losses associated with hazards of concern, Armstrong County used standardized tools, combined with local, state, and federal data and expertise to conduct the risk assessment. Three different levels of analysis were used depending upon the data available for each hazard as described below.

1. ***Historical Occurrences and Qualitative Analysis** – This analysis includes an examination of historical impacts to understand potential impacts of future events of similar size. In addition, potential impacts and losses are discussed qualitatively using best available data and professional judgment.*
2. ***Exposure Assessment** – This analysis involves overlaying available spatial hazard layers, or hazards with defined extent and locations, with assets in GIS to determine which assets are located in the impact area of the hazard. The analysis highlights which assets might be affected by the hazard. If the center of each asset is located in the hazard area, it is deemed exposed and potentially vulnerable to the hazard.*
3. ***Loss estimation** – The FEMA HAZUS modeling software was used to estimate potential losses for the following hazards: Flood, Earthquake, Hurricane (Wind). In addition, an examination of historical impacts and an exposure assessment was conducted for these spatially-delineated hazards.*

Table 4.4-1. Summary of Risk Assessment Analyses

Hazard	Data Analyzed			
	Population	General Building Stock	Critical Facilities	Environment
Dam Failure	Q	Q	Q	Q
Drought	Q	Q	Q	Q
Earthquake	H	H	H	Q
Environmental Hazard	E	E	E	Q
Flood, Flash Flood, Ice Jam	E, H	E, H	E, H	Q
Invasive Species	Q	Q	Q	Q
Landslide	E	E	E	Q
Levee Failure	E	E	E	Q
Pandemic	Q	Q	Q	Q
Radon Exposure	Q	Q	Q	Q
Subsidence/Sinkhole	E	E	E	Q
Terrorism	Q	Q	Q	Q
Tornado, Windstorm	H	H	H	Q
Transportation Accident	Q	Q	Q	Q
Utility Interruption	Q	Q	Q	Q
Wildfire	E	E	E	Q
Winter Storm	Q	Q	Q	Q

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

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

In 1997, FEMA developed a standardized model for estimating losses caused by earthquakes, known as Hazards U.S. or HAZUS. HAZUS was developed in response to the need for more effective national-, state-, and community-level planning and the need to identify areas that face the highest risk and potential for loss. HAZUS was expanded into a multi-hazard methodology: HAZUS-MH with new models for estimating potential losses from wind (hurricanes) and flood (riverine and coastal) hazards. HAZUS-MH is a GIS-based software tool that applies engineering and scientific risk calculations, which have been developed by hazard and information technology experts, to provide defensible damage and loss estimates. These methodologies are accepted by

FEMA and provide a consistent framework for assessing risk across a variety of hazards. The GIS framework also supports the evaluation of hazards and assessment of inventory and loss estimates for these hazards.

HAZUS-MH uses GIS technology to produce detailed maps and analytical reports that estimate a community's direct physical damage to building stock, critical facilities, transportation systems, and utility systems. To generate this information, HAZUS-MH uses default HAZUS-MH-provided data for inventory, vulnerability, and hazards; this default data can be supplemented with local data to provide a more refined analysis. Damage reports can include induced damage (inundation, fire, threats posed by hazardous materials and debris) and direct economic and social losses (casualties, shelter requirements, and economic impact) depending on the hazard and available local data. HAZUS-MH's open data architecture can be used to manage community GIS data in a central location. The use of this software also promotes consistency of data output now and in the future and standardization of data collection and storage. More information on HAZUS-MH is available at http://www.fema.gov/hazus.

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

Table 4.4-2. Summary of HAZUS-MH Analysis Levels

HAZUS-MH Analysis Levels	
Basic	A basic estimate of earthquake, flood, and hurricane wind losses is produced based on national databases and expert-based analysis parameters included in the HAZUS software.
Advanced	More accurate loss estimates are produced by including detailed information on local hazard conditions and/or by replacing the national default inventories with more accurate local inventories of buildings, essential facilities, and other infrastructure.

Source: FEMA 2019

Earthquake

A probabilistic assessment was conducted for Armstrong County for the 500-year and 2,500-year MRPs through a Level 2 analysis in HAZUS-MH v4.2 to analyze the earthquake hazard and provide a range of loss estimates. The probabilistic method uses information from historical earthquakes and inferred faults, locations, and magnitudes and computes the probable ground shaking levels that might be experienced during a recurrence period by Census tract.

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

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

NEHRP soil classifications were not available for Armstrong County at the time of this analysis. Soils were estimated as NEHRP soil Type D across Armstrong County, as a conservative approach to this risk assessment. Groundwater was set at a depth of 5 feet (default setting). Damages and losses due to liquefaction, landslide, or surface fault rupture were not included in this analysis. Although damages are estimated at the Census tract level, results were presented at the municipal level. For Census tracts encompassing multiple municipalities, the default general building stock inventory was used to calculate the percent of the total Census tract replacement cost value in each municipality. This percentage was applied to the Census tract losses to estimate the municipal level losses. For example, the Census blocks from two municipalities are located within one Census tract. The total replacement cost value of Municipality A is 60 percent of the total Census tract replacement cost value, while Municipality B is 40 percent of the total value. Therefore, 60 percent of the losses for the Census tract will be applied to Municipality A, and 40 percent will be applied to Municipality B.

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

Environmental Hazard

To determine potential impact on the County, a 0.25-mile buffer was placed around the identified major roadways and rail lines, and the designated vulnerability radius of each of the County’s 288 SARA Title III planning facilities was used to define the hazard area. The primary roadways in Armstrong County are listed as follows:

- U.S. Route 422
- Pennsylvania Route 12
- Pennsylvania Route 28
- Pennsylvania Route 56
- Pennsylvania Route 58
- Pennsylvania Route 66
- Pennsylvania Route 68
- Pennsylvania Route 85
- Pennsylvania Route 156
- Pennsylvania Route 210
- Pennsylvania Route 268
- Pennsylvania Route 356
- Pennsylvania Route 368
- Pennsylvania Route 536
- Pennsylvania Route 839

Populations and features of the built environment within these areas might be directly or indirectly affected by a potential environmental hazard. The hazard area was overlaid upon the 2010 U.S. Census population data in GIS (U.S. Census 2010).

The vulnerability radius for each hazard facility is determined by the County Local Emergency Planning Committee, and each radius is shown in Appendix I.

Flood, Flash Flood, Ice Jam

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

The effective Armstrong County FEMA Digital Flood Insurance Rate Maps (DFIRM) dated February 2016 were used to evaluate exposure. The FEMA Risk MAP 1 percent annual chance flood depth grid, dated March 2014 was incorporated into HAZUS-MH v4.2 to estimate potential losses for the County. An approximately 520 ft. length of the Buffalo Creek in South Buffalo Township did not have depth associated with the boundaries. The 1 percent annual chance event boundary for that length was used with 1/9 arc-second Digital Elevation Map (DEM) model provided by the U.S. Geological Survey (USGS). The depth grid was integrated into HAZUS-MH, and the model was run to estimate potential losses at the Census block level using the HAZUS-MH v4.2 default building inventory for the 1 percent annual chance flood event.

To estimate exposure to the 1 percent annual chance flood events, the DFIRM flood boundaries, default general building stock inventory, updated critical facility inventories, and 2010 U.S. Census population data were used. A Level 2 HAZUS-MH v4.2 riverine flood analysis was performed. The updated critical facility inventories were incorporated into HAZUS-MH v4.2, replacing the default essential facility (police, fire, schools, etc.) and utility inventories. The HAZUS-MH v4.2 riverine flood model was run to estimate potential losses in Armstrong County for the 1 percent annual chance flood event. HAZUS-MH v4.2 calculated the estimated potential losses to the population (default 2010 U.S. Census data) and potential damages to the general building stock and critical facility inventories based on the depth grid generated and the default HAZUS-MH v4.2 damage functions in the flood model.

Landslide

The 2011 Landslide Incidence and Susceptibility GIS layer from the U.S. Geological Survey was used to coarsely define the general landslide susceptible area. According to Radbruch-Hall and others, the Landslide Incidence and Susceptibility GIS layer from National Atlas; and applies to the U.S. Geological Survey layer as well:

> "….was prepared by evaluating formations or groups of formations shown on the geologic map of the United States (King and Beikman 1974) and classifying them as having high, medium, or low landslide incidence (number of landslides) and being of high, medium, or low susceptibility to landsliding. Thus, those map units or parts of units with more than 15 percent of their area involved in landsliding were classified as having high incidence; those with 1.5 to 15 percent of their area involved in landsliding, as having medium incidence; and those with less than 1.5 percent of their area involved, as having low incidence. This classification scheme was modified where particular lithofacies are known to have variable landslide incidence or susceptibility. In continental glaciated areas, additional data were used to identify surficial deposits that are susceptible to slope movement. Susceptibility to landsliding was defined as the probable degree of response of the areal rocks and soils to natural or artificial cutting or loading of slopes or to anomalously high precipitation. High, medium, and low susceptibility are delimited by the same percentages used in classifying the incidence of landsliding. For example, it was estimated that a rock or soil unit characterized by high landslide susceptibility would respond to widespread artificial cutting by some movement in 15 percent or more of the affected area. We did not evaluate the effect of earthquakes on slope stability, although many catastrophic landslides have been generated by ground shaking during earthquakes. Areas susceptible to ground failure under static conditions would probably also be susceptible to failure during earthquakes" (Radbruch-Hall 1982).

Unlike the flood, wind, and earthquake hazards, there are no standard loss estimation models or methodologies for the landslide hazard. To estimate Armstrong County's vulnerability, the Landslide Incidence and Susceptibility GIS layer from USGS was used to coarsely define the general landslide susceptible area. The entire County is located within the "low incidence" landslide incidence and susceptibility area. Although the entire County and its assets are exposed, previous occurrences and historical damages do not warrant the hazard to be considered a high-risk to all assets.

Levee Failure

Information from the U.S. Army Corps of Engineers (USACE) regarding the levee-protected area of the Kittanning Levee was used to estimate exposure. Levee-protected areas are typically protected from flooding but can become inundated in the event of a levee failure event. The Kittanning Levee, located in Kittanning Borough, is 0.87 mile in length and protects approximately 0.1 square mile of land. Because the levee-protected area boundary is only located within Kittanning Borough, the hazard boundary was overlaid on the Borough's assets (population, building stock, critical facilities) to estimate the Borough's exposure to a levee failure event.

Tornado and Windstorm

A HAZUS-MH v4.2 probabilistic analysis was performed to analyze the wind hazard losses for Armstrong County. The probabilistic hurricane hazard activates a database of thousands of potential storms that have tracks and intensities reflecting the full spectrum of Atlantic hurricanes observed since 1886 and identifies those with tracks associated with Armstrong County. HAZUS-MH v4.2 contains data on historical hurricane events and wind speeds. It also includes surface roughness and vegetation (tree coverage) maps for the area. Surface roughness and vegetation data support the modeling of wind force across various types of land surfaces. Annualized losses and the 100-year and 500-year MRPs were examined for the wind/severe storm hazard. Default demographic and general building stock data in HAZUS-MH v4.2 and the updated critical facility inventories were used for the analysis.

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

Wildfire

The Wildland-Urban Interface (Interface and Intermix) obtained through the SILVIS Laboratory, Department of Forest Ecology and Management, University of Wisconsin – Madison, was referenced to delineate wildfire hazard areas. The University of Wisconsin – Madison wildland fire hazard areas are based on the 2010 Census and 2006 National Land Cover Dataset and the Protected Areas Database. For this risk assessment, the high-, medium-, and low-density interface areas were combined and used as the "Interface" hazard area, and the high-, medium-, and low-density intermix areas were combined and used as the "Intermix" hazard areas.

Asset data (population, building stock, critical facilities, and new development) presented in the County Profile (Section 4) were used to support an evaluation of assets exposed and potential impacts and losses associated with this hazard. To determine what assets are exposed to wildfire, available and appropriate GIS data were overlaid with the hazard area.

Winter Storm

The entire general building stock inventory in Armstrong County is exposed and vulnerable to the winter storm hazard. In general, structural impacts include damage to roofs and building frames rather than building content.

Current modeling tools are not available to estimate specific losses for this hazard. Historical data on structural losses to general building stock are not adequate to predict specific losses to this inventory; therefore, a percentage of the custom-building stock structural replacement cost value was utilized to estimate damages that could result from winter storm conditions. This methodology is based on FEMA's How-to Series (FEMA 386-2), "Understanding Your Risks, Identifying and Estimating Losses" (FEMA 2001) and FEMA's "Using HAZUS-MH for Risk Assessment (FEMA 433)" (FEMA 2004). Given professional knowledge and the currently available information, the potential losses for this hazard are considered to be overestimated; hence, providing a conservative estimate for losses associated with winter storm events.

Qualitative Analyses

For many of the hazards evaluated in this risk assessment, historical data are not adequate to model future losses at this time. Where GIS data are not available, a qualitative analysis was conducted for the following hazards using the best available data and professional judgment. Multiple federal, state, and academic sources were used to evaluate these hazards:

- Dam Failure
- Drought
- Invasive Species
- Pandemic
- Radon Exposure
- Terrorism
- Transportation Accident
- Utility Interruption

Limitations

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

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

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

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

4.4.2 Ranking Results

As discussed in Section 4.2, Hazard Identification, a comprehensive range of natural and non-natural hazards that pose significant risk to Armstrong County were selected and considered in this plan. However, the communities in Armstrong County have differing levels of exposure and vulnerability to each of these hazards. It is important for each community participating in this plan to recognize those hazards that pose the greatest risk to their community and direct their attention and resources accordingly to manage risk effectively and efficiently.

To this end, a relative hazard risk ranking process was conducted for the County using the Risk Factor (RF) methodology identified in Section 5 and Appendix 9 of Pennsylvania Emergency Management Agency's (PEMA) All-Hazard Planning Standard Operating Guide (PEMA October 2013). The guidance states:

> The RF approach produces numerical values that allow identified hazards to be ranked against one another (the higher the RF value, the greater the hazard risk). RF values are obtained by assigning varying degrees of risk to five categories for each hazard: *probability, impact, spatial extent, warning time*, and *duration*.
>
> To calculate the RF value for a given hazard, the assigned risk value for each category is multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the example equation below:

Example Equation

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

> Hazards identified as high-risk have RFs greater than or equal to 2.5. RFs ranging from 2.0 to 2.4 are considered moderate-risk hazards. Hazards with RFs less than 2.0 are considered low-risk.

Table 4.4-3 identifies the five risk assessment categories, the criteria and associated risk level indices used to quantify their risk, and the suggested weighting factor (weight value) applied to each risk assessment category. Table 4.4-4 shows the five risk assessment categories' values for each of Armstrong County's hazards and each hazard's RF.

Table 4.4-3. Summary of Risk Factor (RF) Approach

Summary of Risk Factor (RF) Approach				
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, or death, would you anticipate impacts to be minor, limited, critical, or catastrophic when a significant hazard event occurs?*	MINOR	VERY FEW INJURIES, IF ANY. ONLY MINOR PROPERTY DAMAGE & MINIMAL DISRUPTION ON QUALITY OF LIFE. TEMPORARY SHUTDOWN OF CRITICAL FACILITIES.	1	30%
	LIMITED	MINOR INJURIES ONLY. MORE THAN 10% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE DAY.	2	
	CRITICAL	MULTIPLE DEATHS/INJURIES POSSIBLE. MORE THAN 25% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR MORE THAN ONE WEEK.	3	
	CATASTROPHIC	HIGH NUMBER OF DEATHS/INJURIES POSSIBLE. MORE THAN 50% OF PROPERTY IN AFFECTED AREA DAMAGED OR DESTROYED. COMPLETE SHUTDOWN OF CRITICAL FACILITIES FOR 30 DAYS OR MORE.	4	
SPATIAL EXTENT *How large of an area could be impacted by a hazard event? Are impacts localized or regional?*	NEGLIGIBLE	LESS THAN 1% OF AREA AFFECTED	1	20%
	SMALL	BETWEEN 1 & 10.9% OF AREA AFFECTED	2	
	MODERATE	BETWEEN 11 & 25% OF AREA AFFECTED	3	
	LARGE	GREATER THAN 25% 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	

Source: PEMA 2013

Table 4.4-4. Risk Ranking for Armstrong County

HAZARD RISK	HAZARDS	RISK ASSESSMENT CATEGORY					RISK FACTOR (RF)
		PROBABILITY	IMPACT	SPATIAL EXTENT	WARNING TIME	DURATION	
HIGH	Tornado, Windstorm	4	3	4	4	2	3.5
	Flood, Flash Flood, and Ice Jam	4	4	2	3	3	3.4
	Invasive Species	4	2	4	1	4	3.1
	Pandemic	2	4	4	1	4	3.1
	Utility Interruptions	4	3	2	4	2	3.1
	Winter Storm	4	2	4	2	2	3
	Radon Exposure	4	1	4	1	4	2.8
	Environmental Hazards	4	2	1	4	2	2.6
	Landslide	4	1	1	4	4	2.5
MODERATE	Levee Failure	1	4	1	4	3	2.4
	Transportation Accidents	4	1	2	4	1	2.4
	Drought	2	1	4	1	4	2.2
	Wildfire	4	1	1	4	1	2.2
LOW	Earthquake	1	1	4	4	1	1.9
	Subsidence and Sinkholes	2	1	1	4	3	1.8
	Terrorism	2	1	1	4	2	1.7
	Dam Failure	1	1	1	3	2	1.3

Based on these results, there are 9 high-risk hazards, 4 moderate-risk hazards, and 4 low-risk hazards in Armstrong County. Mitigation actions were developed for all high-risk, moderate-risk, and low-risk hazards (see Section 6.4). The threat posed to life and property for moderate-risk and high-risk hazards is considered significant enough to warrant the need for establishing hazard-specific mitigation actions. Mitigation actions related to future public outreach and emergency service activities are identified to address low-risk hazard incidents.

A risk assessment result for the entire County does not mean that each municipality is at the same amount of risk to each hazard. Table 4.4-5 shows the different municipalities in Armstrong County and whether they believe their risk is greater than (>), less than (<), or equal to (=) the RF assigned to the County as a whole. Municipal officials' responses were then reviewed and updated (as appropriate) by the Planning Team.

Table 4.4-5. Jurisdictional Risk by Municipality

Municipality	Dam Failures	Drought	Earthquake	Environmental Hazards	Flooding/Flash Flood/Ice Jam	Invasive Species	Landslide	Levee Failure	Pandemic	Radon Exposure	Subsidence/Sinkhole	Terrorism	Tornado/Windstorm	Transportation Accidents	Utility Interruption	Wildfire	Winter Storm
	1.3	2.2	1.9	2.6	3.4	3.1	2.5	2.4	3.1	2.8	1.8	1.7	3.5	2.4	3.1	2.2	3.0
Apollo Borough	=	=	<	<	>	=	=	<	=	=	=	=	<	=	=	=	=
Applewold Borough	>	=	=	>	>	>	>	=	=	=	=	=	=	=	=	=	=
Atwood Borough	<	=	=	=	<	<	=	<	=	=	=	=	=	=	=	=	=
Bethel Township	>	=	=	=	=	=	>	<	=	=	>	>	=	=	=	>	=
Boggs Township	=	=	=	=	>	=	>	<	=	=	>	=	=	=	=	=	=
Bradys Bend Township	<	=	=	<	<	=	=	<	=	=	=	=	=	=	=	=	=
Burrell Township	<	>	=	=	<	=	=	<	=	=	>	=	=	<	<	>	=
Cadogan Township	<	=	=	=	=	=	>	<	=	=	>	=	=	=	=	=	=
Cowanshannock Township	<	=	=	=	>	=	=	<	=	=	>	=	=	=	=	=	=
Dayton Borough	<	=	=	=	=	=	<	<	=	=	<	=	=	=	=	=	=
East Franklin Township	=	=	=	>	>	=	<	<	=	=	=	=	=	>	>	>	=
Elderton Borough	<	=	=	=	<	<	<	<	=	=	=	=	=	>	=	<	=
Ford City Borough	=	=	=	<	=	=	<	<	>	=	>	=	=	<	=	<	=
Ford Cliff Borough	<	=	=	=	<	=	<	<	=	=	=	=	=	<	=	<	=
Freeport Borough	<	=	=	=	>	=	>	<	=	=	<	=	=	=	=	=	=
Gilpin Township	>	>	>	>	=	>	=	<	>	>	=	>	>	>	=	>	=
Hovey Township	<	=	=	=	<	=	<	<	=	=	<	=	=	=	=	=	=
Kiskiminetas Township	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=	=
Kittanning Borough	=	<	<	=	>	<	=	>	=	<	=	=	<	<	=	<	=
Kittanning Township	<	=	=	=	=	=	=	<	=	=	=	=	=	>	>	=	=

	Dam Failures	Drought	Earthquake	Environmental Hazards	Flooding/Flash Flood/Ice Jam	Invasive Species	Landslide	Levee Failure	Pandemic	Radon Exposure	Subsidence/Sinkhole	Terrorism	Tornado/Windstorm	Transportation Accidents	Utility Interruption	Wildfire	Winter Storm
Municipality	**1.3**	**2.2**	**1.9**	**2.6**	**3.4**	**3.1**	**2.5**	**2.4**	**3.1**	**2.8**	**1.8**	**1.7**	**3.5**	**2.4**	**3.1**	**2.2**	**3.0**
Leechburg Borough	<	=	=	=	=	=	>	<	=	=	>	=	=	=	=	=	=
Madison Township	<	=	=	<	<	=	<	<	=	=	=	=	=	=	=	=	=
Mahoning Township	>	=	=	=	>	=	>	<	=	=	=	<	=	>	>	=	=
Manor Township	<	=	=	>	=	>	>	<	=	=	=	>	=	=	>	=	=
Manorville Borough	=	<	<	=	=	<	<	<	<	=	<	<	=	<	=	<	=
North Apollo Borough	>	=	=	=	=	=	=	=	=	>	=	<	<	>	=	=	=
North Buffalo Township	=	=	=	=	=	=	=	<	=	=	<	=	=	=	=	=	=
City of Parker	<	=	=	<	=	=	<	<	=	=	<	=	=	=	=	=	=
Parks Township	<	=	=	>	=	=	>	<	=	=	=	=	=	=	=	=	=
Perry Township	<	=	=	<	=	=	=	<	=	=	=	=	=	=	=	=	=
Pine Township	=	=	=	=	=	=	=	<	=	=	=	=	=	=	=	=	=
Plumcreek Township	>	=	=	>	=	=	=	<	=	=	=	=	=	=	=	=	=
Rayburn Township	<	>	=	=	>	=	>	<	=	=	>	=	>	>	>	>	>
Redbank Township	<	=	=	<	=	=	<	<	=	=	=	=	=	=	=	=	=
Rural Valley Borough	<	=	=	<	=	=	<	<	=	=	>	=	=	=	=	=	=
South Bend Township	=	=	=	=	=	=	<	<	=	=	>	=	=	=	=	=	=
South Bethlehem Borough	=	=	=	=	=	=	<	<	=	=	<	=	=	=	=	<	=
South Buffalo Township	<	=	=	=	=	=	>	<	=	=	<	=	=	=	=	=	=
Sugarcreek Township	=	=	=	<	<	=	=	<	=	=	<	=	=	=	=	=	=
Valley Township	<	=	=	<	=	=	<	<	=	=	<	=	=	=	=	=	=
Washington Township	>	=	<	<	=	=	>	<	=	=	=	<	=	<	>	=	>
Wayne Township	=	=	=	<	=	=	<	<	=	=	<	=	=	=	=	=	=

	Dam Failures	Drought	Earthquake	Environmental Hazards	Flooding/Flash Flood/Ice Jam	Invasive Species	Landslide	Levee Failure	Pandemic	Radon Exposure	Subsidence/Sinkhole	Terrorism	Tornado/Windstorm	Transportation Accidents	Utility Interruption	Wildfire	Winter Storm
Municipality	**1.3**	**2.2**	**1.9**	**2.6**	**3.4**	**3.1**	**2.5**	**2.4**	**3.1**	**2.8**	**1.8**	**1.7**	**3.5**	**2.4**	**3.1**	**2.2**	**3.0**
West Franklin Township	=	>	=	=	=	>	=	<	=	=	=	=	=	>	=	=	<
West Kittanning Borough	<	=	=	<	<	=	>	<	=	=	>	=	=	<	=	<	=
Worthington Borough	=	>	=	=	=	=	<	<	=	>	=	=	=	>	=	=	=

4.4.3 Potential Loss Estimates

Potential loss estimates for hazard events help a community understand the monetary value of what might be at stake during a hazard event. Estimates are considered *potential* in that they generally represent losses that could occur in a countywide hazard scenario. Localized events could yield lower losses, while regional events could yield higher losses.

The data utilized to conduct the vulnerability assessment came from a variety of sources as noted throughout each hazard profile and Appendix A. As summarized in the Methodology subsection the 2010 U.S. Census demographic data, HAZUS-MH v4.2 default building inventory and its associated replacement cost value of the structures and contents, and the comprehensive critical facility inventory update in HAZUS-MH v4.2 were used for Armstrong County.

Potential loss estimates provided in Section 4.3 (Hazard Profiles) were either based on historical losses, current-condition losses, and/or predictive losses by performing spatial analyses in GIS and hazard probabilistic modeling. In summary, HAZUS-MH v4.2 was used to estimate potential losses for the earthquake, flood, and hurricane (tornado, windstorm). For many of the hazards evaluated, historical data are not adequate to model future losses at this time. For these hazards of concern, areas and inventory susceptible to specific hazards were mapped, and exposure was evaluated to help guide mitigation efforts (mitigation efforts are discussed further in Section 6). Spatial analyses were conducted to assess potential exposure for hazards of concern with delineated hazard areas: environmental hazards; flood, flash flood, and ice jam; landslide; levee failure; subsidence and sinkhole; and wildfire. Where GIS data are not available for some hazards, a qualitative analysis was conducted using the best available data and professional judgment.

4.4.4 Future Development and Vulnerability

Risk and vulnerability to natural and human-caused hazard events are not static. Risk will increase or decrease as counties and municipalities see changes in land use and development as well as changes in population. Population change (in terms of total and demographics) and the age of the housing stock continue to be the main indicators of vulnerability change in Armstrong County.

Armstrong County experienced a 7.23 percent decrease in population from 2000 to 2016, as summarized in Section 2. According to the Pennsylvania Population Projections from the Center for Rural Pennsylvania, the population in Armstrong County is projected to decrease over the coming decades. The range of projected change in population varies from a 39 percent population decrease in Bradys Bend Township to a 40.6 increase in population in Wayne Township (PA DEP 2012).

Continued analysis of the age structure in Armstrong County will provide deeper understanding of future vulnerability to at-risk populations. Approximately 18 percent of Armstrong County's population is age 65 or older (ACS 2017). As these residents continue to age in the County, they might have increased special needs. For example, many residents in this age bracket might be unable to drive; therefore, development of special evacuation plans for them will be necessary. They might also have hearing or vision impairments that could hinder their reception of emergency instructions. Both older and younger populations are at higher risks for contracting certain diseases. Armstrong County's combined under-5-years-of-age and over-65 populations constitute approximately 23.6 percent of its population (ACS 2017).

Approximately 0.9 percent of Armstrong County's population lives in group quarters, which are communal settings that can include inmates in a prison, students in a dorm, or elderly or mentally disabled in group-care homes. Many residents living in group quarters have special needs. It is important to ensure that each group-quarter facility has an emergency plan to account for the unique needs of its residents during a hazard event.

Less than 1 percent of Armstrong County's population is not proficient in English. Future hazard mitigation strategies should consider addressing language barriers to ensure that all residents can receive emergency instructions.

In addition, remote and sparsely populated municipalities also face higher vulnerability to hazards because they do not have as easy access to care facilities or response personnel. For instance, the sparsely populated municipalities such as Redbank Township face increased vulnerability to tornadoes, windstorms, and winter storms due to isolation, access issues, and longer emergency response times.

The aging housing stock in Armstrong County is another source of current and future vulnerability in many hazard events. According to the American Community Survey Estimate (2012-2016, there are over 10,500 structures in Armstrong County built earlier than 1940 (32.6 percent of the building stock). As discussed throughout the risk assessment (Section 4), Armstrong County can experience strong gusts of wind during windstorms, tornadoes, hurricanes, tropical storms, or Nor'easters. The structure of these older houses can cause them to be at greater risk of destruction under these strong wind conditions. These structures might also be at risk during flooding and winter storm events if the materials are either not strong enough to withstand the pressure or weight of the precipitation or are liable to leak, causing further risk of destruction to the house.

While any development increases the risk of damage and loss to natural hazards, a number of factors indicate that this increase in risk is low and mitigated by existing federal, state, county, and local regulations, policies, and programs. 18 municipalities in Armstrong County have adopted subdivision regulations, and 17 municipalities have adopted local zoning regulations. The Armstrong County Planning Commission reviews and reports on subdivisions, land developments, comprehensive plans, and municipal land use ordinance amendments. This broad range of planning review services is separated into two areas of activity: subdivision and land development reviews and community planning reviews. Most types of reviews are presented to the commission for its consideration at a public meeting prior to them being forwarded on to the respective municipalities and/or applicants.

Armstrong County and its municipalities have not identified areas of potential new urban growth. In the future, as urban growth is planned, it should be compared with identified hazard areas to determine hazard vulnerability.

SECTION 5 CAPABILITY ASSESSMENT

The capability assessment evaluates the community's capabilities and resources already in place at the municipal, county, state, and federal levels to reduce hazard risks. The assessment also identifies where improvements can be made to increase disaster resistance in the community.

The first step in organizing hazard mitigation capabilities or resources is to describe the basic approaches available to reduce hazard risks. According to the 2013 Pennsylvania Emergency Management Agency (PEMA) All-Hazard Mitigation Planning Standard Operating Guide (SOG), the following four general approaches may reduce hazard risks: (1) local plans and regulations, (2) structure and infrastructure, (3) natural systems protection, and (4) education and awareness. A brief description of each (according to the PEMA All-Hazard Mitigation Planning SOG) is provided below:

- **Local Plans and Regulations** – These actions include government authorities, policies, or codes that influence the ways land and buildings are developed and built.
- **Structure and Infrastructure** – These actions involve modifying existing structures and infrastructure or constructing new structures to reduce hazard vulnerability.
- **Natural Systems Protection –** These actions minimize damage and losses and preserve or restore the functions of natural systems.
- **Education and Awareness** – These actions inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate these hazards, and may also include participation in national programs.

Capability assessments document the existing resources available to local communities to reduce hazard risks. Resources can be divided into five categories: human, physical, technical, informational, and financial. For each basic capability or approach, one or more of the five resources may be available. A brief description of each resource (PEMA 2013) is provided below:

- **Human resources** include local police, fire, ambulance, and emergency management and response personnel; local government services; and electric, gas, and other utility providers that are critical during disasters.
- **Physical resources** include the equipment and vehicles (such as emergency response and recovery equipment and vehicles), public lands, facilities, and buildings available to the community.
- **Technical/technological resources** include early warning systems, weather alert radios, stream-level monitoring gauges, and 9-1-1 communications systems. Technical/technological resources also include technical requirements established by law, regulation, or ordinance.
- **Informational resources** include materials about disasters and hazard mitigation and planning; these resources are available from a wide variety of sources, such as applicable websites, libraries, and state and federal agencies.
- **Financial resources** identify the sources of funding available for hazard mitigation. Most state and federal grant programs require local communities to provide at least part of the necessary project funding in real dollars or through in-kind services. Local communities need to assess their financial capability and resources to implement hazard mitigation action plans.

This section describes and summarizes the federal, state, county, and local capabilities to address hazard risk in Armstrong County.

5.1 UPDATE PROCESS SUMMARY

During the plan update process, Armstrong County and all participating municipalities were asked to provide an updated assessment of their mitigation planning capabilities. Each municipality was provided with a Capability Assessment Survey based on Appendix 3 of the October 2013 edition of the PEMA All-Hazard Mitigation Planning SOG (PEMA 2013). The survey was provided to each of the municipal planning points of contact at the Planning Team kickoff meeting. Completed Capability Assessment Surveys, whether completed by hand, electronically, or filled in working alongside the planning consultant, are provided in Appendix D.

Armstrong County has several resources available to implement hazard mitigation initiatives, including emergency response measures; local planning and regulatory tools; administrative assistance and technical expertise; fiscal capabilities; and participation in local, regional, state, and federal programs. These resources enable community resiliency through actions taken before, during, and after a hazard event. Emergency services, manpower, equipment, and fiscal resources are important tools in addressing hazard potential and mitigation in Armstrong County communities.

This section describes and summarizes the federal, state, county, and local capabilities to address hazard risk in Armstrong County.

5.2 CAPABILITY ASSESSMENT FINDINGS

A jurisdiction's ability to effectively manage natural hazard risk is directly related to its level of hazard mitigation capabilities. As such, mitigation strategies developed in coordination with Armstrong County's municipalities have a direct effect on establishing new capability functions in the community or strengthening existing capabilities.

Armstrong County and most of its municipalities updated and completed the Capability Assessment Survey (Appendix D). If municipalities did not update or partially updated their capabilities information, the same information provided by those municipalities for the 2014 Hazard Mitigation Plan (HMP) was carried forward into this plan update.

The following sections further detail the capability assessment findings.

5.2.1 Planning and Regulatory Capability

While municipalities in Pennsylvania must comply with the minimum regulatory requirements established under the Pennsylvania Municipal Planning Code, they otherwise have considerable latitude in adopting ordinances, policies, and programs that can be used to manage natural and non-natural hazard risks. Specifically, municipalities can manage these risks through comprehensive land use planning, hazard-specific ordinances (for example, flood damage prevention, sinkholes, and steep slopes), zoning, site-plan approval, and building code enforcement. When effectively prepared and administered, these regulations can lead to hazard mitigation.

For example, the adoption of the National Flood Insurance Program (NFIP) and the Pennsylvania Flood Plain Management Act (Act 166 of 1978) established minimum floodplain management criteria. A municipality must adopt and enforce these minimum criteria to be eligible for participation in the NFIP. Municipalities have the option of adopting a single-purpose ordinance or incorporating these provisions into their zoning and/or subdivision and land development ordinances or building codes, thereby mitigating the potential impacts of local flooding.

County and Municipal Planning Capabilities

Armstrong County Comprehensive Plan

A comprehensive plan is a policy document that states objectives and guides the future growth and physical development of a municipality. The comprehensive plan is a blueprint for housing, transportation, community facilities, utilities, and land use. It examines how the past led to the present and charts the community's future path. The Pennsylvania Municipalities Planning Code (MPC) Act 247 of 1968, as reauthorized and amended, requires counties to prepare and maintain a comprehensive plan. In addition, the MPC requires counties to update the comprehensive plan every 10 years.

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

The County's comprehensive plan, "Armstrong County Comprehensive Plan," is slated to guide Armstrong County until 2025. The comprehensive plan was adopted in 2005 and addresses the following plan elements:

- Housing
- Economic development
- Transportation
- Recreation / Open Space / Natural Resources
- Public Utilities / Services / Facilities
- Land Use

Each plan element includes a profile, trends, conclusions, and policy statements as well as an implementation matrix.

Policy statements for housing include: encourage various types of residential units to meet the needs of present and future residents, including special needs populations; use zoning classifications or land use criteria to guide residential development and to establish funding priorities regarding the extension of utilities; promote homeownership; in rural areas, continue existing housing development patterns (low density detached single-family housing) except in areas where public sewer and water infrastructure permits higher density residential development.

Policy statements for economic development include: promote countywide tourism efforts; utilize the county's historic buildings and properties to attract tourists; pursue economic development based on criteria that promote efficient land use and provision of public utilities; promote brownfield development; consider adaptive re-use of abandoned/underutilized/vacant non-brownfield properties (e.g., former schools) for commercial and industrial uses; increase all types of development in the county.

Policy statements for transportation include: maintain and improve the existing transportation network; improve public transit; continue collaborative efforts with neighboring counties, transportation planning agencies, and Pennsylvania Department of Transportation (PennDOT) to seek and secure federal funding for the extension of Route 28 as a four-lane highway to I-80; to the greatest extent possible, link various modes of travel; integrate transportation policies with land use policies to make them mutually supportive, i.e., target transportation improvements to growth areas/corridors.

Policy statements for recreation, open space/natural resources include: ensure that current recreational needs are being met and future recreational needs will be met; to conserve natural resources and scenic rural character of the county; to coordinate with other regional environmental studies; promote countywide tourism efforts through recreational opportunities.

Although the MPC requires that municipal plans be in accord with the County plan, the code provides no measures for ensuring this occurs. Several municipalities have adopted single- or multi-jurisdictional regional comprehensive plans. The County is also working on a new comprehensive plan to be entitled Places 2040.

Stormwater Management Planning

In 1978, the Pennsylvania General Assembly passed the Stormwater Management Act (Act 167) of 1978 (Pennsylvania State Data Center 1978). Act 167 requires counties to prepare stormwater management plans on a watershed-by-watershed basis. The plans must be developed in consultation with the affected municipalities. Each new plan is required to provide standards for control of runoff from new development, based on a detailed hydrologic assessment. A key objective of each plan is to coordinate the stormwater management decisions of the watershed municipalities. Implementation of each plan is through mandatory municipal adoption of ordinance provisions consistent with the plan.

Plans prepared under Act 167 will not resolve all drainage issues. A key goal of the planning process is to maintain existing peak runoff rates throughout a watershed as land development continues to take place. While the planning process does not solve existing flooding problems, it aims to prevent these problems from getting worse. Each municipality is responsible for correcting existing flooding problems.

In July 2017, Armstrong County developed the Act 167 Scope of Study for Armstrong County Stormwater Management Plan (Armstrong County Planning Commission 2017). This Plan is the result of Phase 1 of the Act 167 Plan and includes:

- A summary of County watershed characteristics
- An inventory of relevant problems
- A proposed scope of study, schedule, and budget for completion of the Phase 2 Plan project.

The plan is designed to provide consistency in stormwater management planning, regulation, and implementation; provide an integrated stormwater management plan; provide useable technical information in a GIS format; and provide technical information for future hydrologic and hydraulic analysis and regulatory activities.

An Act 167 Stormwater Management Plan for the Glade Run Watershed was previously completed in 1991.

According to Section 11(b) of Act 167, municipalities subject to the Stormwater Management Plan must enact or amend and implement such ordinances as necessary to regulate development in a manner consistent with the Stormwater Management Plan. Municipalities are encouraged to use the model ordinance included in the plan.

Open Space and Natural Resource Planning

Armstrong County has prepared several plans with the goal of preserving open space in the County for recreational and environmental purposes. These plans include chapters in the Armstrong County Comprehensive Plan (Armstrong County Planning Commission 2005) and the Armstrong County Comprehensive Recreation, Park, Open Space and Greenway Plan.

Transportation Planning

Armstrong County participates in the Southwestern Pennsylvania Commission (SPC). The SPC works with the 10 member counties, PennDOT and other organizations as the Metropolitan Planning Organization (MPO) for southwestern Pennsylvania. The MPO is responsible for developing a long-range transportation plan, the transportation improvement program (TIP) and other transportation-related documents and reports.

Informational Resources

Armstrong County has a variety of informational resources available. Informational resources include websites, brochures, pamphlets, workshops, and public service announcements PSAs.

- The Department of Public Safety (DPS) has an informational website located at https://www.armcodps.com/
- The County's website is located at http://co.armstrong.pa.us/.
- Information on hazard mitigation and preparedness was referenced at the websites for Federal Emergency Management Agency (FEMA) (www.fema.gov) and PEMA (www.pema.state.pa.us).

Armstrong County Emergency Management

The Armstrong County Department of Public Safety (DPS) maintains a strong emergency management capability that supports Armstrong County. The County operates an emergency 9-1-1 call center and activates its own emergency operations center (EOC) during emergencies. In addition, the County provides or supports emergency service programs and measures, including emergency response, public alert and warning systems, emergency communications systems, hazard event monitoring systems, and public information and outreach programs. Capabilities include the 9-1-1 center, CodeRED, EOC, emergency service measures, emergency response planning, public information programs, and geographic information system, which are described in the sections below.

9-1-1 Center

9-1-1 is the telephone number used to report emergencies. Citizens use the service in the event of the presence or potential for an immediate threat to life or property and to request response from police, fire, or emergency medical services (EMS) agencies. Examples include reporting a crime that has just occurred or is in progress; describing an odor such as gas or reporting a fire; or calling for assistance with a sick or injured person who requires treatment and possibly transportation to a hospital emergency department. The 9-1-1 system is capable of accepting calls from hearing or speech-impaired callers using a Telecommunications Device for the Deaf (TDD), and text messages. Each county in Pennsylvania operates a 9-1-1 Public Safety Answering Point (PSAP). Personnel at these PSAPs would need to coordinate their efforts in a regional hazard event. Computerized mapping of streets with address information is critical for emergency response purposes. The 9-1-1 center is also used to alert citizens during an emergency. Armstrong County 911 can also flag resident addresses that have special needs such as mobility restrictions and health issues to better serve the public.

Emergency Operations Center

In the event of an impending emergency or disaster, Armstrong County would activate its EOC. When activated, the EOC is in constant communication with the 9-1-1 center to ensure coordination of activities. The EOC is located in the Emergency Services Facility in Rayburn Township and was completed in 2012.

The DPS capabilities fall under two categories: emergency service measures and emergency response planning. These capabilities are described below.

Emergency Operations Plan

The Pennsylvania Emergency Management Services Code, Title 35, requires all political jurisdictions in the Commonwealth to have an Emergency Operations Plan (EOP), an Emergency Management Coordinator (EMC), and an EOC.

The Armstrong County EOP documents the County's emergency preparedness planning. The EOP includes County-specific emergency response procedures during significant emergency events. Armstrong County's EOP complies with the National Incident Management System (NIMS) and is updated every 2 years. The updated risk assessment information from this HMP will be incorporated into subsequent updates to the EOP.

Mutual Aid Agreements

Armstrong County has mutual aid agreements (formal agreements) with the contiguous Pennsylvania counties as a result of the Pennsylvania Intrastate Mutual Assistance Program. Every county participates in this program. Armstrong County is also part of a larger county consortium, the Pennsylvania Region 13 Task Force (Region 13), which works together and shares resources during times of emergency. Originally formed in response to the increasing threat of weapons of mass destruction (WMD) and other terroristic activity, Region 13 also provides all-hazards preparedness, mitigation, prevention, response, and recovery services to citizens in its purview. This intergovernmental agreement is between the following counties:

- Allegheny
- Armstrong
- Beaver
- Butler
- Cambria
- Fayette
- Greene
- Indiana
- Lawrence
- Somerset
- Mercer
- Westmoreland
- Washington

Regional Planning Initiatives

Armstrong County also assists in County or regional planning and preparation for the following:

- Local (Municipal) EOPs
- Medical facilities
- Dams
- Airports
- Pandemic
- Mass casualty/fatality incidents
- Counterterrorism preparedness
- Special events, such as concerts, parades, etc.
- School emergency planning
- Day care, group home, and special needs facilities
- Superfund Amendments and Reauthorization Act of 1986 (SARA) – The Local Emergency Planning Committee program is based on the SARA of 1986, Title III. This legislation requires local planning by businesses and response agencies (such as fire departments and hazardous materials teams) whenever hazardous materials are involved. SARA also requires the establishment of a system in each community that informs the citizens of chemicals used, manufactured, and stored locally.
- In cooperation with the American Red Cross, the County has designated shelters that may be used during emergencies and disasters.

Local Emergency Management Capabilities

According to Pennsylvania Title 35 (Emergency Management Services Code), Chapter 7500, the following stipulations apply:

- Each political subdivision of this Commonwealth is directed and authorized to establish a local emergency management organization in accordance with the plan and program of PEMA. Each local organization shall have responsibility for emergency response and recovery within the territorial limits of the political subdivision within which it is organized and, in addition, shall conduct such services outside of its jurisdictional limits as may be required under this part.
- The governing body of a political subdivision may declare a local disaster emergency upon finding a disaster has occurred or is imminent. The effect of a declaration of a local disaster emergency is to activate the response and recovery aspects of any and all applicable local emergency management plans and to authorize the furnishing of aid and assistance.
- Each local organization of emergency management shall have a coordinator who shall be responsible for the planning, administration, and operation of the local organization.
- Each political subdivision shall adopt an Intergovernmental Cooperation agreement with other political subdivisions to accomplish the following:
    - Prepare, maintain, and keep current a disaster emergency management plan for (1) the prevention and minimization of injury and damage caused by a disaster, (2) prompt and effective response to disaster, and (3) disaster emergency relief and recovery consistent with the Pennsylvania Emergency Management Plan.
    - Establish, equip, and staff an EOC (integrated with warning and communication systems) to support government operations in emergencies and provide other essential facilities and equipment for agencies and activities assigned emergency functions.
    - Provide individual and organizational training programs to ensure prompt, efficient, and effective disaster emergency services.

- Organize, prepare, and coordinate all locally available manpower, materials, supplies, equipment, facilities, and services necessary for disaster emergency readiness, response, and recovery.
- Adopt and implement precautionary measures to mitigate the anticipated effects of a disaster. Execute and enforce such rules and orders as the agency shall adopt and promulgate under the authority of this part.
- Cooperate and coordinate with any public and private agency or entity in achieving any purpose of this part.
- Have available for inspection at its EOC all emergency management plans, rules, and orders of the Governor and PEMA.
- Provide prompt and accurate information regarding local disaster emergencies to appropriate Commonwealth and local officials and agencies and the general public.
- Participate in all tests, drills, and exercises—including remedial drills and exercises—scheduled by the agency or by the federal government.
- Participate in the program of integrated flood warning systems under Section 7313 (6) (relating to powers and duties).

- Direction of disaster emergency management services is first the responsibility of the lowest level of government affected. When two or more political subdivisions within a county are affected, the county organization shall exercise responsibility for coordination and support to the area of operations. When two or more counties are involved, coordination shall be provided by PEMA or by area organizations established by PEMA.
- When all appropriate locally available forces and resources are fully committed by the affected political subdivision, assistance from a higher level of government shall be provided.
- Local coordinators of emergency management shall develop mutual aid agreements with adjacent political subdivisions for reciprocal emergency assistance. The agreements shall be consistent with the plans and programs of PEMA.

Mutual Aid Agreements

Armstrong County has formal mutual aid agreements in place with its municipalities.

Emergency Operations Centers

In the event of an impending emergency or disaster, the local EOC may be activated. The purpose of the EOC is to manage the emergency response and coordinate distribution of resources to a disaster incident at the local level.

Emergency Response

Each municipality is responsible for providing emergency response to their municipality consisting of EMS, fire, and police. If a municipality does not have one of these providers in their community, they should have mutual aid agreements with an adjacent political subdivision or the Commonwealth (e.g., law enforcement coverage by the Pennsylvania State Police [PSP]) to respond.

Monitoring Systems

The municipalities may also be equipped with several systems to monitor emergency information and warnings, including the Radio Amateur Civil Emergency Service (RACES) and the National Weather Service (NWS), which have been described previously.

Emergency Response Planning

The municipalities may also assist with planning for:

1. Municipal EOPs

2. Medical facilities
3. Dams
4. Counterterrorism preparedness
5. Special events
6. School emergency planning
7. Day care, group homes, and special needs facilities
8. Evacuation

A summary of existing federal, state, regional, and county programs (regulatory and otherwise) to manage specific hazard risks may be found in the hazard profiles in Section 4 of this plan update. While the risk of certain hazards can be addressed at least partially through mitigation, the risks of other hazards (particularly certain non-natural hazards) are primarily managed through the preparedness and response elements of emergency management or through other regulatory programs at the federal and state levels.

Participation in the National Flood Insurance Program

According to FEMA's 2002 NFIP: Program Description, the U.S. Congress established the NFIP with the passage of the National Flood Insurance Act of 1968 (FEMA 2002). The NFIP is a federal program enabling property owners in participating communities to purchase insurance as a protection against flood losses in exchange for state and community floodplain management regulations that reduce future flood damages.

Participation in the NFIP is based on an agreement between communities and the federal government. If a community adopts and enforces a floodplain management ordinance to reduce future flood risk to new construction and substantial improvements in floodplains, the federal government will make flood insurance available within the community as a financial protection against flood losses. This insurance is designed to provide an alternative to disaster assistance and reduce the escalating costs of repairing damage to buildings and their contents caused by floods (FEMA 2002).

NFIP-participating communities in Armstrong County are required to adopt a flood damage prevention ordinance (also sometimes called a "floodplain" or "floodplain management ordinance") and update this ordinance whenever the regulatory NFIP Flood Insurance Rate Maps (FIRM) are officially updated. The Pennsylvania Department of Community and Economic Development (PA DCED) (Commonwealth-coordinating agency for the NFIP) provides support to municipalities by providing suggested text for floodplain management ordinances.

All of the County's municipalities except Atwood, Burrell, Elderton, Ford Cliff, and West Kittanning participate in the NFIP. Neither borough is located within the 1 percent annual chance floodplain, and neither borough has an identified flood hazard. Armstrong County's municipalities' FIRMs were made effective in February 2016. All participating municipalities have adopted a floodplain ordinance, and many have adopted a stormwater management ordinance.

The municipalities' floodplain administrators, who are often either the code enforcement officer or zoning officer for the municipality, enforce the floodplain ordinances locally. Throughout Armstrong County, all municipalities enforce the Uniform Construction Code, and most enforce zoning regulations. Rather than using a specific Floodplain Development Permit, the County's municipalities include a space for applicants to state whether the proposed development is in the floodplain on zoning and/or building permit applications. The permit application reviewer confirms whether the property in question is in the floodplain. If it is, the municipal floodplain administrator reviews the proposed development against the municipality's floodplain management ordinance. The floodplain administrator conducts similar reviews of any revisions to the permit application until all requirements are met. As the proposed activity is conducted, the floodplain administrator works with the code enforcement officer and/or zoning officer to conduct inspections and ensure that the proposed activity is carried out as it was permitted.

NFIP-participating communities in Armstrong County are required to make current NFIP FIRMs available to their residents for review and may provide mapping assistance through their floodplain administrators. Typically, this mapping is available at the municipal offices in each community. Floodplain administrators provide information about mapping to their residents using established outreach methods such as municipal websites, newsletters, and mailings. At the time of this plan update, the Armstrong County FEMA Digitized Flood Insurance Rate Maps (DFIRM) (dated February 2016) were used to evaluate exposure and determine potential future losses.

Floodplain administrators also use established outreach methods to provide information about flood insurance to residents and business owners. They can provide information on the availability of flood insurance, how to get a flood insurance policy, and determining the appropriate level of coverage.

Municipal participation in and compliance with the NFIP is supported at the federal level by FEMA Region III and the Insurance Services Organization (ISO) and at the state level by the PA DEP, PA DCED, and PEMA. The County's Department of Planning and Development and Conservation District also supports flood mitigation efforts, associated training, and public education and awareness programs.

Flood hazard risk management in Armstrong County is further supported by the Act 167 Scope of Study for Armstrong County Stormwater Management Plan (see above). Ideally, this plan will continue to reduce the effects of flooding in certain areas of the County.

Additional information on the NFIP program and its implementation within the County can be found in the flood hazard profile in Section 4.3.5.

Community Rating System (CRS)

In the 1990s, the Flood Insurance Administration (FIA) established the CRS to encourage local governments to increase their standards for floodplain development. The goal of the program is to encourage communities, through flood insurance rate adjustments, to implement standards beyond the minimum required in order to:

- Reduce losses from floods
- Facilitate accurate insurance ratings
- Promote public awareness of the availability of flood insurance

CRS is a voluntary program designed to reward participating jurisdictions for their efforts to create more disaster-resistant communities using the principles of sustainable development and management. By enrolling in CRS, municipalities can leverage greater flood protection while receiving flood insurance discounts.

There are 10 CRS classes that provide varied reduction in insurance premiums. Class 1 requires the most credit points and gives the largest premium reduction; Class 10 receives no premium reduction. CRS premium discounts on flood insurance range from 5 percent for Class 9 communities up to 45 percent for Class 1 communities. The CRS recognizes 18 creditable activities that are organized under four categories: Public Information, Mapping and Regulations, Flood Damage Reduction, and Flood Preparedness.

Currently, no Armstrong County municipalities participate in the CRS Program. Increased participation will be supported by the County and will be promoted through the local emergency management coordinators as identified in the updated mitigation strategies.

Municipal Capabilities

Participating municipalities in this planning effort were provided a Capability Assessment Survey. Table 5-1 summarizes the responses of the municipalities based on planning and regulatory capability, supplemented by information received from the County regarding municipal capabilities. Detailed information regarding Armstrong County municipalities' planning and regulatory capabilities can be found in the municipal survey responses provided in Appendix D.

Table 5-1. Planning and Regulatory Capability

Municipality	Hazard Mitigation Plan	EOP	Disaster Recovery Plan	Evacuation Plan	COOP Plan	NFIP	NFIP – CRS	Floodplain Regulations	Floodplain Mgmt. Plan	Zoning Regulations	Subdivision Regulations	Comprehensive Land Use Plan (or General, Master, or Growth Mgmt. Plan)	Open Space Mgmt. Plan	Stormwater Mgmt. Plan/Ordinance	Natural Resource Protection Plan	Capital Improvements Plan	Economic Dev. Plan	Historic Preservation Plan	Farmland Preservation	Building Code	Fire Code	Other
Armstrong County	X	X	-	X	X	N/A	N/A	N/A	-	-	X	X	X	+	-	-	-	-	-	N/A	N/A	-
Apollo Borough	X					X	-	X		X	X	X		-								
Applewold Borough	X	X	-	-	-	X	-	X	X	X	-	-	-	-	-	-	-	-	X	-	-	-
Atwood Borough	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Bethel Township	X	X	-	-	-	X	-	X	-	-	-	X	-	-	-	-	-	-	X	X	-	-
Boggs Township	X					X	-	X		-	-	-		-								
Bradys Bend Township	X	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Burrell Township	X	+	-	-	-	-	-	-	+	X	X	-	-	-	-	-	X	+	X	X	-	-
Cadogan Township	X	+	-	-	-	X	-	X	X	X	-	X	-	-	-	-	-	-	-	X	-	-
Cowanshannock Township	X	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Dayton Borough	X	X	-	X	X	X	-	X	X	-	X	-	-	-	-	-	-	-	-	X	X	-
East Franklin Township	X	+	+	+	+	X	-	X	X	X	X	X	X	X	X	X	X	X	X	X	X	-
Elderton Borough	X	X	-	-	-	-	-	-	-	-	X	-	-	X	-	X	-	-	-	X	-	-
Ford City Borough	X	X	+	X	-	X	-	X	X	X/+	X	X	X	+	-	+	X/+	-	-	X	X	-
Ford Cliff Borough	X					-	-	-		-	-	-		-								
Freeport Borough	X	X	-	-	-	X	-	X	X	X	-	-		-	-	-	-	-	-	X	-	-
Gilpin Township	X	X	X	X	-	X	-	X	X	X	-	X	-	-	-	-	-	-	-	-	-	-
Hovey Township	X	X	-	X	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	X	-	-
Kiskiminetas Township	X	X	-	-	-	X	-	X	-	X	X	X	-	X	-	-	-	-	-	X	-	-
Kittanning Borough	X	X	-	X	-	X	-	X	X	X	-	-	-	X	-	-	X	-	-	X	X	-
Kittanning Township	X					X	-	X		-	-	-		-								
Leechburg Borough	X					X	-	X		X	-	X		X								

Municipality	Hazard Mitigation Plan	EOP	Disaster Recovery Plan	Evacuation Plan	COOP Plan	NFIP	NFIP – CRS	Floodplain Regulations	Floodplain Mgmt. Plan	Zoning Regulations	Subdivision Regulations	Comprehensive Land Use Plan (or General, Master, or Growth Mgmt. Plan)	Open Space Mgmt. Plan	Stormwater Mgmt. Plan/Ordinance	Natural Resource Protection Plan	Capital Improvements Plan	Economic Dev. Plan	Historic Preservation Plan	Farmland Preservation	Building Code	Fire Code	Other
Madison Township	X	X	-	-	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Mahoning Township	X	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Manor Township	X	X	+	+	X	X	-	X	X	-	X	X	+	X	-	-	X	X	X	X	X	-
Manorville Borough	X	X	-	-	-	X	-	X	X	-	X	X	-	-	-	-	-	-	-	X	-	-
North Apollo Borough	X	X	-	-	-	X	-	X	X	X	X	-	-	X	-	-	-	-	-	-	-	-
North Buffalo Township	X	X	X	X	X	X	-	X	X	X	X	-	-	-	-	X	X	-	-	X	X	-
Parker City	X	X	-	X	-	X	-	X	X	-	-	X	-	-	-	-	X	-	-	X	-	-
Parks Township	X	X	-	X	-	X	-	X	X	-	X	X	-	X	-	-	-	-	-	X	X	-
Perry Township	X	+	-	+	-	X	-	X	X	-	X	-	-	-	-	-	-	-	X	X	-	-
Pine Township	X	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Plumcreek Township	X	X	-	-	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Rayburn Township	X	X	-	-	-	X	-	X	X	-	-	-	-	X	-	-	-	-	-	X	-	-
Redbank Township	X	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rural Valley Borough	X	X	-	-	-	X	-	X	X	-	X	-	-	X	-	-	-	-	-	X	X	-
South Bend Township	X	X	-	-	-	X	-	X	X	X	X	-	-	-	-	-	-	-	X	X	-	-
South Bethlehem Borough	X	X	-	-	-	X	-	X	X	-	-	-	-	-	-	-	-	-	-	-	-	-
South Buffalo Township	X	X	+	+	+	X	-	X	X	X	X	X	+	X	X	+	+	+	X	X	+	-
Sugarcreek Township	X	X	+	+	+	X	-	X	X	X	X	X	+	X	+	+	+	+	+	X	+	-
Valley Township	X	X	-	-	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Washington Township	X					X	-	X		-	-	-		-								
Wayne Township	X	X	-	X	-	X	-	X	X	X	X	X	-	-	-	-	-	-	-	X	-	-
West Franklin Township	X	X	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-
West Kittanning Borough	X	X	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	X	X	-
Worthington Borough	X	X	-	X	-	X	-	X	-	-	-	-	-	-	-	-	-	-	-	X	X	-

Notes:
"X" indicates that the municipality currently has this capability in place.
"-" indicates no capability is currently in place.
"+" indicates that the capability is under development.
"N/A": Not applicable
Blank space indicates no response was received from the municipality.

5.2.2 Administrative and Technical Capability

Administrative capability is described as the adequacy of departmental and personnel resources for the implementation of mitigation-related activities. Technical capability relates to an adequacy of knowledge and technical expertise of local government employees or the ability to contract outside resources for this expertise in order to effectively execute mitigation activities. Common examples of skillsets and technical personnel needed for hazard mitigation include: planners with knowledge of land development/management practices, engineers or professionals trained in construction practices related to buildings and/or infrastructure (e.g., building inspectors), planners or engineers with an understanding of natural and/or human-caused hazards, emergency managers, floodplain managers, land surveyors, scientists familiar with hazards in the community, staff with the education or expertise to assess community vulnerability to hazards, personnel skilled in geographic information systems, resource development staff or grant writers, and fiscal staff to handle complex grant application processes.

Municipalities are further supported by county, regional, state, and federal administrative and technical capabilities. For this HMP, the majority of support agencies and resources have been identified and referenced throughout this plan update.

It is noted that the County and many of its municipalities have identified specific mitigation initiatives described in this plan update, which will help build and enhance mitigation-related administrative and technical capabilities in Armstrong County.

Federal and Commonwealth Capabilities

Federal agencies that can provide technical assistance for mitigation activities include but are not limited to:

- U.S. Army Corps of Engineers
- Department of Housing and Urban Development
- Department of Agriculture
- Economic Development Administration
- Emergency Management Institute
- Environmental Protection Agency
- FEMA
- Small Business Administration

Commonwealth agencies which can provide technical assistance for mitigation activities include but are not limited:

- Pennsylvania Department of Community and Economic Development
- Pennsylvania Department of Conservation and Natural Resources
- Pennsylvania Department of Environmental Protection
- Pennsylvania Emergency Management Agency
- Pennsylvania Silver Jackets

Municipal Capabilities

Participating municipalities in this planning effort were provided with a capabilities survey. Table 5-2 summarizes the responses of the municipalities based on administrative and technical capability. Copies of the individual municipal responses are found in Appendix D.

Table 5-2. Administrative and Technical Capability

Municipality	Planners (with land use/land development knowledge)	Planners or Engineers (with natural and/or human-caused hazards knowledge)	Engineers or Professionals trained in building and/or infrastructure construction practices	Emergency Manager	NFIP Floodplain Administrator	Land Surveyors	Scientists or Staff familiar with the hazards of the community	Personnel skilled in GIS and/or the FEMA HAZUS program	Grant Writers or Fiscal Staff to handle large/complex grants	Staff with expertise or training in Benefit-Cost Analysis	Other
Armstrong County	X	-	-	X	N/A	-	-	-	-	-	-
Apollo Borough				X	X						
Applewold Borough	-	-	-	X	X	-	-	-	-	-	-
Atwood Borough	-	-	-	X	-	-	-	-	-	-	-
Bethel Township	-	-	-	X	X	-	-	-	-	-	-
Boggs Township				X	X						
Bradys Bend Township	-	-	-	X	X	X	-	-	-	-	-
Burrell Township	-	-	X	X	-	-	-	-	-	-	-
Cadogan Township	-	-	-	X	X	-	-	-	-	-	-
Cowanshannock Township	-	-	-	X	X	-	-	-	-	-	-
Dayton Borough	-	-	-	X	X	-	-	-	-	-	-
East Franklin Township	-	-	-	-	X	-	-	-	-	-	-
Elderton Borough	X	-	X	X	-	-	-	-	-	-	-
Ford City Borough	X	X	X	X	X	-	-	-	X	X	-
Ford Cliff Borough				X	-						
Freeport Borough				X	X						
Gilpin Township	-	-	-	X	X	-	X	-	-	-	-
Hovey Township	-	-	-	X	X	-	-	-	-	-	-
Kiskiminetas Township	X	-	X	X	X	-	-	-	X	X	-
Kittanning Borough	-	-	X	X	X	-	-	-	-	-	-
Kittanning Township				X	X						
Leechburg Borough				X	X						
Madison Township				X	X						
Mahoning Township	-	-	-	X	X	-	X	-	X	-	-
Manor Township	-	X	X	X	X	-	X	X	-	-	-
Manorville Borough	-	-	-	X	X	-	-	-	-	-	-
North Apollo Borough	X	X	X	X	X	X	-	X	-	-	-
North Buffalo Township	-	-	X	X	X	X	-	X	X	X	-
Parker City	-	-	-	X	X	-	-	-	X	-	-
Parks Township	-	X	X	X	X	-	-	-	-	-	-
Perry Township	-	-	X	X	X	X	-	-	-	-	-
Pine Township	-	-	-	-	X	-	-	-	-	-	-

Municipality	Planners (with land use/land development knowledge)	Planners or Engineers (with natural and/or human-caused hazards knowledge)	Engineers or Professionals trained in building and/or infrastructure construction practices	Emergency Manager	NFIP Floodplain Administrator	Land Surveyors	Scientists or Staff familiar with the hazards of the community	Personnel skilled in GIS and/or the FEMA HAZUS program	Grant Writers or Fiscal Staff to handle large/complex grants	Staff with expertise or training in Benefit-Cost Analysis	Other
Plumcreek Township	-	-	-	-	X	-	-	-	-	-	-
Rayburn Township	-	-	X	X	X	-	-	-	-	-	-
Redbank Township	X	-	X	X	X	-	-	-	-	-	-
Rural Valley Borough	-	X	X	X	X	-	-	-	-	-	-
South Bend Township	X	-	X	-	X	-	-	-	-	-	-
South Bethlehem Borough	-	-	-	X	X	-	-	-	-	-	-
South Buffalo Township	-	-	X	-	X	-	-	-	-	-	-
Sugarcreek Township	-	-	X	X	X	-	-	-	-	-	-
Valley Township	-	-	X	-	X	-	-	-	-	-	-
Washington Township				-	X						
Wayne Township	-	-	X	X	X	-	-	-	-	-	-
West Franklin Township	-	-	-	X	X	-	-	-	-	-	-
West Kittanning Borough	-	-	-	X	-	-	-	-	-	-	-
Worthington Borough	-	-	-	X	X	-	-	-	-	-	-

Notes:
"X" indicates that the municipality currently has this capability in place.
"-" indicates no capability is currently in place.
Blank space indicates no response was received from the municipality.

5.2.3 Financial Capability

Mitigation projects and initiatives are largely or entirely dependent on available funding. As such, it is critical to identify all available sources of funding at the local, county, regional, state, and federal level to support implementation of the mitigation strategies identified in this plan update.

Jurisdictions fund mitigation projects though existing local budgets, local appropriations (including referendums and bonding), and through myriad federal and state loan and grant programs.

Federal mitigation grant funding (Stafford Act 404 and 406) (FEMA 2000) is available to all communities with a current HMP (this plan); however, most of these grants require a "local share" in the range of 10 to 25 percent of the total grant amount.

Federal Hazard Mitigation Funding Opportunities

The Hazard Mitigation Grant Program

The Hazard Mitigation Grant Program (HMGP) (Stafford Act 404 and 406) is a post-disaster mitigation program made available to states by FEMA after each federal disaster declaration. The HMGP can provide up to 75 percent funding for hazard mitigation measures and can be used to fund cost-effective projects to protect public or private property in an area covered by a federal disaster declaration or that projects to reduce the likely damage from future disasters. Examples of projects include acquisition and demolition of structures in hazard-prone areas, flood proofing, or elevation to reduce future damage, minor structural improvements, and development of state or local standards.

Projects must fit into an overall mitigation strategy for the area identified as part of a local planning effort. All applicants must have a FEMA-approved HMP. Applicants who are eligible for the HMGP include state and local governments, certain nonprofit organizations or institutions that perform essential government services, and Indian tribes and authorized tribal organizations. Individuals or homeowners cannot apply directly for the HMGP; a local government must apply on their behalf. Applications are submitted to PEMA for ranking and submission to FEMA for final approval. Eligible projects not selected for funding are placed in an inactive status and may be considered as additional HMGP funding becomes available.

Sections 404 and 406 hazard mitigation funding are two distinct criteria associated with mitigation funding. Participation in FEMA 404 HMGP may cover mitigation activities, including raising, removing, relocating, or replacing structures within flood hazard areas. FEMA 406 HMGP is applied to parts of a facility that were actually damaged by a disaster and the mitigation measures that provide protection from subsequent events.

Flood Mitigation Assistance Program

Flood Mitigation Assistance (FMA) provides funding to assist states and communities in implementing measures to reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other structures insurable under the NFIP. FMA is funded annually; no federal disaster declaration is required. Only NFIP-insured homes and businesses are eligible for mitigation in this program. Funding for FMA is limited and, as with the HMGP, individuals cannot apply directly. Applications must come from local governments or other eligible organizations.

The federal government cost share for an FMA project is 75 percent. At least 25 percent of the total eligible costs must be provided by a non-federal source, and of this 25 percent, no more than half can be provided as in-kind contributions from third parties. At a minimum, a FEMA-approved local HMP is required before a project can be approved. FMA funds are distributed from FEMA to the Commonwealth. PEMA serves as the grantee and program administrator for FMA.

As of fiscal year 2013, the Severe Repetitive Loss and Repetitive Flood Claims Programs were dismantled and incorporated into the FMA Program. As a result, residential and non-residential properties currently insured with NFIP are eligible to receive FMA funds as long as they meet either the Repetitive Loss Properties (RLP) or Severe Repetitive Loss (SRL) property definitions as described in Section 4.3.5 of this plan.

Pre-Disaster Mitigation Program

The Pre-Disaster Mitigation (PDM) Program is an annually funded, nationwide, competitive grant program. No disaster declaration is required. Federal funds will cover 75 percent of a project's cost up to $3 million. As with the HMGP and FMA, a FEMA-approved local HMP is required to be approved for funding under the PDM program.

Federal Disaster Assistance Programs

Following a disaster, various types of assistance may be made available by local, state, and federal governments. The types and levels of disaster assistance depend on the severity of the damage and the declarations that result from the disaster event. General types of assistance that may be provided, should the President of the United States declare the event a major disaster, include the following:

- Individual Assistance – Provides help for homeowners, renters, businesses, and some nonprofit entities after disasters occur. This program is largely funded by the U.S. Small Business Administration. For homeowners and renters, those who suffered uninsured or underinsured losses may be eligible for a Home Disaster Loan to repair or replace damaged real estate or personal property. Renters are eligible for loans to cover personal property losses. Individuals may borrow up to $200,000 to repair or replace real estate and $40,000 to cover losses to personal property. For businesses, loans may be made to repair or replace disaster damages to property owned by the business, including real estate, machinery and equipment, inventory, and supplies. Businesses of any size are eligible. Nonprofit organizations such as charities, churches, private universities, etc., are also eligible. An Economic Injury Disaster Loan provides necessary working capital until normal operations resume after a physical disaster. These loans are restricted, by law, to small businesses only.

- Public Assistance – Provides cost reimbursement aid to local governments (state, county, local, municipal authorities, and school districts) and certain nonprofit agencies that were involved in disaster response and recovery programs or that suffered loss or damage to facilities or property used to deliver government-like services.

U.S. Department of Housing and Urban Development Community Development Block Grants

The U.S. Department of Housing and Urban Development (HUD) Community Development Block Grants (CDBG) are federal funds intended to provide low- and moderate-income citizens with decent housing, a suitable living environment, and expanded economic opportunities. Eligible activities include community facilities and improvements, roads and infrastructure, housing rehabilitation and preservation, development activities, public services, economic development, planning, and administration. Public improvements may include flood and drainage improvements. In limited instances, and during times of "urgent need" (for example, post-disaster) as defined by the CDBG National Objectives, CDBG funding may be used to acquire a property located in a floodplain that was severely damaged by a recent flood, demolish a structure severely damaged by an earthquake, or repair a public facility severely damaged by a hazard event.

Additional Federal Resources

Weatherization Assistance Program: Minimizes the adverse effects of high-energy costs on low-income, elderly, and disabled citizens through client education activities and weatherization services like heating system modifications and insulation (US DOE 2011).

Section 108 Loan Guarantee Programs: Provides loan guarantees as security for federal loans for acquisition, rehabilitation, relocation, clearance, site preparation, special economic development activities, and construction of certain public facilities and housing (HUD 2011).

U.S. Department of Agriculture: Provides disaster assistance through the following:

- The Emergency Conservation Program provides emergency funding for farmers to rehabilitate farmland damaged by natural disasters and for carrying out emergency water conservation measures during periods of severe drought.
- The Non-Insured Crop Disaster Assistance Program provides financial assistance for non-insurable crop losses and planting prevented by disasters.

Emergency Watershed Protection Program: Undertakes emergency measures, including the purchase of floodplain easements for runoff retardation and soil erosion prevention to safeguard lives and property from floods, drought, and the products of erosion on any watershed whenever fire, flood, or any other natural occurrence is causing or has caused a sudden impairment of the watershed (NRCS 2011). It is not necessary for an emergency to be declared by the President for an area to be eligible for assistance. The program objective is to assist sponsors and individuals in implementing emergency measures to relieve imminent hazards to life and property created by a natural disaster. Activities include providing financial and technical assistance to remove debris from streams, protecting destabilized stream banks, establishing cover on critically eroding lands, repairing conservation practices, and purchasing of floodplain easements. The program is designed for installation of recovery measures.

Commonwealth Hazard Mitigation Funding Opportunities

Commonwealth programs that may provide financial support for mitigation activities include but are not limited to:

- Community Conservation Partnerships Program

- Community Revitalization Program
- Floodplain Land Use Assistance Program
- Growing Greener Program
- Keystone Grant Program
- Local Government Capital Projects Loan Program
- Land Use Planning and Technical Assistance Program
- Pennsylvania Heritage Areas Program
- Pennsylvania Recreational Trails Program
- Shared Municipal Services
- Technical Assistance Program

Marcellus Shale Legacy Fund - Act 13 of 2012

Watershed Restoration and Protection Program (WRPP): Act 13 of 2012 establishes the Marcellus Legacy Fund and allocates funds to the Commonwealth Financing Authority for watershed restoration and protection projects. The overall goal of this program is to restore, and maintain restored stream reaches impaired by the uncontrolled discharge of non-point source polluted runoff, and ultimately to remove these streams from the PA DEP's Impaired Waters list.

Greenways, Trails and Recreation Program (GTRP): In addition, Act 13 of 2012 allocates funds to the Commonwealth Financing Authority (the "Authority") for planning, acquisition, development, rehabilitation, and repair of greenways, recreational trails, open space, parks and beautification projects. Projects can involve development, rehabilitation, and improvements to public parks, recreation areas, greenways, trails, and river conservation.

Flood Mitigation Projects: Finally, Act 13 of 2012 allocates funds to the Commonwealth Financing Authority (the "Authority") for funding statewide initiatives to assist with flood mitigation projects.

While most of the identified fiscal capabilities are available to all of the municipalities in Armstrong County, the extent to which communities have leveraged these funding sources varies widely. It is expected that communities familiar with accessing grant programs will continue to pursue those grant sources, as appropriate.

Municipal Capabilities

The implementation of mitigation actions requires time and fiscal resources. While some mitigation actions are less costly than others, it is important that funds are available locally to implement policies and projects. Financial resources are particularly important if jurisdictions are trying to take advantage of Commonwealth or federal mitigation grant funding opportunities that require local-match contributions.

Capital Improvement Planning

Capital improvement plans are often recommended by counties to their municipalities because these plans help identify specific capital projects to be funded and completed according to a defined schedule. Some of these projects involve improvements to facilities and infrastructure that provide hazard mitigation benefits. As such, during this update process, the County and its municipalities have been encouraged to consider the mitigation benefits associated with their known or anticipated capital projects as a way to help prioritize their execution and to develop awareness that mitigation grants may be available to help fund such projects.

Special Purpose Taxes

Communities may exercise their taxing authority to raise funds for any project they see fit. This includes special taxes to fund mitigation measures. Spreading the cost of a community project among the community's taxpayers helps provide the greatest public good for relatively low individual cost.

Gas/Electric Utility Fees

In the same way that special taxes can be levied to fund mitigation projects, another avenue for financing a project that a community may utilize is to dedicate a portion of homeowners' gas and electric utilities' fees to upgrade and maintain the related infrastructure. Burying transmission lines, thereby mitigating from the effects of winds and ice storms, is expensive. These fees help to offset that cost.

Water/Sewer Fees

Water Authorities and Fees

Water authorities are multipurpose authorities with water projects, many of which operate both water and sewer systems. The financing of water systems for lease back to the municipality is among the principal activities of the local government facilities' financing authorities. An operating water authority issues bonds to purchase existing facilities or to construct, extend, or improve a system. The primary source of revenue is user fees based on metered usage.

The cost of constructing or extending water supply lines can be funded by special assessments against abutting property owners. Tapping fees also help fund water system capital costs. Water utilities are directly operated by municipal governments and by privately owned public utilities regulated by the Pennsylvania Public Utility Commission. The PA DEP has a program to assist with consolidation of small individual water systems to make system upgrades more cost-effective.

Sewer Authorities and Fees

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

Stormwater Utility Fees

Stormwater utility fees are assessed and collected to offset the cost of maintaining and upgrading stormwater management structures such as drains, retention ponds, and culverts.

Development Impact Fees

Development impact fees are one-time fees assessed to offset the cost of providing public services to a new development. They may be dedicated to providing the related new water or sewer infrastructure, roads, parks and recreational areas, libraries, schools, etc. The new infrastructure may be less vulnerable to hazard impacts.

General Obligation, Revenue, and/or Special Tax Bonds

Jurisdictions may simply decide to dedicate general fund or similar financing to implement hazard mitigation projects.

Partnering Arrangements or Intergovernmental Agreements

Intergovernmental cooperation is one manner of accomplishing common goals, solving mutual problems, and reducing expenditures. There are 45 municipalities within Armstrong County. Each of these municipalities conducts its daily operations and provides various community services according to local needs and limitations.

Each municipality varies in staff size, resource availability, fiscal status, service provision, constituent population, overall size, and vulnerability to the identified hazards.

Table 5-3. Fiscal Capability

Municipality	Capital Improvements Program	Community Development Block Grants (CDBG)	Special Purpose Taxes	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other
Armstrong County	-	X	-	-	-	-	-	-	-	-
Apollo Borough										
Applewold Borough	-	-	-	-	-	-	-	-	-	-
Atwood Borough	-	X	-	-	-	-	-	-	-	-
Bethel Township										
Boggs Township										
Bradys Bend Township	-	-	-	-	-	-	-	-	-	-
Burrell Township	-	X	-	-	-	-	X	-	X	-
Cadogan Township	-	-	-	-	-	-	-	-	-	-
Cowanshannock Township										
Dayton Borough	-	X	-	-	X	-	-	-	-	-
East Franklin Township	-	X	-	-	X	-	-	X	X	-
Elderton Borough	X	X	X	-	-	X	X	X	X	-
Ford City Borough	-	X	X	X	X	-	-	X	X	-
Ford Cliff Borough										
Freeport Borough										
Gilpin Township	-	-	-	X	X	-	-	-	-	-
Hovey Township	-	X	-	-	-	-	-	-	-	-
Kiskiminetas Township	-	X	-	-	X	-	-	-	X	-
Kittanning Borough	-	X	X	-	X	-	-	-	-	-
Kittanning Township										
Leechburg Borough										
Madison Township										
Mahoning Township	-	X	X	-	-	-	-	-	-	-
Manor Township	-	X	X	-	X	-	-	-	X	-
Manorville Borough	-	-	-	-	-	-	-	-	-	-
North Apollo Borough	-	X	-	-	X	-	-	-	-	-
North Buffalo Township	-	X	-	-	-	-	-	-	X	-
Parker City	-	X	-	-	-	-	X	X	X	-
Parks Township	-	-	-	-	-	-	-	-	-	-
Perry Township	-	X	-	X	-	-	-	-	-	-
Pine Township	-	-	-	-	-	-	-	-	-	-
Plumcreek Township										

Municipality	Capital Improvements Program	Community Development Block Grants (CDBG)	Special Purpose Taxes	Gas/Electric Utility Fees	Water/Sewer Fees	Stormwater Utility Fees	Development Impact Fees	General Obligation, Revenue, and/or Special Tax Bonds	Partnering Arrangements or Intergovernmental Agreements	Other
Rayburn Township										
Redbank Township	-	X	X	-	-	-	-	-	-	-
Rural Valley Borough	-	X	X	-	X	-	-	-	X	-
South Bend Township	-	-	-	-	-	-	-	-	-	-
South Bethlehem Borough	-	X	X	-	-	-	-	-	-	-
South Buffalo Township	-	-	-	-	-	-	-	-	-	-
Sugarcreek Township	-	X	X	-	-	-	-	X	-	-
Valley Township	-	-	-	-	-	-	-	-	-	-
Washington Township										
Wayne Township	-	X	-	-	-	-	-	-	-	-
West Franklin Township	-	-	-	-	-	-	-	-	-	-
West Kittanning Borough	-	-	-	-	-	-	-	-	-	-
Worthington Borough	-	-	X	-	-	-	-	-	-	-

Notes:
"X" indicates that the municipality currently has this capability in place.
"-" indicates no capability is currently in place.
Blank space indicates no response was received from the municipality.

5.2.4 Education and Outreach

Education and outreach programs and methods are used to implement mitigation activities and communicate hazard-related information. Examples include obtaining certification in programs such as Firewise and StormReady and developing and communicating hazard awareness and safety information to residents.

At the municipal level, education and outreach capabilities vary. Some municipalities have the capability to handle outreach initiatives, while others rely on County resources. Several municipal websites post local plans and ordinances, and many municipalities post information regarding hazard-related topics. The local fire departments and emergency managers are active in the schools participating in programs such as fire safety in the fall and attending other community activities to conduct outreach. Appendix D details the outreach and education conducted at the municipal level.

Public Information Programs

Flood Maps

Flood maps and flood data, including new digital maps for Armstrong County, are available at the municipal offices. County and municipality maps, tax maps, and property assessment records are available at the Assessment Office and GIS offices, and deeds are available at the Register and Recorder Office.

Library Education Tools

Libraries have educational materials, available upon request, which are used at public speaking events or County meetings, when appropriate. Educational materials include but are not limited to:

- Various types of training videos
- Pennsylvania emergency preparedness guides
- American Red Cross packets for flash flooding, hurricane, thunder and lightning, tornado, and winter storms
- Family disaster planning guides
- Homeland security information for businesses, family, individuals, neighborhoods, and schools
- Pandemic brochures

Outreach Projects

Several organizations (both public and private sector) have developed outreach projects, educational tools, and training programs. The County promotes both online and traditional in-person programs to appeal to as wide an audience as possible.

- *ReadyPA Campaign*: Established by the Commonwealth of Pennsylvania, www.readypa.org is a website that aims to prepare the public for times of disaster by providing education on the risks within Pennsylvania, template emergency plans and kits, and information on ways to get involved with community organizations to help others.

- Emergency management courses are provided through the County DPS to local coordinators and elected officials, including Duties and Responsibilities of the Local Emergency Management Coordinator (LEMC), Damage Assessment, and Basic Orientation.

Local Emergency Planning Committee

The Local Emergency Planning Committee (LEPC) works closely with the business industry community to form a safety net around the chemical industry to protect the general population from the possible outcome of hazardous material incidents. The following features of the LEPC demonstrate the capability of the LEPC to support County emergency management and preparedness initiatives.

- The LEPC shall have a minimum of seven members, with at least one representative from each of the following groups:
    - Group 1 – Elected official representing local government within the County
    - Group 2 – Local law enforcement, first aid, health, environmental, hospital, and transportation personnel
    - Group 3 – Firefighting personnel
    - Group 4 – Civil defense and emergency management personnel
    - Group 5 – Broadcast and print media personnel
    - Group 6 – Community groups not affiliated with emergency service groups
    - Group 7 – Owners and operators of facilities subject to the requirements of SARA Title III

- *Reporting Facilities:* The minimum reporting threshold for which facilities are required to have or prepared a Material Safety Data Sheet is 10,000 pounds of hazardous chemicals. This document provides workers and emergency personnel with procedures for handling or working with hazardous materials in a safe manner. It includes information on the chemicals' physical properties, toxicity, health effects, first aid, reactivity, storage, disposal, protective equipment, and spill-handling procedures.

- *Planning Facilities:* The reporting threshold for Extremely Hazardous Substances (as designated under Section 302 of Title III) is 500 pounds or the threshold planning quantity, whichever is lower. Qualifying facilities are subject to additional reports and accident prevention regulations.

Technical Assistance

The County DPS can support local, public, and private entities as needed through coordination and provision of information and equipment resources. These include both existing County capabilities and predetermined private and public resources.

Municipalities participating in this planning effort were provided with a Capability Assessment Survey. Table 5-4 summarizes the responses of the municipalities based on education and outreach capabilities. Copies of the individual municipal responses are found in Appendix D.

Table 5-4. Education and Outreach Capability

Municipality	Firewise Communities Certification	StormReady Certification	Natural Disaster or Safety-Related School Programs	Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Public-private partnership initiatives addressing disaster-related issues	Local citizen groups or nonprofit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Other
Armstrong County	-	X	-	-	-	-	-
Apollo Borough		X					
Applewold Borough	-	X	-	-	-	-	-
Atwood Borough	-	X	-	-	-	-	-
Bethel Township		X					
Boggs Township		X					
Bradys Bend Township	-	X	-	-	-	-	-
Burrell Township	-	X	-	-	-	X	X
Cadogan Township	-	X	-	-	-	-	-
Cowanshannock Township		X					
Dayton Borough	-	X	-	-	-	-	-
East Franklin Township	-	X	X	X	-	-	-
Elderton Borough	-	X	-	-	X	-	-
Ford City Borough	-	X	X	X	-	-	-
Ford Cliff Borough		X					
Freeport Borough		X					
Gilpin Township	-	X	X	-	-	-	-
Hovey Township	-	X	-	-	-	-	-
Kiskiminetas Township	-	X	-	-	-	-	-
Kittanning Borough		X					
Kittanning Township		X					
Leechburg Borough		X					
Madison Township		X					
Mahoning Township	-	X	-	-	-	-	-
Manor Township	-	X	-	X	X	X	-
Manorville Borough	-	X	-	-	-	-	-

Municipality	Firewise Communities Certification	StormReady Certification	Natural Disaster or Safety-Related School Programs	Ongoing public education or information program (e.g., responsible water use, fire safety, household preparedness, environmental education)	Public-private partnership initiatives addressing disaster-related issues	Local citizen groups or nonprofit organizations focused on environmental protection, emergency preparedness, access and functional needs populations, etc.	Other
North Apollo Borough	-	X	-	-	-	-	-
North Buffalo Township	-	X	-	-	-	-	-
Parker City	-	X	-	-	-	-	-
Parks Township	-	X	-	-	-	-	-
Perry Township	-	X	-	-	-	-	-
Pine Township	-	X	-	-	-	-	-
Plumcreek Township		X					
Rayburn Township	-	X	-	-	-	-	-
Redbank Township	-	X	-	-	-	-	-
Rural Valley Borough	-	X	-	-	-	-	-
South Bend Township	-	X	-	-	-	-	-
South Bethlehem Borough	-	X	-	-	-	-	-
South Buffalo Township	-	-	-	-	-	-	-
Sugarcreek Township	-	X	-	-	-	-	-
Valley Township	-	X	-	-	-	-	-
Washington Township		X					
Wayne Township	X	X	-	-	-	-	-
West Franklin Township	-	X	-	-	-	-	-
West Kittanning Borough	-	X	-	-	-	-	-
Worthington Borough	-	X	-	-	-	-	-

Notes:
"X" indicates that the municipality currently has this capability in place.
"-" indicates no capability is currently in place.
Blank space indicates no response was received from the municipality.
Other:
Burrell Township – Burrell Township Volunteer Fire Department Fall Festival

5.2.5 Self-Assessment

Through the Capability Assessment Surveys, all participating jurisdictions were further asked to provide a self-assessment of their jurisdiction's capability in the areas of Planning and Regulatory Capability, Administrative and Technical Capability, Financial Capability, and Education and Outreach Capability. Respondents evaluated their degree of capability in these areas as "Limited", "Moderate", or "High." Table 5-5 provides the summary results from municipalities that completed capability self-assessment worksheets.

Table 5-5. Capability Self-Assessment Matrix

Municipality	Capability Category			
	Planning and Regulatory Capability	Administrative and Technical Capability	Financial Capability	Education and Outreach Capability
Armstrong County				
Apollo Borough				
Applewold Borough	L	L	L	L
Atwood Borough	L	L	L	L
Bethel Township	M	M	L	
Boggs Township				
Bradys Bend Township	L	L	L	L
Burrell Township	L	L	L	L
Cadogan Township	L	L	M	L
Cowanshannock Township	L	L	L	L
Dayton Borough	L	L	L	L
East Franklin Township	M	M	M	M
Elderton Borough	M	L	L	M
Ford City Borough	L	M	H	H
Ford Cliff Borough				
Freeport Borough	L	L	L	
Gilpin Township	M	L	M	M
Hovey Township	L	L	L	L
Kiskiminetas Township	L	L	L	L
Kittanning Borough				
Kittanning Township				
Leechburg Borough				
Madison Township				
Mahoning Township	L	L	L	L
Manor Township	L	M	L	M
Manorville Borough	L	L	L	L
North Apollo Borough	M	M	L	L
North Buffalo Township	M	M	L	L
Parker City	L	L	L	L
Parks Township	L	L	L	L
Perry Township	L	L	L	L
Pine Township	-	-	-	-
Plumcreek Township				
Rayburn Township				
Redbank Township	L	L	L	L
Rural Valley Borough	L	L	M	L
South Bend Township	L	L	L	L
South Bethlehem Borough	L	L	L	L
South Buffalo Township	L	L	L	L

Municipality	Capability Category			
	Planning and Regulatory Capability	Administrative and Technical Capability	Financial Capability	Education and Outreach Capability
Sugarcreek Township	L	L	L	L
Valley Township	M	M	M	L
Washington Township				
Wayne Township	L	L	L	L
West Franklin Township	L	L	L	L
West Kittanning Borough	L	L	L	L
Worthington Borough	L	L	L	L

Note:
Blank space indicates no response was received from the municipality.

Detailed information regarding the municipalities' capabilities self-assessments can be found in the municipal survey responses provided in Appendix D.

5.2.6 Plan Integration

According to FEMA, plan integration is a process where communities look critically at their existing planning framework and align their efforts. Integration of hazard mitigation principles into other local planning mechanisms (comprehensive plans, transportation plans, floodplain ordinances, etc.) and vice versa is vital to build a safer, more resilient community. This two-way exchange of information supports community-wide risk reduction, both before and after disasters occur. Not only will the community's planning efforts be better integrated, but by going through this process, there is a higher level of interagency coordination, which is just as important as the planning mechanisms themselves.

Within Armstrong County, there are many existing plans and programs that support hazard risk management; thus, it is critical that this HMP integrate and coordinate with, and complement, those mechanisms.

The intention of the Planning Team and participating jurisdictions is to incorporate mitigation planning as an integral component of daily government operations. Planning Team members will work with local government officials to integrate the newly adopted hazard mitigation goals and actions into the general operations of government and partner organizations. Further, the sample adoption resolution (located in Section 8 of this HMP) includes a resolution item stating the intent of the local governing body to incorporate mitigation planning as an integral component of government and partner operations. By doing so, the Planning Team anticipates the following:

1) Hazard mitigation planning will be formally recognized as an integral part of overall emergency management efforts.
2) Hazard mitigation planning will be formally recognized as an integral part of land use policies and mechanisms.
3) The HMP, the County and municipal comprehensive plans, and the County and municipal EOPs will become mutually supportive documents that work in concert to meet the goals and needs of County residents.
4) Duplication of effort can be minimized.

As noted in Section 6 of this plan, Armstrong County has made a concerted effort to reduce its vulnerability to natural and non-natural hazards in its planning and in its daily operations since the Armstrong County HMP was last updated in 2014. The County and its jurisdictions have implemented various programs and projects to reduce the impacts of hazards. These projects, programs, and regulations have reduced risk caused by natural and non-natural hazards and support the goals and objectives of this HMP. It is the intent of the County and its participating municipalities to strengthen this focus on mitigation by continuing existing policies and by further implementing the mitigation policies contained in this HMP.

Implementation actions will include incorporating the goals of the HMP into ongoing planning, zoning, building, and engineering activities. Specifically, the County will urge municipalities to take the following actions:

- Fund hazard mitigation projects or actions in operating budgets to the extent possible.
- Notify other municipalities about grant and other funding opportunities as they arise.
- Use data and maps from this HMP as supporting documentation in grant applications.
- Review mitigation actions when allocating funding for the municipal budgets.
- Include hazard mitigation when updating municipal ordinances.
- Identify hazard areas in updates of comprehensive plans to identify land use issues.
- Review the HMP prior to land use or zoning changes and permitting or development decisions.

The information on hazards, risk, vulnerability, and mitigation contained in this HMP is based on the best science and technology available at the time of the plan's preparation. Additionally, certain plans (including Blueprints) were incorporated directly into this HMP update. All participating jurisdictions recognize that this information can be invaluable in making decisions under other planning programs, such as comprehensive, capital improvement, and emergency management plans. Figure 5-1 illustrates the interrelationships between the HMP, the Armstrong County comprehensive plan, the County EOP, and other community planning mechanisms. Existing processes and programs through which the HMP should be implemented are described below.

Plan participants will make every effort to implement the relevant sections and or data contained in the HMP utilizing administrative, budgetary, and regulatory processes as well as partnerships to the maximum extent, as described below.

Administrative

Administrative processes include departmental or organizational work plans, policies, or procedural changes that can be addressed by the following departments:

- Department of Children, Youth & Family Services
- 911 Center
- Department of Public Safety
- Planning and Development
- Department of Public Works
- Sheriff's Office

Additional administrative measures may include the creation of paid or unpaid internships to assist in HMP maintenance.

The Armstrong County DPS is responsible for preparing and maintaining the County EOP, including a minimum biennial review. Whenever portions of the plan are implemented in an emergency event or training exercise, a review is performed, and changes are made where necessary. The risk assessment information presented in the 2014 HMP was used to update the Hazard Vulnerability Assessment section of the County EOP. The updated risk assessment information will affect subsequent updates to the EOP. Recommended changes to the HMP, based on changes to the EOP, will then be coordinated with the Planning Team.

The Armstrong County Planning Commission is responsible for maintaining and updating the County comprehensive plan, which covers all 45 municipalities.

The administrative practices described above will continue through the development of subsequent Armstrong County comprehensive plan updates using the information in this updated HMP. In return, the Armstrong County comprehensive plan, located on the Armstrong County Planning Commission's website, was incorporated into multiple aspects of this HMP. Information from the comprehensive plan and other documents was used to formulate the County profile, identify the history of individual hazards, and detail the population projections in Armstrong County.

Budgetary Process

In terms of budgetary processes, the County will review capital budgets and, if funding is available, include a line item for mitigation actions. In addition, the County will maximize mitigation aspects of proposed projects and will encourage municipalities to do likewise.

Regulatory Measures

Regulatory measures—such as the creation of executive orders, ordinances, and other directives—will be considered to support hazard mitigation in the following areas:

- Comprehensive Planning – Institutionalize hazard mitigation for new construction and land use.
- Zoning and Ordinances
- Building Codes – Enforce codes or higher standards in hazard areas.
- Capital Improvements Plan – Ensure that the person responsible for projects under this plan evaluates whether new construction is in a high-hazard area (such as a flood plain) so the construction is designed to mitigate the risk. Revise requirements for this plan to include hazard mitigation in the design of new construction.
- NFIP – Continue participation in this program and explore participation in CRS Program.
- Stormwater Management – Continue to implement stormwater management plans and ordinances. Stormwater management plans/ordinances are developed for nine municipalities with another currently under development.
- HMP Plan Coordination – Prior to formal changes (amendments) to master plans, zoning, ordinances, capital improvement plans, or other mechanisms that control development, all above-mentioned plans must be reviewed to ensure they are consistent with the HMP.

Funding

The County and its jurisdictions will consider multiple grant sources to fund eligible projects. These opportunities may include, but are not limited to:

- Federal
  - Federal Emergency Management Agency (FEMA) Pre-Disaster Mitigation Program (PDM)
  - FEMA Flood Mitigation Assistance Program (FMA)
  - FEMA Hazard Mitigation Grant Program (HMGP) – Stafford Act, Section 404
  - U.S. Department of Housing and Urban Development (HUD) – Community Development Block Grant (CDBG)
  - U.S. Department of Agriculture (USDA) – USDA Community Facilities
  - U.S. Economic Development Administration (EDA) Public Works Program
- Commonwealth
  - Pennsylvania Department of Transportation (PennDOT) Pennsylvania Infrastructure Bank
  - Act 13 Marcellus Shale Legacy Funds – Flood Mitigation Program
  - Growing Greener
- Regional
  - Appalachian Regional Commission
  - Southwestern Pennsylvania Commission

- Nonprofit organizations, foundations, and private sources

Other potential federal funding sources include:

- Stafford Act, Section 406 – Public Assistance Program Mitigation Grants
- Federal Highway Administration
- Catalog of Federal Domestic Assistance
- U.S. Fire Administration – Assistance to Firefighter Grants
- U.S. Small Business Administration Pre- and Post-Disaster Mitigation Loans
- U.S. Department of Economic Development Administration Grants
- U.S. Army Corps of Engineers
- U.S. Department of Interior, Bureau of Land Management
- Other sources as yet to be defined

Partnerships

The following opportunities for partnerships will be encouraged to provide broader support and understanding of hazard mitigation:

Existing Committees and Councils

- Local Government Committees:
  - Armstrong County Agricultural Preservation Board (https://armstrongcd.org/farmland-preservation/)
  - Armstrong County Conservancy Charitable Trust
  - Armstrong County Conservation District (https://armstrongcd.org/)
  - Armstrong County Industrial Development Council (http://armstrongidc.org/)
  - Housing Authority of the County of Armstrong (http://hacarmstrong.org/)
  - Armstrong County Land Bank (under development)
  - Armstrong County Local Emergency Planning Committee (https://www.armcodps.com/about/l-e-p-c)
  - Town and Country Transit (https://www.tandctransit.com/)

Creative Partnerships for Funding and Incentives

- Public-private partnerships, including utilities and businesses
- State cooperation
- In-kind resources

Working with other Federal and Commonwealth Agencies

- U.S. Army Corps of Engineers (USACE)
- Department of Homeland Security (DHS)
- Federal Emergency Management Agency (FEMA)
- National Oceanic and Atmosphere Administration (NOAA)
- National Weather Service (NWS)
- Pennsylvania Department of Transportation (PennDOT)
- Pennsylvania Department of Environmental Protection (PADEP)
- Pennsylvania State Police (PSP)

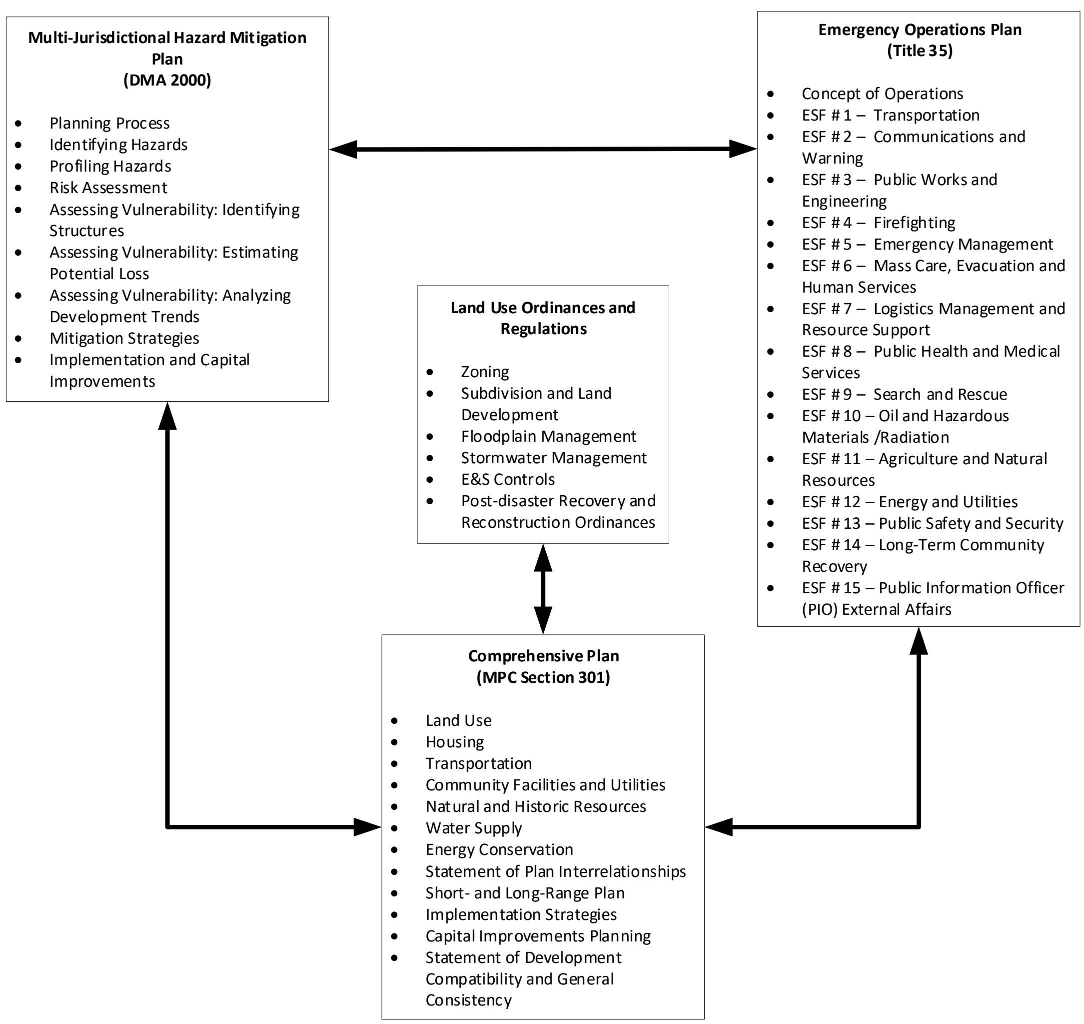
- United States Department of Agriculture (USDA)
- United States Department of Transportation (USDOT)
- United States Geological Service (USGS)

American Red Cross

Watershed Associations

- Buffalo Creek
- Cowanshannock (http://www.cowanshannock.org/)
- Crooked Creek (http://www.crookedcreekallegheny.com/)
- Kiski (https://www.facebook.com/kiskiwatershed/)
- Redbank (http://www.orgsites.com/pa/redbankwatershed/)
- Roaring Run (http://www.roaringrun.org/)

Figure 5-1. Plan Interrelationships



Note:

E&S	Erosion and Sedimentation
MPC	Municipal Planning Code

During the plan evaluation process, the Planning Team will identify additional policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions and will include these findings and recommendations in the HMP Progress Report.

SECTION 6 MITIGATION STRATEGY

This section describes the process by which the Armstrong County Planning Team will reduce or eliminate potential losses from the natural and non-natural hazards identified in Section 4.2 of this Hazard Mitigation Plan (HMP). The mitigation strategy focuses on existing and potential future mitigation actions to alleviate the effects of hazards on Armstrong County's population, economy, and general building stock.

This section provides a summary of the 2019 HMP update process, outlines the mitigation goals and objectives set forth in the 2019 HMP update, describes the process for identifying and analyzing mitigation techniques, and provides the mitigation action plan.

6.1 UPDATE PROCESS SUMMARY

The goals and objectives listed in the Armstrong County HMP were first examined through the dispersal of the Mitigation Strategy 5-Year Plan Review Worksheet (Mitigation Review Worksheet). During the 5-year review, Planning Team members were afforded the opportunity to comment on the goals, objectives, and actions that were listed in the existing HMP.

The general mitigation planning approach used to develop this plan is based on (1) the Federal Emergency Management Agency (FEMA) publication, "Local Mitigation Planning Handbook" (FEMA 2013), and (2) the Pennsylvania Emergency Management Agency (PEMA) All-Hazard Mitigation Planning Standard Operating Guide (SOG) (PEMA 2013). Specific elements employed in this HMP are summarized below:

1. **Review of Existing Mitigation Plan Goals, Objectives, and Mitigation Action Plan:** Existing mitigation goals and objectives, and the 2014 HMP mitigation actions were first examined at the Kickoff Meeting and revisited during the Mitigation Solutions Workshops and the Mitigation Strategy Review Meeting. All of these meetings were open to members of the Planning Team and stakeholders. The Steering Committee thoroughly reviewed and updated the mitigation goals and objectives utilizing the latest information gathered through the hazard profiles, vulnerability assessments, and the risk assessment; the mitigation goals and objectives were also compared to the State HMP goals and objectives. The updated goals and objectives were then presented at the Mitigation Solutions Workshops and Mitigation Strategy Review Meeting for final review and approval. Plan participants continued to review and provide progress updates on the 2014 mitigation actions throughout the planning process.
2. **Develop and Update Mitigation Strategies:** Mitigation actions were identified based on the risk assessment, mitigation goals and objectives, existing policies, and input from the Planning Team and planning partners.
3. **Mitigation Strategy Prioritization and Implementation:** The potential mitigation actions were qualitatively evaluated and are described in more detail in Section 6.4 of this HMP. Mitigation actions were prioritized into three categories: high, medium, and low. High-priority and medium-priority mitigation actions are recommended for implementation before low-priority actions; however, based on County and municipal-specific needs, cost estimation, and available funding, some low-priority mitigation actions may be addressed first.
4. **Document the Mitigation Planning Process:** The entire mitigation planning process is documented throughout this HMP, particularly in Section 3.

This section summarizes past mitigation goals and past mitigation action status, and provides an update of mitigation strategies and additional past mitigation accomplishments.

6.1.1 Review of the Past Mitigation Goals

The mitigation goals identified in the 2014 version of the HMP are listed below:

- **Goal 1:** Increase public awareness and education on both the potential impacts of natural hazards and activities to reduce those impacts.
- **Goal 2:** Strengthen County and local capabilities to reduce the potential impacts of flooding and other natural or human-caused hazards on existing and future public/private assets, including structures, critical facilities, and infrastructure.
- **Goal 3:** Continue to build the County's spatial information resources to strengthen public and private hazard mitigation planning and decision support capabilities.
- **Goal 4:** Increase intergovernmental cooperation and build public-private partnerships to implement activities that will reduce the impacts of natural, human-caused, and technological hazards.
- **Goal 5:** Enhance planning and emergency response efforts among state, county, and local emergency management personnel to protect public health and safety.

The 2014 mitigation goals were reviewed at the Planning Team Kickoff Meeting conducted on March 14, 2018. Table 6-1 shows the results of the Steering Committee and Planning Team review of the 2014 goals and objectives.

Table 6-1. Steering and Planning Team Evaluation of 2014 Goals and Objectives

2014 Armstrong County Hazard Mitigation Plan Goals and Objectives		Evaluation
Goal 1	**Increase public awareness and education on both the potential impacts of natural hazards and activities to reduce those impacts.**	Update to: "Increase public awareness and education on both the potential impacts of hazards and activities to reduce those impacts."
Objective 1.1	Promote public education about hazards in the County.	Update to include outreach programs and hazard mitigation.
Objective 1.2	Provide training on hazard mitigation techniques and processes.	Keep as is; still applies.
Goal 2	**Strengthen County and local capabilities to reduce the potential impacts of flooding and other natural or human-caused hazards on existing and future public/private assets, including structures, critical facilities, and infrastructure.**	Update to: "Prevent injury/death and damage from natural and human-made hazards."
Objective 2.1	Establish regulations limiting development in hazard-prone areas.	Keep as is; still applies.
Objective 2.2	Direct new growth away from hazard-prone areas.	Keep as is; still applies.
Objective 2.3	Lessen impacts on natural resources and open-space areas from natural and human-caused hazards.	Keep as is; still applies.
Objective 2.4	Encourage property owners in the 1% annual chance floodplain to purchase flood insurance.	Update to include insuring properties against all hazards including flood coverage under the NFIP.
Objective 2.5	Assess and analyze the strengths and weaknesses of critical facilities in regard to the impacts of natural and human-caused hazards.	Remove. Incorporate into Goal 3 under protection of property.
Goal 3	**Continue to build the County's spatial information resources to strengthen public and private hazard mitigation planning and decision support capabilities.**	Remove. No longer applies.
Objective 3.1	Develop data management tools to ensure adequate data management.	Remove. No longer applies.
Objective 3.2	Ensure adequacy of equipment and technology.	Remove. Incorporate into Goal 4.
Objective 3.3	Continue to foster development of information and resources for subsequent HMPs.	Remove.
Objective 3.4	Maintain databases and information tracking systems on streams and culverts to track relevant trends and to reduce backup and flooding.	Still applies.

2014 Armstrong County Hazard Mitigation Plan Goals and Objectives		Evaluation
Goal 4	**Increase intergovernmental cooperation and build public-private partnerships to implement activities that will reduce the impacts of natural, human-caused, and technological hazards.**	Remove. Incorporate goal into Goal 4.
Objective 4.1	Encourage participation in the HMP update process.	Remove.
Objective 4.2	Improve coordination and communication between departments and private industry.	Keep as is; still applies. Include under Goal 4 regarding emergency services capabilities.
Goal 5	**Enhance planning and emergency response efforts among state, county, and local emergency management personnel to protect public health and safety.**	Still applies. Update "Enhance planning and emergency response efforts among state, county, and local emergency management personnel" to "Improve emergency services."
Objective 5.1	Ensure adequate training and resources for those involved in emergency response, services, relief, or hazard mitigation.	Keep as is; still applies.
Objective 5.2	Ensure that residents receive relief and are evacuated as quickly as possible in the event of a disaster.	Keep as is; still applies.

6.1.2 Past Mitigation Action Status and Update of Mitigation Strategies

In the 2014 HMP, Armstrong County identified 34 actions and initiatives to support an improved understanding of hazard risk and vulnerability, to enhance mitigation capabilities, and to reduce vulnerability of infrastructure. Progress on the 2014 mitigation actions was evaluated during the 2019 update process.

Various representatives of Armstrong County on the Steering Committee and Planning Team were provided with a Mitigation Review Worksheet identifying all of the County and municipal actions and initiatives from the 2014 HMP. The respondents were asked to indicate the status of each action ("No Progress/Unknown," "In Progress/Not Yet Complete," "Continuous," "Completed," or "Discontinued") and provide review comments on each.

Feedback compiled from the completed Mitigation Action Plan Review Worksheets is summarized in Table 6-2. Projects and initiatives identified as "Complete" and "Discontinued" have been removed from this plan update. The actions that the County has identified as "No Progress/Unknown" or "In Progress/Not Yet Complete" have been carried forward in the updated mitigation strategies identified in Table 6-4 (unless otherwise determined by the County to be discontinued). Actions from the 2014 HMP that reflect continuously maintaining capabilities have also been removed. The language in some actions being carried over has been adjusted to reflect changes to County needs and capabilities. Some actions were also merged to reduce redundant efforts on behalf of the County and its municipalities.

Table 6-2. Past Mitigation Action Status

Description	Jurisdiction	Status	Review Comments
Action 1.1.1 - Increase advertisement of public meetings.	Countywide	Discontinued	• Burrell Township advertises in the newspaper. • In progress – West Franklin Township, Worthington Borough • Continuous – East Franklin Township, Elderton Borough, Manorville Borough, North Buffalo Township, Parks Township
Action 1.1.2 - Develop and post hazard mitigation information, along with other County resources, plans, and links to outside agency resources, on the County website.	Countywide	In Progress/Not Yet Complete	• In progress – South Bethlehem Borough • Continuous – West Franklin Township, Worthington Borough • Completed – Manor Township
Action 1.1.3 - Provide information on evacuation and shelter-in-place procedures for residents and continuity of operations plans and procedures for businesses on the County website.	Countywide	In Progress/Not Yet Complete	• In progress – Manor Township • Continuous – West Franklin Township, West Kittanning Borough, Worthington Borough • North Buffalo Township attempts to notify residents on the Township website.
Action 1.1.4 - Disseminate informational pamphlets and include information on the County website for residents that explains the risk of hazards, outlines precautionary measures that can be taken to help reduce impacts of disaster to themselves and their property, and emphasizes the value of hazard mitigation.	Countywide	In Progress/Not Yet Complete	• In progress – Bradys Bend Township, West Franklin Township, Worthington Borough • Continuous – West Kittanning Borough • Discontinue – South Bethlehem Borough
Action 1.2.1 - Conduct training sessions on hazard mitigation during County Commissioners meetings or Council of Government meetings.	Countywide	In Progress/Not Yet Complete	• In progress – Bradys Bend Township • Continuous – Elderton Borough, Parks Township, West Franklin Township, Worthington Borough • Discontinue – South Bethlehem Borough • Parks Township identified the ACATO Convention as a venue.
Action 2.1.1 - Encourage the development of safety buffers between industrial facilities and the population.	Countywide	In Progress/Not Yet Complete	• In progress – Bradys Bend Township • Continuous – East Franklin Township, North Buffalo Township, Parks Township, West Franklin Township, West Kittanning Borough • Discontinue – South Bethlehem Borough
Action 2.1.2 - Adopt a Countywide Post-Disaster Recovery and Reconstruction Ordinance using the model ordinance included in the APA/FEMA PAS Report No. 483/484.	Countywide	Continuous	• In progress – West Franklin Township • Continuous – East Franklin Township, West Kittanning Borough • Discontinue – South Bethlehem Borough • North Buffalo Township thinks this should be a municipal responsibility, not County.
Action 2.1.3 - Ensure that the County and municipal Subdivision and Land Development Ordinances are consistent with Chapter 102: Erosion & Sedimentation Control Requirements.	Countywide	In Progress/Not Yet Complete	• In progress – South Bethlehem Borough, Sugarcreek Township, West Franklin Township • Continuous – East Franklin Township, Elderton Borough, Manorville Borough, Parks Township, Wayne Township, West Kittanning Borough
Action 2.1.4 - Adopt/Continue to enforce zoning ordinances that prevent construction in hazard-prone areas.	Countywide	Continuous	• Zoning ordinances are enforced on an ongoing basis. • In progress – West Franklin Township • Completed – Sugarcreek Township

Description	Jurisdiction	Status	Review Comments
Action 2.2.1 - Coordinate with the municipal zoning boards to stop growth in the floodplain.	Countywide	Continuous	• Development in the floodplain is reviewed as it is proposed. • Completed – Sugarcreek Township • North Buffalo Township stated that the Flood Insurance Rate Maps (FIRM) for the Township are incorrect. • Continuous – Parks Township
Action 2.2.2 - Encourage the review of planned infrastructure to ensure that it will be developed outside of of hazard-prone areas.	Countywide	Continuous	• This action is performed by the local and County Planning Boards/Commissions. • Continuous – Parks Township • Completed – Sugarcreek Township
Action 2.3.1 - Review and conduct hazard vulnerability assessments on parks and recreational areas.	Countywide	Continuous	• Continuous – East Franklin Township, Parks Township, West Franklin Township, West Kittanning Borough
Action 2.3.2 - Consider incorporating mitigation strategies for natural resources and open-space areas when incorporating strategies for infrastructure.	Countywide	Discontinued/ Integrated	• This action is carried out as infrastructure is developed.
Action 2.4.1 - Conduct outreach to municipalities to ensure compliance with the NFIP.	Countywide	Continuous	• Continuous – Burrell Township, Elderton Borough, Parks Township, Wayne Township
Action 2.4.2 - Develop informational workshops on risk and mitigation for property owners in areas prone to flooding.	Countywide	Continuous	• Continuous – East Franklin Township • North Buffalo Township requests additional assistance from the County Planning Department.
Action 2.5.1 - Conduct a thorough critical facilities vulnerability assessment and impact analysis using the GIS-based critical infrastructure history in the HMP.	Countywide	Discontinued	• In progress – Manorville Borough • Discontinue – North Buffalo Township
Action 2.5.2 - Prepare and implement a Continuity of Government Plan for the County government.	Countywide	In Progress/ Not Yet Complete	• Continuous – Elderton Borough • Discontinue – North Buffalo Township
Action 2.5.3 - Conduct analysis on the future demand for expanded infrastructure.	Countywide	Discontinued	• In progress – Manor Township • Continuous – East Franklin Township, North Buffalo Township
Action 3.1.1 - Implement a Countywide electronic damage assessment management tool to increase the efficiency of County and municipal damage survey and reporting.	Countywide	Continuous	• Continuous – West Kittanning Borough • In progress – West Franklin Township, Worthington Borough • Discontinue – North Buffalo Township
Action 3.1.2 - Create a GIS dataset of the locations of the Superfund Amendments and Reauthorization Act (SARA) facilities in the County to analyze their vulnerability to potential hazards.	Countywide	Discontinued	• In progress – West Franklin Township
Action 3.1.3 - Review and approve the County's DFIRM information and incorporate the data into the County GIS.	Countywide	Discontinued	• New FIRMs were made effective in February 2016 and were used in the 2019 HMP update.
Action 3.2.1 - Conduct an audit of information systems and technology. Update the technology and information systems when new alternatives become available.	Countywide	Discontinued	• Current technology is updated as funding and better technology is available. New technology is constantly evaluated.
Action 3.3.1 - Maintain a list of repetitive loss structures from the Governor's Center for Local Government Service's NFIP Coordinator and incorporate the data into the HMP during five-year updates.	Countywide	Discontinued	• A list of repetitive loss properties was obtained at the beginning of the planning process for the 2019 HMP update.

Description	Jurisdiction	Status	Review Comments
Action 3.3.2 - Continue to work with municipalities to identify and incorporate hazard mitigation project opportunity forms to include in the five-year update of the HMP.	Countywide	Discontinued	• Projects are incorporated into the 2019 HMP update. • Manor Township reported having several projects to add. • In progress – Parks Township, South Bethlehem Borough • Continuous – Burrell Township, Elderton Borough, North Buffalo Township, Sugarcreek Township, Wayne Township, West Franklin Township
Action 3.3.3 - Collect and analyze data on the specific impacts identified in the HMP.	Countywide	Discontinued	• This action is too generic. • Continuous – East Franklin Township, Elderton Borough, North Buffalo Township
Action 3.4.1 - Work with municipalities to regularly inspect culverts.	Countywide	Discontinued/ Integrated	• Continuous – East Franklin Township, North Buffalo Township, Parks Township, South Bethlehem Borough, Wayne Township, West Franklin Township, West Kittanning Borough
Action 3.4.2 - Work with municipalities to create and maintain a Countywide database of streams prone to backup and flooding.	Countywide	Discontinued/ Integrated	• In progress – Parks Township, South Bethlehem Borough, Wayne Township • Continuous – East Franklin Township • Discontinue – North Buffalo Township • Parks Township stated the Armstrong Conservation District maintains this database.
Action 4.1.1 - Promote HMP outreach opportunities with municipalities in the County.	Countywide	Discontinued/ Integrated	• Continuous – East Franklin Township, Elderton Borough • Discontinue – North Buffalo Township
Action 4.2.1 - Encourage the involvement of private industry with plan revisions.	Countywide	Discontinued/ Integrated	• Private industry was invited to participate in the planning process. • Discontinue – North Buffalo Township
Action 4.2.2 - Integrate the five-year maintenance cycle of the HMP with the review and maintenance cycles of both the County Comprehensive Plan and County EOP, respectively.	Countywide	Discontinued/ Integrated	• In progress – South Bethlehem Borough • Continuous – East Franklin Township, Elderton Borough, West Franklin Township, Worthington Borough • Completed – Wayne Township • Discontinue – North Buffalo Township
Action 5.1.1 - Locate and secure funding streams for emergency response and support services.	Countywide	Discontinued/ Integrated	• This action is performed on an ongoing basis.
Action 5.1.2 - Update the County EOP to be consistent with the National Response Framework.	Countywide	Discontinued/ Integrated	• This is done on an ongoing basis as the EOP is updated. • Discontinue – North Buffalo Township
Action 5.1.3 - Continue to encourage multi-jurisdictional exercises and drills.	Countywide	Discontinued/ Integrated	• This action is performed on an ongoing basis.
Action 5.2.1 - Maintain a web-based inventory of the County's at-risk populations to strengthen emergency response and evacuations.	Countywide	Discontinued/ Integrated	• East Franklin Township marked this as Continuous. • Discontinue – North Buffalo Township

6.1.3 Additional Past Mitigation Accomplishments

Armstrong County and its municipalities have performed ongoing maintenance projects to reduce the impacts of natural hazards. The County has not identified specific mitigation projects or activities that have been completed that were not identified in the previous mitigation strategy in the 2014 HMP.

6.2 MITIGATION GOALS AND OBJECTIVES

This section describes the mitigation goals and objectives set forth in the 2019 HMP update.

6.2.1 2019 Mitigation Goals

After reviewing the mitigation goals set forth in 2014 HMP to determine their continuing applicability to County's mitigation needs, the Steering Committee decided to update them. The updated goals and objectives were distributed to the Planning Team at the Mitigation Solutions Workshop, wherein the Planning Team reviewed and approved the updated goals for the 2019 HMP. The 2019 HMP goals for Armstrong County are in line with State mitigation goals, embody the overarching needs and concerns of the County and participating municipalities, and address both natural and non-natural hazard risk reduction.

The 2019 County HMP goals are listed below:

1. **Goal 1:** Increase public awareness and education on both the potential impacts of hazards and activities to reduce those impacts.
2. **Goal 2:** Prevent injury/death and damage from natural and human-made hazards.
3. **Goal 3:** Protect the citizens of Armstrong County, as well as public and private property, from the impacts of natural and human-caused hazards.
4. **Goal 4:** Improve emergency services and capabilities to protect public health and safety.

6.2.2 2019 Mitigation Objectives

The goals listed above were used to develop relevant objectives. The objectives address the results of the vulnerability assessment in more specific terms and reflect the possible effects that can be mitigated for the identified hazards, as well as existing limitations in available data and information. The Steering Committee reviewed the objectives that were identified during the 2014 HMP update process and updated the 2014 HMP's objectives to reflect changes in County priorities and capabilities since the 2014 HMP was written in 2014. The revised and updated objectives were presented to the Planning Team and finalized at the December 2018 Mitigation Solutions Workshop. Objectives related to each of the goals are listed below, and Table 6-1 summarizes the evaluation of all goals and objectives from the 2014 HMP.

Goal 1: Increase public awareness and education on both the potential impacts of hazards and activities to reduce those impacts.

Objective 1.1 Promote public education and outreach programs on hazards and hazard mitigation.

Objective 1.2 Provide training on hazard mitigation techniques and processes.

Objective 1.3 Educate property owners and residents regarding their risks and the precautions they can take.

Goal 2: Prevent injury/death and damage from natural and human-made hazards.

Objective 2.1 Develop regulations limiting development in hazard-prone areas.

Objective 2.2 Direct new growth away from hazard-prone areas.

Objective 2.3 Lessen impacts on natural resources and open-space areas from natural and human-caused hazards.

Objective 2.4 Encourage homeowners, renters, and businesses to insure their properties against all hazards, including purchasing flood coverage under the National Flood Insurance Program (NFIP).

Goal 3: Protect the citizens of Armstrong County, as well as public and private property, from the impacts of natural and human-caused hazards.

Objective 3.1 Protect existing structures, including critical facilities, from damage that can be caused by hazards.

Objective 3.2 Acquire, relocate, elevate, and/or retrofit existing structures located in hazard areas.

Objective 3.3 Acquire, relocate, elevate, and/or retrofit repetitive loss properties from flood-prone areas.

Objective 3.4 Improve and maintain stormwater management systems to reduce back-up and flooding.

Objective 3.5 Protect the health of County residents from disease.

Goal 4: Improve emergency services and capabilities to protect public health and safety.

Objective 4.1 Ensure adequate training and resources for those involved in emergency response, emergency services, disaster relief, or hazard mitigation.

Objective 4.2 Improve coordination and communication between departments and private industry.

Objective 4.3 Ensure that residents receive relief and are evacuated as quickly as possible in the event of a disaster.

Objective 4.4 Ensure adequacy of equipment and technology.

6.3 IDENTIFICATION AND ANALYSIS OF MITIGATION TECHNIQUES

Concerted efforts were made to ensure that the County and its municipalities developed updated mitigation strategies. Updated strategies included activities and initiatives covering the range of mitigation action types described in the recent FEMA planning guidance, "Local Mitigation Planning Handbook" (FEMA 2013). Mitigation action types listed in the FEMA guidance include the following:

1. **Local Plans and Regulations:** These actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.
2. **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. These project types 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.
3. **Natural Systems Protection:** These include actions that minimize damage and losses and also preserve or restore the functions of natural systems.
4. **Education and Awareness Programs:** These are actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as the National Flood Insurance Program (NFIP) and Community Rating System (CRS), StormReady (National Oceanic and Atmospheric

Administration [NOAA]), and Firewise (National Fire Protection Association [NFPA]) Communities (FEMA 2013).

The participants of the Mitigation Strategy Workshops and the Planning Team identified actions that relate to the categories listed above. Table 6-3 identifies which mitigation action types are applicable for the hazards included in the 2019 HMP. In some cases, the mitigation techniques identified for a particular hazard reflect ongoing mitigation capabilities, not specific projects included in the updated HMP.

Table 6-3. Mitigation Technique Matrix

Hazard	Local Plans and Regulations	Structure and Infrastructure Projects	Natural Systems Protection	Education and Awareness Programs
Dam Failure	✓			✓
Drought	✓			✓
Earthquake	✓			✓
Environmental Hazards	✓			✓
Flood, Flash Flood, and Ice Jam	✓	✓	✓	✓
Invasive Species	✓		✓	✓
Landslide	✓	✓		✓
Levee Failure	✓			✓
Pandemic	✓			✓
Radon Exposure	✓			✓
Subsidence and Sinkholes	✓	✓		✓
Terrorism	✓			✓
Tornado Wind	✓			✓
Transportation Accidents	✓	✓		✓
Utility Interruption	✓	✓		✓
Wildfire	✓			✓
Winter Storm	✓			✓

6.4 MITIGATION ACTION PLAN

Representatives from the County and all participating municipalities selected mitigation strategies and initiatives to pursue until the next plan update. The updated action list also includes some actions identified during the 2014 update that are still relevant or in progress. This section describes 2019 mitigation initiatives, mitigation strategy prioritization and implementation, and prioritization of mitigation actions.

6.4.1 2019 Mitigation Initiatives

Table 6-4 summarizes the updated mitigation strategies identified by the County and all municipalities, including the following information:

- Mitigation actions for individual and multiple hazards
- Mitigation action type

- Department or agency primarily responsible for project initiation and/or implementation
- Estimated cost for the mitigation action and identification of known or potential sources of funding
- Implementation schedule
- Implementation priority

The updated mitigation actions were documented using the Mitigation Action Worksheet distributed at the Mitigation Solution Workshops. Appendix G includes a blank version of the Mitigation Action Worksheet, and Appendix H includes copies of the completed worksheets. Specific mitigation actions were identified to prevent future losses; however, current funding is not identified for all of these actions at present. Potential funding sources (Section 5) are indicated to support future implementation. The County and municipalities have limited resources to take on new responsibilities or projects. The implementation of these mitigation actions is dependent on the approval of the local elected governing body and the ability of the jurisdiction to obtain funding from local or outside sources.

The Planning Team prioritized proposed mitigation actions during the Mitigation Action Worksheet documentation process. In general, mitigation actions ranked as highest priorities should be addressed first within each jurisdiction, depending upon funding. However, medium- or low-priority mitigation actions will be considered for implementation as funding becomes available. Therefore, the ranking levels should be considered as a preliminary ranking, which will evolve based on prevailing priorities and discretion of local governments, the public, PEMA, and FEMA as the plan update is implemented.

Table 6-4. Hazard Mitigation Strategy

Note: Some of the identified mitigation initiatives in Table 6-4 are dependent upon available funding (grants and local match availability) and may be modified or omitted at any time based on the occurrence of new hazard events and changes in County or municipal priorities. Actions that have been carried over from the 2014 version of the HMP may have been reworded and given a new initiative designation to conform to current needs and procedures.

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
County-Led (Multiple Municipalities)												
AC-1	Adopt a Post-Disaster Recovery and Reconstruction Ordinance using the model ordinance included in the APA/FEMA PAS Report No. 483/484.	New	All	1, 4	AC DPS	Municipal EMCs	High	Low	Operating Budget	Short	High	LPR
AC-2	Enforce building codes, floodplain management ordinances, and other local regulations to protect new structures constructed in hazard-prone areas.	New	Earthquake; Environmental Hazards; Flood, Flash Flood, and Ice Jams; Landslide; Levee Failure; Subsidence and Sinkholes; Tornado/ Windstorm; Wildfire; Winter Storm	3	Municipal Code Enforce-ment Officers	Municipal Code Enforcement Officers; Municipal Zoning Officers; Municipal FPAs	High	Low	Operating Budget	Short	High	LPR
AC-3	Inspect and remove debris from waterways at bridges on a regular basis.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	Municipal EMC	Medium	Medium	Operating Budget	Long	Low	SIP
AC-4	Acquire properties in hazard areas, notably those in the 1% annual chance floodplain, to convert them to open space.	Existing	Flood, Flash Flood, and Ice Jams	2	Municipal FPAs	AC DPS; Municipal EMCs	High	High	FEMA HMGP, PDM, FMA; PA DCED FMP	Long	Medium	SIP
AC-5	Develop informational workshops on risk and mitigation for property owners in areas prone to flooding.	N/A	Flood, Flash Flood, and Ice Jams	1	AC DPS	Municipal FPAs, EMCs	Low	Low	Operating Budget	Short	Medium	EAP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
AC-6	Encourage the development of safety buffers between industrial facilities and the population.	Existing	Hazardous Material	3	Municipal Chief Executive Officers	Municipal Code Enforcement Officers; Municipal Zoning Officers; Municipal FPAs	Medium	Low	Operating Budget	Short	Medium	LPR
AC-7	Implement a Countywide electronic damage assessment management tool to increase the efficiency of County and municipal damage survey and reporting, and to assist in substantial damage determinations.	New	All	1,4	AC DPS	Municipal Code Enforcement Officers; Municipal Zoning Officers; Municipal FPAs	High	Low	Operating Budget	Short	Low	EAP
AC-8	Provide information on evacuation and shelter-in-place procedures for residents and continuity of operations plans and procedures for businesses on the County website.	New	All	1, 4	AC DPS	Municipal FPAs, EMCs	High	Low	Operational Budget	Short	Medium	EAP
AC-9	Separate stormwater management infrastructure from sewer infrastructure.	Existing	Flood, Flash Flood, and Ice Jams; Utility Interruption	3	DPW	Municipal FPAs, EMCs	High	High	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Med.	Medium	SIP
AC-10	Treat ash trees to protect against the emerald ash borer.	Existing	Invasive Species	3	DPW		Medium	Medium	Operational Budget	Short	Low	NSP
AC-11	Educate residents in flood-prone areas about the benefits of purchasing flood insurance.	N/A	Flood, Flash Flood, and Ice Jams	4	AC DPS; Municipal FPAs		Low	Low	Operating Budget	Short	Low	EAP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
AC-12	Elevate structures at risk of flooding.	Existing	Flood, Flash Flood, and Ice Jams	2	Municipal FPAs	Municipal EMCs	High	High	FEMA HMGP, PDM, FMA; PA DCED FMP	Short	Medium	SIP
AC-13	Work with hazardous materials facilities in the floodplain to flood-proof structures up to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	2	AC DPS	DPW, Municipal EMCs	High	Low	Operating Budget; LEPC	Short	Medium	SIP
AC-14	Acquire repetitive loss properties to convert them to open space.	Existing	Flood, Flash Flood, and Ice Jams	2	Municipal FPAs	AC DPS; Municipal EMCs	High	High	FEMA HMGP, PDM, FMA; PA DCED FMP	Long	Medium	SIP
AC-15	Protect the Divine Redeemer School to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
AC-16	Work with childcare facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	AC DPS	Municipal FPAs, EMCs	High	Low	Operating Budget	Short	Medium	SIP
AC-17	Work with group home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	AC DPS	Municipal FPAs, EMCs	High	Low	Operating Budget	Short	Medium	SIP
AC-18	Work with nursing home and personal care home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	AC DPS	Municipal FPAs, EMCs	High	Low	Operating Budget	Short	Medium	SIP
AC-19	Work with the United States Postal Service to protect post offices in the floodplain to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	AC DPS	US Postal Service	High	Low	Operating Budget	Short	Medium	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
AC-20	Install a stormwater retention basin behind the Armstrong County Courthouse to protect the courthouse and other properties in the area from runoff.	New	Flood, Flash Flood, and Ice Jams	3	DPW	Municipal FPAs, DPWs, EMCs	Medium	High	Capital Improvement	Short	Low	SIP
AC-21	Protect the Area on Aging Office to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	AC DPS	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
AC-22	Coordinate with the municipal zoning boards to stop growth in the floodplain.	New	Flood, Flash Flood, and Ice Jams	3	AC DPS	Municipal Zoning Officers	High	Low	Operating Budget	Short	Medium	LPR
AC-23	Develop and post hazard mitigation information—along with other County resources, plans, and links to outside agency resources—on the County website.	N/A	All	1	AC DPS	Armstrong County IT	Low	Low	Operating Budget	Short	Medium	EAP
AC-24	Disseminate informational pamphlets and include information on the County website for residents that explains the risk of hazards, outlines precautionary measures that can be taken to help reduce impacts of disaster to themselves and their property, and emphasizes the value of hazard mitigation.	N/A	All	1	AC DPS	Municipal EMCs	Low	Low	Operating Budget	Short	Medium	EAP
AC-25	Prepare and implement a Continuity of Government Plan for the County government.	New	All	4	AC DPS	All County Departments	High	Low	Operating Budget; Region 13 Funding	Short	High	LPR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
AC-26	Protect the Armstrong County Health Center to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	AC DPS	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
AC-27	Work with Windstream to protect its infrastructure in the floodplain to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jam	3	AC DPS	DPW, Municipal EMCs	High	Low	Operating Budget	Short	Medium	SIP
AC-28	Conduct a traffic study or analysis of previous transportation accidents on PA-268 from Morris' Service Station in West Kittanning, north through East Franklin Township through Cowansville to Kepper's Corners in Sugarcreek Township to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	AC DPW	PennDOT, Municipal DPW	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR
Applewold Borough												
AB-1	Protect the Applewold Borough building to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
AB-2	Protect the Applewood Borough DPW facility to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
Bethel Township												
BeT-1	Identify mitigation or structural projects to reduce flood vulnerability along the Allegheny River at the confluence of Crooked Creek, and Taylor Run from the P&A Inn to the river.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Medium	LPR
BeT-2	Identify mitigation or structural projects to reduce flooding along Taylor Run.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Medium	LPR
BeT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate at Dime Road to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR
BeT-4	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at Cooks Summit Hill to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR
BeT-5	Install a backup power generator at the Bethel Township Hose Co. 1 building.	New	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
Bradys Bend Township												
BBT-1	Protect the Bradys Bend Township building to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
BBT-2	Identify mitigation or structural projects to reduce flood vulnerability on Seybertown Road along the Allegheny River, and along PA-68 from State Game Lands 105 (Poncic Road) to Kittanning Hollow Road.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Long	High	LPR
Burrell Township												
BT-1	Address the landslide hazard area on Cherry Run Hill Road.	Existing	Landslide	2, 3	DPW	Municipal EMCs	High	High	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Long	High	SIP
BT-2	Address the landslide hazard area on McIntire Road.	Existing	Landslide	2, 3	DPW	Municipal EMCs	High	High	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Long	High	SIP
BT-3	Address the landslide hazard area on Robb's Fording Road.	Existing	Landslide	2, 3	DPW	Municipal EMCs	High	High	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Long	High	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
BT-4	Install a backup power generator at the Township Building.	Existing	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP
BT-5	Install culverts at erosion and mudslide areas on Slease Road.	New	Flood, Flash Flood, and Ice Jams	3	DPW	Municipal EMC	Medium	High	Capital Improvement	Short	Low	SIP
BT-6	Protect Gibson Road from erosion during heavy rain events.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Low	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
BT-7	Replace the Creek Road bridge with one with a wider opening.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Long	Low	SIP
BT-8	Upgrade the culverts along Creek Road with larger ones.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Low	SIP
BT-9	Upgrade the culverts along Long Run Road with larger ones.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Low	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
BT-10	Work with the U.S. Army Corps of Engineers to address the backwater flooding problem at the Cochran's Mill Bridge on the Mill Hill Road outflow.	Existing	Flood, Flash Flood, and Ice Jams	3	FPA	DPW	High	Low	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	High	SIP
Dayton Borough												
DB-1	Install a four-way stop in the center of town.	New	Transportation Accidents	3	DPW		High	High	Capital Improvement	Short	Medium	SIP
DB-2	Protect the Dayton Borough building to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
DB-3	Protect the water plant to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP	Short	High	SIP
DB-4	Replace and upgrade water lines in the Borough to prevent them from freezing.	Existing	Utility Interruption; Winter Storm	3	DPW		High	High	FEMA HMGP, PDM, FMA; PA DCED FMP; User Fees	Short	Medium	SIP
East Franklin Township												
EFT-1	Identify mitigation or structural projects to reduce flooding on Pleasant View Drive along Glade Run.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Medium	LPR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
EFT-2	Identify mitigation or structural projects to reduce flooding near Glade Run at the John's Road Bridge. Glade Run is deteriorating the streambanks and when flooding occurs, seven homes are isolated.	New	Flood, Flash Flood, and Ice Jams	2,3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	High	LPR
EFT-3	Conduct a traffic study or analysis of previous transportation accidents at the intersection of Wible Road and Butler Road to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement , Operating Budget	Short	High	LPR
EFT-4	Install a backup power generator at the Wastewater Treatment Plant.	New	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP
EFT-5	Install a backup power generator at the Municipal Building	New	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP
Elderton Borough												
EB-1	Elevate the traffic light to prevent trucks from routinely destroying it.	Existing	Transportation Accidents; Utility Interruption	2,3	DPW	Municipal EMC	Medium	Medium	Operating Budget	Short	Medium	SIP
EB-2	Upgrade drainage areas to prevent stormwater from causing damages.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		High	High	FEMA HMGP, PDM, FMA; PA DCED FMP; User Fees	Short	Medium	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
Ford City Borough												
FCB-1	Protect the Ford City Borough building to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
FCB-2	Protect the Ford City Borough DPW facility to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
FCB-3	Protect the Ford City EMS facility to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
FCB-4	Protect the Ford City Hose Company No. 1 station to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
FCB-5	Protect the Ford City Public Library to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
FCB-6	Replace and upgrade sewer lines in the Borough.	Existing	Utility Interruption	3	DPW		High	High	FEMA HMGP, PDM, FMA; PA DCED FMP, Sewer Grant; User Fees	Short	Medium	SIP
FCB-7	Replace and upgrade water lines in the Borough.	Existing	Utility Interruption	3	DPW		High	High	FEMA HMGP, PDM, FMA; PA DCED FMP; User Fees	Short	Medium	SIP
FCB-8	Upgrade stormwater management infrastructure to prevent flooding from runoff from the Lenape Heights area.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		High	High	FEMA HMGP, PDM, FMA; PA DCED FMP; User Fees	Short	Medium	SIP
FCB-9	Upgrade stormwater retention basin at 302 5th Avenue.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Low	SIP
FCB-10	Upgrade stormwater retention basin at 400 5th Avenue.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Low	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
FCB-11	Upgrade stormwater retention basin behind the businesses at 202 5th Avenue.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Low	SIP
FCB-12	Upgrade stormwater retention basin behind the residences on the 1000 block of 7th Avenue.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Low	SIP
FCB-13	Identify mitigation or structural projects to reduce flooding on South 6th Street between the 800 and 1000 blocks.	New	Flood, Flash Flood, and Ice Jams	2,3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	High	LPR
FCB-14	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-66 and PA-128 to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR
FCB-15	Install a backup power generator at the Public Works Garage.	New	Utility Interruption	3	DPW		High	Medium	FEMA HMGP, PDM; RACP	Short	High	SIP
FCB-16	Install a backup power generator at the Public Works Facility on 3rd Avenue.	New	Utility Interruption	3	DPW		High	Medium	FEMA HMGP, PDM; RACP	Short	High	SIP
FCB-17	Work with the Divine Redeemer School to assist with the purchase and installation of a backup power generator.	New	Utility Interruption	3	DPW	Divine Redeemer School	High	Medium	FEMA HMGP, PDM; RACP	Short	High	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
Freeport Borough												
FB-1	Protect the Freeport Sewage Treatment Plant to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Sewer Grant; Sewer Fees	Short	High	SIP
Kittanning Borough												
KB-1	Protect Kittanning EMS Station 1 to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	2, 3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
KB-2	Protect the Kittanning Hose Hook & Ladder Co No. 1 station to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
KB-3	Protect the Kittanning Public Library to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
KB-4	Repair and protect against future sinkholes along North Water Street between Montieth Street and Ewing Street.	Existing	Subsidence and Sinkholes	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM; Operating Budget	Long	High	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
KB-5	Upgrade stormwater management infrastructure in the area of Martin Avenue, Johnston Avenue, Lemon Way, and Orr Avenue.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW		High	High	FEMA HMGP, PDM, FMA; PA DCED FMP; User Fees	Short	Medium	SIP
KB-6	Identify mitigation or structural projects to reduce flooding along Martin Avenue at the Courthouse, and on Mulberry Street.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	High	LPR
KB-7	Install a backup power generator at the Kittanning Borough Fire Department.	New	Utility Interruption	3	DPW		High	Medium	FEMA HMGP, PDM; RACP	Short	High	SIP
KB-8	Install a backup power generator at the Kittanning Borough Police Department.	New	Utility Interruption	3	DPW		High	Medium	FEMA HMGP, PDM; RACP	Short	High	SIP
KB-9	Install a backup power generator at the Kittanning Borough Municipal Building.	New	Utility Interruption	3	DPW		High	Medium	FEMA HMGP, PDM; RACP	Short	High	SIP
Mahoning Township												
MaT-1	Identify mitigation or structural projects to reduce flooding in the Village of Rimer.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	High	LPR
MahT-2	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-28/66 at Hogback Hill to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
Manor Township												
MT-1	Protect the Manor Township building to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
MT-2	Protect the Manor Township Police Station to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
MT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at the Lenape Heights Golf Course to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR
MT-4	Install a backup power generator at the Manor Township Fire Department building.	New	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP
MT-5	Install a backup power generator at the Manor Township Municipal Building.	New	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP
Manorville Borough												
MB-1	Identify mitigation or structural projects to reduce flooding on Water Street.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Medium	LPR
MB-2	Install a backup power generator at the Manorville Borough Municipal Building.	New	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
North Buffalo Township												
NBT-1	Identify mitigation or structural projects to reduce flooding near Glade Run along Skinall Road, and PA-128 (Cadogan/Slatelick Road) from Church Road south to the Township line.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Medium	LPR
Parker City												
PC-1	Identify mitigation or structural projects to reduce flooding near Parker Flats.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Medium	LPR
Parks Township												
PT-1	Identify mitigation or structural projects to reduce flooding in the Village of Dime. There are 12 structures along Upper Mateer Road which are susceptible to flooding.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	High	LPR
PT-2	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate in the Village of Dime to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement, Operating Budget	Short	High	LPR
Plumcreek Township												
PluT-1	Conduct a traffic study or analysis of previous transportation accidents at the intersection of US-422 at PA-210 to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
Rayburn Township												
RT-1	Protect the Rayburn Township building to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
RT-2	Protect the Rayburn Township DPW facility to the 0.2% annual chance flood level.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	High	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	SIP
RT-3	Identify mitigation or structural projects to reduce flooding at the of the Cowanshannock Creek with the Allegheny River.	New	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Medium	FEMA HMGP, PDM, FMA; PA DCED FMP; Operating Budget	Short	Medium	LPR
South Bethlehem Borough												
SBB-1	Work with PennDOT to address the 90-degree turn of PA-66/28, possibly by installing a traffic light or rumble strips.	Existing	Transportation Accidents	3	DPW	PennDOT	Medium	High	Operating Budget	Short	High	SIP
Valley Township												
VT-1	Conduct a traffic study or analysis of previous transportation accidents on PA-85 between Rural Valley Borough and Sunnyside at the Rayburn Township line.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR
West Franklin Township												
WFT-1	Install stormwater management infrastructure along Hindman Hill Road.	New	Flood, Flash Flood, and Ice Jams	3	DPW	Municipal EMC	Medium	High	Capital Improvement	Short	Low	SIP

Initiative*	Mitigation Initiative	Applies to New and/or Existing Structures**	Hazard(s) Mitigated	Goals Met	Lead Agency	Support Agencies	Estimated Benefits	Estimated Cost	Sources of Funding	Timeline	Priority	Mitigation Category
WFT-2	Protect Craigsville Road from flooding of the Buffalo Creek.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Low	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	High	NSP
WFT-3	Protect Yellow Dog Road from flooding of the Buffalo Creek.	Existing	Flood, Flash Flood, and Ice Jams	3	DPW	FPA, Municipal EMC	Medium	Low	FEMA HMGP, PDM, FMA; PA DCED FMP, Operating Budget	Short	Low	NSP
Worthington Borough												
WB-1	Conduct a traffic study or analysis of previous transportation accidents at the Intersection of US-422 and Bear Road to determine feasible projects to reduce the occurrence of accidents.	New	Transportation Accidents	3	DPW	PennDOT	High	Medium	PennDOT, Capital Improvement Plan, Operating Budget	Short	High	LPR
Washington Township												
WT-1	Install a backup power generator at the Washington Township Municipal Building.	New	Utility Interruption	3	DPW	Municipal EMC	Medium	High	FEMA HMGP, PDM; RACP	Short	Medium	SIP

Notes:
** The letters associated with the initiative number indicate the lead agency (i.e., County or municipality).*
*** Does this mitigation initiative reduce the effects of hazards on new and/or existing buildings and/or infrastructure? Not applicable (N/A) is inserted if this does not apply.*

AC DPS = Armstrong County Department of Public Safety
APA = American Planning Association
DPW = Department of Public Works
EMC = Emergency Management Coordinator
EMS = Emergency Medical Services
FEMA = Federal Emergency Management Agency
FMP = Flood Mitigation Program
FPA = Floodplain Administrator
PA DCED = Pennsylvania Department of Community and Economic Development
PAS = Planning Advisory Service
PDM = Pre-Disaster Mitigation Program
PennDOT = Pennsylvania Department of Transportation
RACP = Redevelopment Assistance Capital Program

Costs:
These rough estimates should be used where actual project costs cannot reasonably be established at this time:
Low = < $10,000
Medium = $10,000 to $100,000
High = > $100,000

DOF = Depending on funding
HMGP = Hazard Mitigation Grant Program

Timeline:
Short Term = 1 to 5 years. Long Term = 5 years or greater.

Mitigation Category:
- *Education and Awareness Programs (EAP) - Actions to inform and educate citizens, elected officials, and property owners about hazards and potential ways to mitigate them. These actions may also include participation in national programs, such as StormReady and Firewise Communities.*
- *Local Plans and Regulations (LPR) - Actions include government authorities, policies, or codes that influence the way land and buildings are being developed and built.*
- *Natural Systems Protection (NSP) - Actions that minimize damage and losses, and also preserve or restore the functions of natural systems.*
- *Structure and Infrastructure Project (SIP) - Actions that 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.*

6.4.2 Mitigation Strategy Prioritization and Implementation

Section 201.6(c) (3) (iii) of Title 44 of the *Code of Federal Regulations* (44 CFR) requires the prioritization of the action plan to emphasize the extent to which benefits are maximized according to a cost-benefit review of the proposed projects and their associated costs. This allows the jurisdictions to select the most cost-effective actions for implementation first, not only to use resources efficiently, but also to make a realistic start toward mitigating risks.

Mitigation benefits are defined as future damages and losses that would be eliminated and/or reduced by implementing the proposed mitigation project, and include physical damage to structures and infrastructure, loss of service or function, and emergency management costs. Particularly for physical ("shovel-in-the-ground") mitigation projects, jurisdictions were encouraged to estimate project costs as well as to identify the anticipated benefits. Where exact project costs and potential benefits were not available, ranges were identified (high, medium, low) for each, allowing a qualitative evaluation of project cost-effectiveness.

PEMA has developed a mitigation actions evaluation and prioritization process to provide a consistent, uniform approach for counties and jurisdictions to use to consider, in a systematic way, the best mitigation strategies for their communities (PEMA 2013). Jurisdictions first evaluate feasibility of mitigation actions by using the following ten evaluation criteria:

- **Life Safety:** The Planning Team assesses to what extent a mitigation action will protect individuals from being injured or killed by a hazard.
- **Property Protection:** The Planning Team assesses to what extent the action will protect property, including homes, businesses, and critical infrastructure.
- **Technical:** It is important to determine whether the proposed action is technically feasible, will help to reduce losses in the long term, and has minimal secondary impacts. Here, the Planning Team determines whether the alternative action is a whole or partial solution, or not a solution at all.
- **Political:** Understanding current opinions of community and state political leadership regarding issues related to the environment, economic development, safety, and emergency management will provide valuable insight into the level of political support offered for mitigation activities and programs. Proposed mitigation objectives sometimes fail because of a lack of political acceptability.
- **Legal:** Without the appropriate legal authority, the action cannot lawfully be undertaken. When considering this criterion, the Planning Team determines whether a jurisdiction has the legal authority at the state, tribal, or local level to implement the action, or whether the jurisdiction must pass new laws or regulations. Each level of government operates under a specific source of delegated authority. As a general rule, most local governments operate under enabling legislation that gives them the power to engage in different activities. Jurisdictions should identify the unit of government undertaking the mitigation action, and include an analysis of the inter-relationships between local, regional, state, and federal governments. Legal authority is likely to have a significant role later in the process when the state, tribe, or community determines the ways in which mitigation activities can best be carried out, and the extent to which mitigation policies and programs can be enforced.
- **Environmental:** Impact on the environment is an important consideration because of public desire for sustainable and environmentally healthy communities. In addition, many statutory considerations, such as the National Environmental Policy Act (NEPA), should be counted when using federal funds. Jurisdictions need to evaluate whether, when implementing mitigation actions, the potential negative consequences to environmental assets such as threatened and endangered species, wetlands, and other protected natural resources.
- **Social:** The public must support the overall implementation strategy and specific mitigation actions. Therefore, the projects have to be evaluated in terms of community acceptance. Likewise, the Planning

Team should determine if implementing a mitigation action will have a beneficial or negative effect on a particular segment of the population.

- **Administrative:** Under this part of the evaluation criteria, the Planning Team examines the anticipated staffing, funding, and maintenance requirements for the mitigation action to determine whether the jurisdiction has the personnel and administrative capabilities necessary to implement the action or whether outside help will be necessary.
- **Local Champion:** Having an individual lead the implementation of a project, particularly a complex project, is essential for implementing it.
- **Other Community Objectives:** The Planning Team evaluates to what extent implementing the mitigation action supports other community objectives, such as increasing parks and recreation, quality of life, and economic development.

Table 6-5 shows the feasibility evaluation for each identified mitigation action. The feasibility or effectiveness of each action is assessed in relation to the above criteria as indicated with a "+" (highly effective or feasible), "N" (neutral or not applicable), or a "-" (ineffective or not feasible). All actions were deemed feasible.

Table 6-5. Evaluation of Mitigation Actions

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
AC-1	Adopt a Post-Disaster Recovery and Reconstruction Ordinance using the model ordinance included in the APA/FEMA PAS Report No. 483/484.	+	+	+	+	N	N	N	+	N	+	6 (+) 4 (N) 0 (-)
AC-2	Enforce building codes, floodplain management ordinances, and other local regulations to protect new structures constructed in hazard-prone areas.	+	+	+	+	N	N	N	+	N	+	6 (+) 4 (N) 0 (-)
AC-3	Inspect and remove debris from waterways at bridges on a regular basis.	N	+	+	N	N	N	+	N	N	+	4 (+) 6 (N) 0 (-)
AC-4	Acquire properties in hazard areas, notably those in the 1% annual chance floodplain, to convert them to open space.	N	+	+	N	N	N	+	N	N	+	4 (+) 6 (N) 0 (-)
AC-5	Develop informational workshops on risk and mitigation for property owners in areas prone to flooding.	N	+	+	N	N	N	N	N	N	+	3 (+) 7 (N) 0 (-)
AC-6	Encourage the development of safety buffers between industrial facilities and the population.	+	+	+	+	+	+	+	+	+	+	10 (+) 0 (N) 0 (-)
AC-7	Implement a Countywide electronic damage assessment management tool to increase the efficiency of County and municipal damage survey and reporting, and to assist in substantial damage determinations.	N	N	+	N	N	N	+	+	N	N	3 (+) 7 (N) 0 (-)
AC-8	Provide information on evacuation and shelter-in-place procedures for residents and continuity of operations plans and procedures for businesses on the County website.	N	+	+	+	+	+	+	N	N	N	6 (+) 4 (N) 0 (-)
AC-9	Separate stormwater management infrastructure from sewer infrastructure.	N	+	+	+	+	N	-	N	N	+	5 (+) 4 (N) 1 (-)
AC-10	Treat ash trees to protect against the emerald ash borer.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
AC-11	Educate residents in flood-prone areas about the benefits of purchasing flood insurance.	N	+	+	+	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
AC-12	Elevate structures at risk of flooding.	N	+	+	+	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
AC-13	Work with hazardous materials facilities in the floodplain to flood-proof structures up to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
AC-14	Acquire repetitive loss properties to convert them to open space.	+	+	+	+	+	N	N	+	N	+	7 (+) 3 (N) 0 (-)
AC-15	Protect the Divine Redeemer School to the 0.2% annual chance flood level.	N	+	+	+	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
AC-16	Work with child care facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	+	+	+	+	+	N	N	+	N	+	7 (+) 3 (N) 0 (-)
AC-17	Work with group home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	N	+	+	+	+	N	+	N	N	N	5 (+) 5 (N) 0 (-)
AC-18	Work with nursing home and personal care home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	N	+	+	+	+	N	+	N	N	N	5 (+) 5 (N) 0 (-)
AC-19	Work with the United States Postal Service to protect post offices in the floodplain to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
AC-20	Install a stormwater retention basin behind the Armstrong County Courthouse to protect the courthouse and other properties in the area from runoff.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
AC-21	Protect the Area on Aging Office to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	N	N	N	6 (+) 4 (N) 0 (-)
AC-22	Coordinate with the municipal zoning boards to stop growth in the floodplain.	N	N	+	+	+	N	N	N	N	+	4 (+) 6 (N) 0 (-)
AC-23	Develop and post hazard mitigation information—along with other County resources, plans, and links to outside agency resources—on the County website.	+	N	+	+	+	N	N	N	N	+	5 (+) 5 (N) 0 (-)
AC-24	Disseminate informational pamphlets and include information on the County website for residents that explains the risk of hazards, outlines precautionary measures that can be taken to help reduce impacts of disaster to themselves and their property, and emphasizes the value of hazard mitigation.	+	+	+	+	N	N	N	+	N	+	6 (+) 4 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
AC-25	Prepare and implement a Continuity of Government Plan for the County government.	N	N	+	+	+	N	N	N	N	+	4 (+) 6 (N) 0 (-)
AC-26	Protect the Armstrong County Health Center to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	N	N	N	6 (+) 4 (N) 0 (-)
AC-27	Work with Windstream to protect its infrastructure in the floodplain to the 0.2% annual chance flood level.	+	N	+	+	+	N	+	+	N	N	6 (+) 4 (N) 0 (-)
AC-28	Conduct a traffic study or analysis of previous transportation accidents on PA-268 from Morris' Service Station in West Kittanning, north through East Franklin Township through Cowansville to Kepper's Corners in Sugarcreek Township to determine feasible projects to reduce the occurrence of accidents.	+	+	+	+	N	N	+	+	N	N	6 (+) 4 (N) 0 (-)
AB-1	Protect the Applewold Borough building to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
AB-2	Protect the Applewood Borough DPW facility to the 0.2% annual chance flood level.	+	+	+	+	N	N	+	+	N	N	6 (+) 4 (N) 0 (-)
BeT-1	Identify mitigation or structural projects to reduce flood vulnerability along the Allegheny River at the confluence of Crooked Creek, and Taylor Run from the P&A Inn to the River.	+	+	+	N	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
BeT-2	Identify mitigation or structural projects to reduce flooding along Taylor Run.	+	+	+	N	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
BeT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate at Dime Road to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
BeT-4	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at Cooks Summit Hill to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
BeT-5	Install a backup power generator at the Bethel Township Hose Co. 1 building.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BBT-1	Protect the Bradys Bend Township building to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
BBT-2	Identify mitigation or structural projects to reduce flood vulnerability on Seybertown Road along the Allegheny River, and along PA-68 from State Game Lands 105 (Poncic Road) to Kittanning Hollow Road.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-1	Address the landslide hazard area on Cherry Run Hill Road.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-2	Address the landslide hazard area on McIntireRoad.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-3	Address the landslide hazard area on Robb's Fording Road.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-4	Install a backup power generator at the Township Building.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-5	Install culverts at erosion and mudslide areas on Slease Road.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-6	Protect Gibson Road from erosion during heavy rain events.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-7	Replace the Creek Road bridge with one with a wider opening.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-8	Upgrade the culverts along Creek Road with larger ones.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-9	Upgrade the culverts along Long Run Road with larger ones.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
BT-10	Work with the U.S. Army Corps of Engineers to address the backwater flooding problem at the Cochran's Mill Bridge on the Mill Hill Road outflow.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
DB-1	Install a four-way stop in the center of town.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
DB-2	Protect the Dayton Borough building to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
DB-3	Protect the water plant to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
DB-4	Replace and upgrade water lines in the Borough to prevent them from freezing.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
EFT-1	Identify mitigation or structural projects to reduce flooding on Pleasant View Drive along Glade Run	+	+	+	+	+	N	N	+	N	N	6 (+) 4 (N) 0 (-)
EFT-2	Identify mitigation or structural projects to reduce flooding near Glade Run at the John's Road Bridge. Glade Run is deteriorating the streambanks and when flooding occurs, seven homes are isolated.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
EFT-3	Conduct a traffic study or analysis of previous transportation accidents at the intersection of Wible Road and Butler Road to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
EFT-4	Install a backup power generator at the Wastewater Treatment Plant.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
EFT-5	Install a backup power generator at the Municipal Building.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
EB-1	Elevate the traffic light to prevent trucks from routinely destroying it.	+	+	+	+	+	N	N	+	N	+	7 (+) 3 (N) 0 (-)
EB-2	Upgrade drainage areas to prevent stormwater from causing damages.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
FCB-1	Protect the Ford City Borough building to the 0.2% annual chance flood level.	N	+	+	+	+	N	+	N	N	N	5 (+) 5 (N) 0 (-)
FCB-2	Protect the Ford City Borough DPW facility to the 0.2% annual chance flood level.	+	N	+	+	+	N	+	+	N	+	7 (+) 3 (N) 0 (-)
FCB-3	Protect the Ford City EMS facility to the 0.2% annual chance flood level.	+	+	+	+	N	N	+	N	N	+	6 (+) 4 (N) 0 (-)
FCB-4	Protect the Ford City Hose Company No. 1 station to the 0.2% annual chance flood level.	+	+	+	+	+	N	+		N	N	6 (+) 3 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
FCB-5	Protect the Ford City Public Library to the 0.2% annual chance flood level.	+	+	+	+	+	N	+		N	N	6 (+) 3 (N) 0 (-)
FCB-6	Replace and upgrade sewer lines in the Borough.	+	+	+	+	+	N	+		N	N	6 (+) 3 (N) 0 (-)
FCB-7	Replace and upgrade water lines in the Borough.	N	+	+	+	+	N	+	N	N	N	5 (+) 5 (N) 0 (-)
FCB-8	Upgrade stormwater management infrastructure to prevent flooding from runoff from the Lenape Heights area.	+	N	+	+	+	+	+	N	N	N	6 (+) 4 (N) 0 (-)
FCB-9	Upgrade stormwater retention basin at 302 5th Avenue.	N	N	+	+	+	N	+	N	N	N	4 (+) 6 (N) 0 (-)
FCB-10	Upgrade stormwater retention basin at 400 5th Avenue.	+	+	+	+	+	N	+		N	N	6 (+) 3 (N) 0 (-)
FCB-11	Upgrade stormwater retention basin behind the businesses at 202 5th Avenue.	+	+	+	+	+	N	+		N	N	6 (+) 3 (N) 0 (-)
FCB-12	Upgrade stormwater retention basin behind the residences on the 1000 block of 7th Avenue.	+	+	+	+	+	N	+		N	N	6 (+) 3 (N) 0 (-)
FCB-13	Identify mitigation or structural projects to reduce flooding on South 6th Street between the 800 and 1000 blocks.	+	+	+	+	+	N	+	N	N	N	6 (+) 4 (N) 0 (-)
FCB-14	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-66 and PA-128 to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	N	6 (+) 4 (N) 0 (-)
FCB-15	Install a backup power generator at the Public Works Garage.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
FCB-16	Install a backup power generator at the Public Works Facility on 3rd Avenue.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
FCB-17	Work with the Divine Redeemer School to assist with the purchase and installation of a backup power generator.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
FB-1	Protect the Freeport Sewage Treatment Plant to the 0.2% annual chance flood level.	N	+	+	+	+	N	+		N	N	5 (+) 4 (N) 0 (-)
KB-1	Protect Kittanning EMS Station 1 to the 0.2% annual chance flood level.	N	+	+	+	+	N	+		N	N	5 (+) 4 (N) 0 (-)
KB-2	Protect the Kittanning Hose Hook & Ladder Co No. 1 station to the 0.2% annual chance flood level.	N	+	+	+	+	N	+		N	N	5 (+) 4 (N) 0 (-)
KB-3	Protect the Kittanning Public Library to the 0.2% annual chance flood level.	N	+	+	+	+	N	+		N	N	5 (+) 4 (N) 0 (-)
KB-4	Repair and protect against future sinkholes along North Water Street between Montieth Street and Ewing Street.	N	+	+	+	+	N	+		N	N	5 (+) 4 (N) 0 (-)
KB-5	Upgrade stormwater management infrastructure in the area of Martin Avenue, Johnston Avenue, Lemon Way, and Orr Avenue.	N	+	+	+	+	N	+		N	N	5 (+) 4 (N) 0 (-)
KB-6	Identify mitigation or structural projects to reduce flooding along Martin Avenue at the Courthouse, and on Mulberry Street.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
KB-7	Install a backup power generator at the Kittanning Borough Fire Department.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
KB-8	Install a backup power generator at the Kittanning Borough Police Department.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
KB-9	Install a backup power generator at the Kittanning Borough Municipal Building.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
MaT-1	Identify mitigation or structural projects to reduce flooding in the Village of Rimer.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
MahT-1	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-28/66 at Hogback Hill to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	N	6 (+) 4 (N) 0 (-)
MT-1	Protect the Manor Township building to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
MT-2	Protect the Manor Township Police Station to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
MT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at the Lenape Heights Golf Course to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	N	6 (+) 4 (N) 0 (-)
MT-4	Install a backup power generator at the Manor Township Fire Department building.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
MT-5	Install a backup power generator at the Manor Township Municipal Building.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
MB-1	Identify mitigation or structural projects to reduce flooding on Water Street.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
MB-2	Install a backup power generator at the Manorville Borough Municipal Building	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
NBT-1	Identify mitigation or structural projects to reduce flooding near Glade Run along Skinall Road, and PA-128 (Cadogan/Slatelick Road) from Church Road south to the Township line.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
PC-1	Identify mitigation or structural projects to reduce flooding near Parker Flats.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
PT-1	Identify mitigation or structural projects to reduce flooding in the Village of Dime. There are 12 structures along Upper Mateer Road which are susceptible to flooding.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
PT-2	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate in the Village of Dime to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	N	6 (+) 4 (N) 0 (-)
PluT-1	Conduct a traffic study or analysis of previous transportation accidents at the intersection of US-422 at PA-210 to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	N	6 (+) 4 (N) 0 (-)
RT-1	Protect the Rayburn Township building to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
RT-2	Protect the Rayburn Township DPW facility to the 0.2% annual chance flood level.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)

Initiative	Mitigation Action	Life Safety	Property Protection	Technical	Political	Legal	Environmental	Social	Administrative	Local Champion	Other Community Objectives	Total Score
RT-3	Identify mitigation or structural projects to reduce flooding at the of the Cowanshannock Creek with the Allegheny River.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
SBB-1	Work with PennDOT to address the 90-degree turn of PA-66/28, possibly by installing a traffic light or rumble strips.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
VT-1	Conduct a traffic study or analysis of previous transportation accidents on PA-85 between Rural Valley Borough and Sunnyside at the Rayburn Township line.	+	+	+	N	+	+	+	+	N	N	7 (+) 3 (N) 0 (-)
WFT-1	Install stormwater management infrastructure along Hindman Hill Road.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
WFT-2	Protect Craigsville Road from flooding of the Buffalo Creek.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)
WFT-3	Protect Yellow Dog Road from flooding of the Buffalo Creek.	+	+	+	+	+	N	+	+	N	N	7 (+) 3 (N) 0 (-)
WB-1	Conduct a traffic study or analysis of previous transportation accidents at the Intersection of US-422 and Bear Road to determine feasible projects to reduce the occurrence of accidents.	+	+	+	N	+	N	+	+	N	N	6 (+) 4 (N) 0 (-)
WT-1	Install a backup power generator at the Washington Township Municipal Building.	+	+	+	+	+	N	+	+	N	+	8 (+) 2 (N) 0 (-)

6.4.3 Prioritization of Mitigation Actions

Actions that are deemed feasible (i.e., receive a positive evaluation score) were then compared and prioritized using the set of criteria outlined below (PEMA 2013):

- Effectiveness (20 percent of score) – The extent to which an action reduces the vulnerability of people and property.
- Efficiency (30 percent of score) – The extent to which time, effort, and cost is well used as a means of reducing vulnerability. This criterion assesses the benefits of an action versus the cost of the action's implementation.
- Multi-Hazard Mitigation (20 percent of score) – The action reduces vulnerability for more than one hazard.
- Addresses High-Risk Hazard (15 percent of score) – The action reduces vulnerability for people and property from a hazard(s) identified as high-risk.
- Addresses Critical Communications/Critical Infrastructure (15 percent of score) – The action pertains to the maintenance of critical functions and structures such as transportation, supply chain management, data circuits, etc.

Scores in each criterion range from 0 to 3. The action's priority is determined by using a formula based on the criteria values and weights. Priority values range from 0 to 3 as well. An action's priority is then determined using the following scale (PEMA 2013):

- Low priority = 0 – 1.8
- Medium priority = 1.9 – 2.4
- High priority = 2.5 – 3

Table 6-6 shows the prioritization scores for the identified, feasible mitigation actions. Municipal officials reviewed and updated the prioritization values based on local needs.

Table 6-6. Prioritization Scoring of Mitigation Actions

Initiative	Mitigation Action	Effectiveness	Efficiency	Multi-Hazard Mitigation	Addresses High-Risk Hazard	Addresses Critical Communications/ Critical Infrastructure	Priority
AC-1	Adopt a Post-Disaster Recovery and Reconstruction Ordinance using the model ordinance included in the APA/FEMA PAS Report No. 483/484.	3	3	1	3	0	2.2
AC-2	Enforce building codes, floodplain management ordinances, and other local regulations to protect new structures constructed in hazard-prone areas.	3	3	1	3	0	2.2
AC-3	Inspect and remove debris from waterways at bridges on a regular basis.	3	2	1	3	2	2.2
AC-4	Acquire properties in hazard areas, notably those in the 1% annual chance floodplain, to convert them to open space.	3	2	1	3	2	2.2
AC-5	Develop informational workshops on risk and mitigation for property owners in areas prone to flooding.	3	2	1	3	2	2.2
AC-6	Encourage the development of safety buffers between industrial facilities and the population.	3	3	3	3	3	3.0
AC-7	Implement a Countywide electronic damage assessment management tool to increase the efficiency of County and municipal damage survey and reporting, and to assist in substantial damage determinations.	1	1	3	3	0	1.6
AC-8	Provide information on evacuation and shelter-in-place procedures for residents and continuity of operations plans and procedures for businesses on the County website.	2	2	1	3	1	1.8
AC-9	Separate stormwater management infrastructure from sewer infrastructure.	2	2	1	3	3	2.1
AC-10	Treat ash trees to protect against the emerald ash borer.	2	2	2	2	1	1.9
AC-11	Educate residents in flood-prone areas about the benefits of purchasing flood insurance.	3	2	1	3	3	2.3
AC-12	Elevate structures at risk of flooding.	3	2	1	3	2	2.2
AC-13	Work with hazardous materials facilities in the floodplain to flood-proof structures up to the 0.2% annual chance flood level.	3	3	1	3	3	2.6
AC-14	Acquire repetitive loss properties to convert them to open space.	3	3	1	3	3	2.6
AC-15	Protect the Divine Redeemer School to the 0.2% annual chance flood level.	3	2	1	3	2	2.2
AC-16	Work with child care facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	3	3	3	3	3	3.0
AC-17	Work with group home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	3	2	1	3	2	2.2
AC-18	Work with nursing home and personal care home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	3	2	1	3	2	2.2
AC-19	Work with the United States Postal Service to protect post offices in the floodplain to the 0.2% annual chance flood level.	3	3	1	3	3	2.6
AC-20	Install a stormwater retention basin behind the Armstrong County Courthouse to protect the courthouse and other properties in the area from runoff.	3	3	1	3	3	2.6
AC-21	Protect the Area on Aging Office to the 0.2% annual chance flood level.	2	3	1	3	0	2.0
AC-22	Coordinate with the municipal zoning boards to stop growth in the floodplain.	1	2	3	3	0	1.9
AC-23	Develop and post hazard mitigation information—along with other County resources, plans, and links to outside agency resources—on the County website.	2	2	3	3	0	2.1
AC-24	Disseminate informational pamphlets and include information on the County website for residents that explains the risk of hazards, outlines precautionary measures that can be taken to help reduce impacts of disaster to themselves and their property, and emphasizes the value of hazard mitigation.	2	2	3	3	0	2.1

Initiative	Mitigation Action	Effectiveness	Efficiency	Multi-Hazard Mitigation	Addresses High-Risk Hazard	Addresses Critical Communications/ Critical Infrastructure	Priority
AC-25	Prepare and implement a Continuity of Government Plan for the County government.	1	3	1	3	0	1.8
AC-26	Protect the Armstrong County Health Center to the 0.2% annual chance flood level.	3	2	2	3	1	2.2
AC-27	Work with Windstream to protect its infrastructure in the floodplain to the 0.2% annual chance flood level.	2	2	1	3	2	2.0
AC-28	Conduct a traffic study or analysis of previous transportation accidents on PA-268 from Morris' Service Station in West Kittanning, north through East Franklin Township through Cowansville to Kepper's Corners in Sugarcreek Township to determine feasible projects to reduce the occurrence of accidents.	2	2	2	2	2	2.0
AB-1	Protect the Applewold Borough building to the 0.2% annual chance flood level.	3	3	3	3	0	2.6
AB-2	Protect the Applewood Borough DPW facility to the 0.2% annual chance flood level.	2	2	1	3	0	1.7
BeT-1	Identify mitigation or structural projects to reduce flood vulnerability along the Allegheny River at the confluence of Crooked Creek, and Taylor Run from the P&A Inn to the River.	2	2	1	1	0	1.4
BeT-2	Identify mitigation or structural projects to reduce flooding along Taylor Run.	2	2	1	1	0	1.4
BeT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate at Dime Road to determine feasible projects to reduce the occurrence of accidents.	2	2	2	3	2	2.2
BeT-4	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at Cooks Summit Hill to determine feasible projects to reduce the occurrence of accidents.	2	2	2	2	2	2.0
BeT-5	Install a backup power generator at the Bethel Township Hose Co. 1 building.	3	3	1	3	3	2.6
BBT-1	Protect the Bradys Bend Township building to the 0.2% annual chance flood level.	3	3	1	3	3	2.6
BBT-2	Identify mitigation or structural projects to reduce flood vulnerability on Seybertown Road along the Allegheny River, and along PA-68 from State Game Lands 105 (Poncic Road) to Kittanning Hollow Road.	2	2	1	1	0	1.4
BT-1	Address the landslide hazard area on Cherry Run Hill Road.	3	3	1	3	3	2.6
BT-2	Address the landslide hazard area on McIntire Road.	3	3	1	3	3	2.6
BT-3	Address the landslide hazard area on Robb's Fording Road.	3	3	1	3	3	2.6
BT-4	Install a backup power generator at the Township Building.	3	3	1	3	3	2.6
BT-5	Install culverts at erosion and mudslide areas on Slease Road.	3	3	1	3	3	2.6
BT-6	Protect Gibson Road from erosion during heavy rain events.	3	3	1	3	3	2.6
BT-7	Replace the Creek Road bridge with one with a wider opening.	3	3	1	3	3	2.6
BT-8	Upgrade the culverts along Creek Road with larger ones.	3	3	1	3	3	2.6
BT-9	Upgrade the culverts along Long Run Road with larger ones.	3	3	1	3	3	2.6
BT-10	Work with the U.S. Army Corps of Engineers to address the backwater flooding problem at the Cochran's Mill Bridge on the Mill Hill Road outflow.	3	3	1	3	3	2.6
DB-1	Install a four-way stop in the center of town.	3	3	1	3	3	2.6
DB-2	Protect the Dayton Borough building to the 0.2% annual chance flood level.	3	3	1	3	3	2.6
DB-3	Protect the water plant to the 0.2% annual chance flood level.	3	3	1	3	3	2.6
DB-4	Replace and upgrade water lines in the Borough to prevent them from freezing.	3	3	1	3	3	2.6
EFT-1	Identify mitigation or structural projects to reduce flooding on Pleasant View Drive along Glade Run.	2	2	1	1	0	1.4
EFT-2	Identify mitigation or structural projects to reduce flooding near Glade Run at the John's Road Bridge. Glade Run is deteriorating the streambanks and when flooding occurs, seven homes are isolated.	3	2	2	3	0	2.1

Initiative	Mitigation Action	Effectiveness	Efficiency	Multi-Hazard Mitigation	Addresses High-Risk Hazard	Addresses Critical Communications/ Critical Infrastructure	Priority
EFT-3	Conduct a traffic study or analysis of previous transportation accidents at the intersection of Wible Road and Butler Road to determine feasible projects to reduce the occurrence of accidents.	2	2	2	3	2	2.2
EFT-4	Install a backup power generator at the Wastewater Treatment Plant.	3	3	1	3	3	2.6
EFT-5	Install a backup power generator at the Municipal Building.	3	3	1	3	3	2.6
EB-1	Elevate the traffic light to prevent trucks from routinely destroying it.	3	3	1	3	3	2.6
EB-2	Upgrade drainage areas to prevent stormwater from causing damages.	3	3	1	3	3	2.6
FCB-1	Protect the Ford City Borough building to the 0.2% annual chance flood level.	2	1	1	3	3	1.8
FCB-2	Protect the Ford City Borough DPW facility to the 0.2% annual chance flood level.	1	2	3	3	0	1.9
FCB-3	Protect the Ford City EMS facility to the 0.2% annual chance flood level.	3	2	1	1	2	1.9
FCB-4	Protect the Ford City Hose Company No. 1 station to the 0.2% annual chance flood level.	2	2	1	3	2	2.0
FCB-5	Protect the Ford City Public Library to the 0.2% annual chance flood level.	2	2	2	3	2	2.2
FCB-6	Replace and upgrade sewer lines in the Borough.	2	2	1	3	2	2.0
FCB-7	Replace and upgrade water lines in the Borough.	2	2	1	3	2	2.0
FCB-8	Upgrade stormwater management infrastructure to prevent flooding from runoff from the Lenape Heights area.	3	2	2	3	2	2.4
FCB-9	Upgrade stormwater retention basin at 302 5th Avenue.	3	2	1	3	0	1.9
FCB-10	Upgrade stormwater retention basin at 400 5th Avenue.	2	2	1	3	1	1.8
FCB-11	Upgrade stormwater retention basin behind the businesses at 202 5th Avenue.	2	2	1	3	2	2.0
FCB-12	Upgrade stormwater retention basin behind the residences on the 1000 block of 7th Avenue.	2	2	1	3	2	2.0
FCB-13	Identify mitigation or structural projects to reduce flooding on South 6th Street between the 800 and 1000 blocks.	2	2	1	2	0	1.5
FCB-14	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-66 and PA-128 to determine feasible projects to reduce the occurrence of accidents.	2	2	2	3	2	2.2
FCB-15	Install a backup power generator at the Public Works Garage.	3	3	1	3	3	2.6
FCB-16	Install a backup power generator at the Public Works Facility on 3rd Avenue.	3	3	1	3	3	2.6
FCB-17	Work with the Divine Redeemer School to assist with the purchase and installation of a backup power generator.	3	3	1	3	3	2.6
FB-1	Protect the Freeport Sewage Treatment Plant to the 0.2% annual chance flood level.	2	2	1	3	1	1.8
KB-1	Protect Kittanning EMS Station 1 to the 0.2% annual chance flood level.	2	2	1	3	1	1.8
KB-2	Protect the Kittanning Hose Hook & Ladder Co No. 1 station to the 0.2% annual chance flood level.	2	2	1	3	1	1.8
KB-3	Protect the Kittanning Public Library to the 0.2% annual chance flood level.	2	2	1	3	1	1.8
KB-4	Repair and protect against future sinkholes along North Water Street between Montieth Street and Ewing Street.	2	2	1	3	1	1.8
KB-5	Upgrade stormwater management infrastructure in the area of Martin Avenue, Johnston Avenue, Lemon Way, and Orr Avenue.	2	2	1	3	1	1.8
KB-6	Identify mitigation or structural projects to reduce flooding along Martin Avenue at the Courthouse, and on Mulberry Street.	2	2	1	2	0	1.5
KB-7	Install a backup power generator at the Kittanning Borough Fire Department.	3	3	1	3	3	2.6
KB-8	Install a backup power generator at the Kittanning Borough Police Department.	3	3	1	3	3	2.6
KB-9	Install a backup power generator at the Kittanning Borough Municipal Building.	3	3	1	3	3	2.6
MaT-1	Identify mitigation or structural projects to reduce flooding in the Village of Rimer.	2	2	1	2	0	1.5

Initiative	Mitigation Action	Effectiveness	Efficiency	Multi-Hazard Mitigation	Addresses High-Risk Hazard	Addresses Critical Communications/ Critical Infrastructure	Priority
MahT-1	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-28/66 at Hogback Hill to determine feasible projects to reduce the occurrence of accidents.	2	2	2	2	2	2.0
MT-1	Protect the Manor Township building to the 0.2% annual chance flood level.	3	3	1	3	1	2.3
MT-2	Protect the Manor Township Police Station to the 0.2% annual chance flood level.	3	3	1	3	1	2.3
MT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at the Lenape Heights Golf Course to determine feasible projects to reduce the occurrence of accidents.	2	2	2	2	2	2.0
MT-4	Install a backup power generator at the Manor Township Fire Department building.	3	3	1	3	3	2.6
MT-5	Install a backup power generator at the Manor Township Municipal Building.	3	3	1	3	3	2.6
MB-1	Identify mitigation or structural projects to reduce flooding on Water Street.	2	2	1	2	0	1.5
MB-2	Install a backup power generator at the Manorville Borough Municipal Building.	3	3	1	3	3	2.6
NBT-1	Identify mitigation or structural projects to reduce flooding near Glade Run along Skinall Road, and PA-128 (Cadogan/Slatelick Road) from Church Road south to the Township line.	2	2	1	0	1	1.4
PC-1	Identify mitigation or structural projects to reduce flooding near Parker Flats.	2	2	1	0	1	1.4
PT-1	Identify mitigation or structural projects to reduce flooding in the Village of Dime. There are 12 structures along Upper Mateer Road which are susceptible to flooding.	3	3	1	1	0	1.9
PT-2	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate in the Village of Dime to determine feasible projects to reduce the occurrence of accidents.	2	2	2	2	2	2.0
PluT-1	Conduct a traffic study or analysis of previous transportation accidents at the intersection of US-422 at PA-210 to determine feasible projects to reduce the occurrence of accidents.	2	2	2	2	2	2.0
RT-1	Protect the Rayburn Township building to the 0.2% annual chance flood level.	3	3	1	3	2	2.5
RT-2	Protect the Rayburn Township DPW facility to the 0.2% annual chance flood level.	3	3	1	3	1	2.3
RT-3	Identify mitigation or structural projects to reduce flooding at the of the Cowanshannock Creek with the Allegheny River.	3	3	1	1	0	1.9
SBB-1	Work with PennDOT to address the 90-degree turn of PA-66/28, possibly by installing a traffic light or rumble strips.	3	3	1	2	2	2.3
VT-1	Conduct a traffic study or analysis of previous transportation accidents on PA-85 between Rural Valley Borough and Sunnyside at the Rayburn Township line.	2	2	2	2	2	2.0
WFT-1	Install stormwater management infrastructure along Hindman Hill Road.	3	3	1	3	2	2.5
WFT-2	Protect Craigsville Road from flooding of the Buffalo Creek.	3	3	1	3	2	2.5
WFT-3	Protect Yellow Dog Road from flooding of the Buffalo Creek.	3	3	1	3	3	2.6
WB-1	Conduct a traffic study or analysis of previous transportation accidents at the Intersection of US-422 and Bear Road to determine feasible projects to reduce the occurrence of accidents.	2	2	2	2	2	2.0
WT-1	Install a backup power generator at the Washington Township Municipal Building.	3	3	1	3	3	2.6

The actions in Table 6-7 are listed in order of priority, with the high-priority actions presented first. This list of actions is the result of the planning effort led by the Planning Team and represents the actions the County and municipalities consider most important. Any actions (including projects) to be implemented will have benefits outweighing their associated costs (i.e., the benefit-cost ratio would be greater than 1).

A blank Mitigation Action Worksheet template is included in Appendix G. The set of completed action worksheets and a table summarizing the worksheets by jurisdiction are presented in Appendix H.

Table 6-7. Prioritized Mitigation Actions

	Mitigation Action	Score
High Priority		
AC-6	Encourage the development of safety buffers between industrial facilities and the population.	3.0
AC-16	Work with child care facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	3.0
AB-1	Protect the Applewold Borough building to the 0.2% annual chance flood level.	2.6
AC-13	Work with hazardous materials facilities in the floodplain to flood-proof structures up to the 0.2% annual chance flood level.	2.6
AC-14	Acquire repetitive loss properties to convert them to open space.	2.6
AC-19	Work with the United States Postal Service to protect post offices in the floodplain to the 0.2% annual chance flood level.	2.6
AC-20	Install a stormwater retention basin behind the Armstrong County Courthouse to protect the courthouse and other properties in the area from runoff.	2.6
BBT-1	Protect the Bradys Bend Township building to the 0.2% annual chance flood level.	2.6
BeT-5	Install a backup power generator at the Bethel Township Hose Co. 1 building.	2.6
BT-1	Address the landslide hazard area on Cherry Run Hill Road.	2.6
BT-2	Address the landslide hazard area on McIntire Road.	2.6
BT-3	Address the landslide hazard area on Robb's Fording Road.	2.6
BT-4	Install a backup power generator at the Township Building.	2.6
BT-5	Install culverts at erosion and mudslide areas on Slease Road.	2.6
BT-6	Protect Gibson Road from erosion during heavy rain events.	2.6
BT-7	Replace the Creek Road bridge with one with a wider opening.	2.6
BT-8	Upgrade the culverts along Creek Road with larger ones.	2.6
BT-9	Upgrade the culverts along Long Run Road with larger ones.	2.6
BT-10	Work with the U.S. Army Corps of Engineers to address the backwater flooding problem at the Cochran's Mill Bridge on the Mill Hill Road outflow.	2.6
DB-1	Install a four-way stop in the center of town.	2.6
DB-2	Protect the Dayton Borough building to the 0.2% annual chance flood level.	2.6
DB-3	Protect the water plant to the 0.2% annual chance flood level.	2.6
DB-4	Replace and upgrade water lines in the Borough to prevent them from freezing.	2.6
EB-1	Elevate the traffic light to prevent trucks from routinely destroying it.	2.6
EB-2	Upgrade drainage areas to prevent stormwater from causing damages.	2.6
EFT-4	Install a backup power generator at the Wastewater Treatment Plant.	2.6
EFT-5	Install a backup power generator at the Municipal Building.	2.6
FCB-15	Install a backup power generator at the Public Works Garage.	2.6
FCB-16	Install a backup power generator at the Public Works Facility on 3rd Avenue.	2.6
FCB-17	Work with the Divine Redeemer School to assist with the purchase and installation of a backup power generator.	2.6
KB-7	Install a backup power generator at the Kittanning Borough Fire Department.	2.6
KB-8	Install a backup power generator at the Kittanning Borough Police Department.	2.6

	Mitigation Action	Score
KB-9	Install a backup power generator at the Kittanning Borough Municipal Building.	2.6
MB-2	Install a backup power generator at the Manorville Borough Municipal Building.	2.6
MT-4	Install a backup power generator at the Manor Township Fire Department building.	2.6
MT-5	Install a backup power generator at the Manor Township Municipal Building.	2.6
WFT-3	Protect Yellow Dog Road from flooding of the Buffalo Creek.	2.6
WT-1	Install a backup power generator at the Washington Township Municipal Building.	2.6
RT-1	Protect the Rayburn Township building to the 0.2% annual chance flood level.	2.5
WFT-1	Install stormwater management infrastructure along Hindman Hill Road.	2.5
WFT-2	Protect Craigsville Road from flooding of the Buffalo Creek.	2.5
Medium Priority		
FCB-8	Upgrade stormwater management infrastructure to prevent flooding from runoff from the Lenape Heights area.	2.4
AC-11	Educate residents in flood-prone areas about the benefits of purchasing flood insurance.	2.3
MT-1	Protect the Manor Township building to the 0.2% annual chance flood level.	2.3
MT-2	Protect the Manor Township Police Station to the 0.2% annual chance flood level.	2.3
RT-2	Protect the Rayburn Township DPW facility to the 0.2% annual chance flood level.	2.3
SBB-1	Work with PennDOT to address the 90-degree turn of PA-66/28, possibly by installing a traffic light or rumble strips.	2.3
AC-1	Adopt a Post-Disaster Recovery and Reconstruction Ordinance using the model ordinance included in the APA/FEMA PAS Report No. 483/484.	2.2
AC-2	Enforce building codes, floodplain management ordinances, and other local regulations to protect new structures constructed in hazard-prone areas.	2.2
AC-3	Inspect and remove debris from waterways at bridges on a regular basis.	2.2
AC-4	Acquire properties in hazard areas, notably those in the 1% annual chance floodplain, to convert them to open space.	2.2
AC-5	Develop informational workshops on risk and mitigation for property owners in areas prone to flooding.	2.2
AC-12	Elevate structures at risk of flooding.	2.2
AC-15	Protect the Divine Redeemer School to the 0.2% annual chance flood level.	2.2
AC-17	Work with group home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	2.2
AC-18	Work with nursing home and personal care home facilities in the floodplain to protect their facilities to the 0.2% annual chance flood level.	2.2
AC-26	Protect the Armstrong County Health Center to the 0.2% annual chance flood level.	2.2
BeT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate at Dime Road to determine feasible projects to reduce the occurrence of accidents.	2.2
EFT-3	Conduct a traffic study or analysis of previous transportation accidents at the intersection of Wible Road and Butler Road to determine feasible projects to reduce the occurrence of accidents.	2.2
FCB-14	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-66 and PA-128 to determine feasible projects to reduce the occurrence of accidents.	2.2
FCB-5	Protect the Ford City Public Library to the 0.2% annual chance flood level.	2.2
AC-9	Separate stormwater management infrastructure from sewer infrastructure.	2.1
AC-23	Develop and post hazard mitigation information—along with other County resources, plans, and links to outside agency resources—on the County website.	2.1
AC-24	Disseminate informational pamphlets and include information on the County website for residents that explains the risk of hazards, outlines precautionary measures that can be taken to help reduce impacts of disaster to themselves and their property, and emphasizes the value of hazard mitigation.	2.1
EFT-2	Identify mitigation or structural projects to reduce flooding near Glade Run at the John's Road Bridge. Glade Run is deteriorating the streambanks and when flooding occurs, seven homes are isolated.	2.1

Mitigation Action		Score
AC-21	Protect the Area on Aging Office to the 0.2% annual chance flood level.	2.0
AC-27	Work with Windstream to protect its infrastructure in the floodplain to the 0.2% annual chance flood level.	2.0
AC-28	Conduct a traffic study or analysis of previous transportation accidents on PA-268 from Morris' Service Station in West Kittanning, north through East Franklin Township through Cowansville to Kepper's Corners in Sugarcreek Township to determine feasible projects to reduce the occurrence of accidents.	2.0
BeT-4	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at Cooks Summit Hill to determine feasible projects to reduce the occurrence of accidents.	2.0
MahT-1	Conduct a traffic study or analysis of previous transportation accidents at the intersection of PA-28/66 at Hogback Hill to determine feasible projects to reduce the occurrence of accidents.	2.0
MT-3	Conduct a traffic study or analysis of previous transportation accidents on PA-66 at the Lenape Heights Golf Course to determine feasible projects to reduce the occurrence of accidents.	2.0
PluT-1	Conduct a traffic study or analysis of previous transportation accidents at the intersection of US-422 at PA-210 to determine feasible projects to reduce the occurrence of accidents.	2.0
PT-2	Conduct a traffic study or analysis of previous transportation accidents on PA-66 Alternate in the Village of Dime to determine feasible projects to reduce the occurrence of accidents.	2.0
VT-1	Conduct a traffic study or analysis of previous transportation accidents on PA-85 between Rural Valley Borough and Sunnyside at the Rayburn Township line.	2.0
WB-1	Conduct a traffic study or analysis of previous transportation accidents at the Intersection of US-422 and Bear Road to determine feasible projects to reduce the occurrence of accidents.	2.0
FCB-11	Upgrade stormwater retention basin behind the businesses at 202 5th Avenue.	2.0
FCB-12	Upgrade stormwater retention basin behind the residences on the 1000 block of 7th Avenue.	2.0
FCB-4	Protect the Ford City Hose Company No. 1 station to the 0.2% annual chance flood level.	2.0
FCB-6	Replace and upgrade sewer lines in the Borough.	2.0
FCB-7	Replace and upgrade water lines in the Borough.	2.0
AC-22	Coordinate with the municipal zoning boards to stop growth in the floodplain.	1.9
FCB-2	Protect the Ford City Borough DPW facility to the 0.2% annual chance flood level.	1.9
FCB-3	Protect the Ford City EMS facility to the 0.2% annual chance flood level.	1.9
FCB-9	Upgrade stormwater retention basin at 302 5th Avenue.	1.9
AC-10	Treat ash trees to protect against the emerald ash borer.	1.9
PT-1	Identify mitigation or structural projects to reduce flooding in the Village of Dime. There are 12 structures along Upper Mateer Road which are susceptible to flooding.	1.9
RT-3	Identify mitigation or structural projects to reduce flooding at the of the Cowanshannock Creek with the Allegheny River.	1.9
Low Priority		
AC-8	Provide information on evacuation and shelter-in-place procedures for residents and continuity of operations plans and procedures for businesses on the County website.	1.8
AC-25	Prepare and implement a Continuity of Government Plan for the County government.	1.8
FB-1	Protect the Freeport Sewage Treatment Plant to the 0.2% annual chance flood level.	1.8
FCB-1	Protect the Ford City Borough building to the 0.2% annual chance flood level.	1.8
FCB-10	Upgrade stormwater retention basin at 400 5th Avenue.	1.8
KB-1	Protect Kittanning EMS Station 1 to the 0.2% annual chance flood level.	1.8
KB-2	Protect the Kittanning Hose Hook & Ladder Co No. 1 station to the 0.2% annual chance flood level.	1.8
KB-3	Protect the Kittanning Public Library to the 0.2% annual chance flood level.	1.8
KB-4	Repair and protect against future sinkholes along North Water Street between Montieth Street and Ewing Street.	1.8
KB-5	Upgrade stormwater management infrastructure in the area of Martin Avenue, Johnston Avenue, Lemon Way, and Orr Avenue.	1.8
AB-2	Protect the Applewood Borough DPW facility to the 0.2% annual chance flood level.	1.7

Mitigation Action		Score
AC-7	Implement a Countywide electronic damage assessment management tool to increase the efficiency of County and municipal damage survey and reporting, and to assist in substantial damage determinations.	1.6
FCB-13	Identify mitigation or structural projects to reduce flooding on South 6th Street between the 800 and 1000 blocks.	1.5
KB-6	Identify mitigation or structural projects to reduce flooding along Martin Avenue at the Courthouse, and on Mulberry Street.	1.5
MaT-1	Identify mitigation or structural projects to reduce flooding in the Village of Rimer.	1.5
MB-1	Identify mitigation or structural projects to reduce flooding on Water Street.	1.5
BBT-2	Identify mitigation or structural projects to reduce flood vulnerability on Seybertown Road along the Allegheny River, and along PA-68 from State Game Lands 105 (Poncic Road) to Kittanning Hollow Road.	1.4
BeT-1	Identify mitigation or structural projects to reduce flood vulnerability along the Allegheny River at the confluence of Crooked Creek, and Taylor Run from the P&A Inn to the River.	1.4
BeT-2	Identify mitigation or structural projects to reduce flooding along Taylor Run.	1.4
EFT-1	Identify mitigation or structural projects to reduce flooding on Pleasant View Drive along Glade Run.	1.4
NBT-1	Identify mitigation or structural projects to reduce flooding near Glade Run along Skinall Road, and PA-128 (Cadogan/Slatelick Road) from Church Road south to the Township line.	1.4
PC-1	Identify mitigation or structural projects to reduce flooding near Parker Flats.	1.4

SECTION 7 PLAN MAINTENANCE PROCEDURES

This section describes how the plan was updated since 2014 (Section 7.1); the system that Armstrong County and all participating jurisdictions have established to monitor, evaluate, and update the Hazard Mitigation Plan (HMP) (Section 7.2); and the strategy to continue public involvement for plan maintenance (Section 7.3).

7.1 UPDATE PROCESS SUMMARY

Monitoring, evaluating, and updating the HMP is critical to maintaining its value and supporting the success of Armstrong County's hazard mitigation efforts. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and supports future resiliency.

The Steering Committee reviewed the 2014 plan maintenance procedures and carried them forward to the current HMP update, as described in the sections below. Going forward, the plan will continue to be available on the Armstrong County Department of Public Safety (DPS) website. The 2019 plan maintenance procedures also describe the ways in which this plan may be integrated into other planning mechanisms in the County.

7.2 MONITORING, EVALUATING, AND UPDATING THE PLAN

The Armstrong County HMP Planning Team intends to remain intact as the organization responsible for monitoring, evaluating, and updating this plan. The DPS Emergency Preparedness Coordinator shall serve as HMP Coordinator for the Planning Team. Each participating jurisdiction is expected to retain a municipal hazard mitigation representative to support the jurisdiction's input to the monitoring, evaluating, and updating responsibilities identified in this section. Members of the Planning Team are listed in Section 3.

Understanding that individual commitments change over time, each jurisdiction and its representatives are responsible for informing the Armstrong County HMP Coordinator of any changes in representation by formal letter. The HMP Coordinator will strive to keep the Planning Team makeup as a representation of planning partners and stakeholders within the County. The HMP Coordinator shall maintain the current membership of the Planning Team on the Armstrong County DPS website (https://www.armcodps.com/) or in publicly-accessible County records.

The following sections describe the monitoring, evaluating, and updating processes and protocols for the Armstrong County HMP.

7.2.1 Monitoring

The Planning Team will be responsible for monitoring implementation, evaluating the effectiveness of the HMP, and documenting this information in a progress report. Prior to Planning Team progress meetings (detailed below), Planning Team representatives may collect information from departments, agencies, and organizations involved with the mitigation activities identified in Section 6 of this plan. The representatives will make phone calls and conduct meetings with persons responsible for initiating and/or overseeing the mitigation projects to obtain progress information. Copies of any grant applications filed on behalf of any of the participating jurisdictions shall be provided to the Planning Team. The Armstrong County HMP Coordinator will work with municipal representatives to provide additional opportunities for members of the public to learn about the hazards they face, and to provide information to be incorporated into the HMP. FEMA's National Flood Hazard Layer tools can be used as an interactive tool to facilitate this process. Further, the representatives shall obtain from their municipal supervisor, mayor, or councilperson any public comments made on the plan and provide them to the Planning Team for inclusion in the progress report.

The Planning Team representatives will be expected to document the following, as needed and as appropriate:

- Additional stakeholders (such as planning agencies and business representatives) who should be invited to participate in the planning process
- Additional local assets (such as major employers, local points of interest, residential areas, etc.) to consider in the risk assessment and mitigation strategy, so that more detail of what each municipality considers vital can be included in the HMP
- Hazard events and losses occurring in their jurisdiction, including their nature, extent, and the effects that hazard mitigation actions have had on impacts and losses
- Progress on the implementation of mitigation actions, including efforts to obtain outside funding for mitigation actions
- Any obstacles or impediments to the implementation of actions
- Additional mitigation actions believed to be appropriate and feasible
- How floodplain management in accordance with the National Flood Insurance Program (NFIP) is carried out in the municipality (through completion of the NFIP Survey worksheet)
- Public and stakeholder input and comments on the plan

Local Planning Team representatives may use the progress reporting forms (Worksheets #1 and #3 in the Federal Emergency Management Agency [FEMA] 386-4 guidance document[1]) to facilitate collection of progress data and information on specific mitigation actions.

7.2.2 Evaluating

The evaluation of the HMP is an assessment of whether (1) the planning process and actions have been effective, (2) the plan's goals are being reached, and (3) changes are needed. The plan will be evaluated on an annual basis to determine the effectiveness of the programs and to reflect changes that may affect mitigation priorities or available funding.

The status of the HMP will be discussed and documented at a plan review meeting of the Hazard Mitigation Planning Team. At least 1 month before the progress plan review meeting, the Armstrong County HMP Coordinator will advise Planning Team members of the meeting date, agenda, and expectations of the members. The Armstrong County HMP Coordinator may also distribute additional flood mitigation survey and mitigation project opportunity forms for jurisdictions that may have new information or jurisdictions that did not participate in the update process.

The Armstrong County HMP Coordinator will be responsible for calling and coordinating the progress plan review meeting and assessing progress toward achieving plan goals and objectives. These evaluations will assess whether:

- Goals and objectives address current and expected conditions
- The nature or magnitude of the risks has changed
- The HMP has been implemented into land use processes on the County and municipal levels
- Current resources are appropriate for implementing the HMP and if different or additional resources are now available
- Actions are cost effective
- Schedules and budgets are feasible
- Implementation problems exist—such as technical, political, legal, or coordination issues with other agencies

[1] https://www.fema.gov/media-library-data/20130726-1521-20490-9008/fema_386_4.pdf

- Outcomes have occurred as expected
- Changes in County or municipal resources have impacted plan implementation (for example, funding, personnel, and equipment)
- New agencies, departments, or staff should be included, including other local governments as defined under 44 *Code of Federal Regulations* (CFR), Section 201.6
- Documentation has been completed for any hazards that occurred during the last year

Specifically, the Planning Team will review the mitigation goals, objectives, activities, and projects using the following performance-based indicators:

- New agencies or departments created that have authority to implement mitigation actions or are required to meet goals, objectives, and actions
- Project evaluation based on current needs of the mitigation plan
- Project completion regarding progress of proposed or ongoing actions
- Under-spending or over-spending regarding proposed mitigation action budgets
- Achievement of the goals and objectives
- Resource allocation to note whether resources are required to implement mitigation activities
- Timeframe comments on whether proposed schedules are sufficient to address actions
- Budget notes (in other words, if budget basis should be changed or is sufficient)
- Lead or support agency commitment notes (if there is a lack of commitment on the part of lead or support agencies)
- Resource comments regarding whether resources are available to implement actions
- Feasibility comments regarding whether certain goals, objectives, or actions prove to be unfeasible

Finally, the Planning Team will evaluate the ways other programs and policies have conflicted or augmented planned or implemented measures, and shall identify policies, programs, practices, and procedures that could be modified to accommodate hazard mitigation actions (described further in Section 5.2.6). These other programs and policies can include those that address the following:

- Economic development
- Environmental preservation and permitting
- Historic preservation
- Redevelopment
- Health and/or safety
- Recreation
- Land use and zoning
- Public education and outreach
- Transportation

The Planning Team may refer to the evaluation forms (Worksheets #2 and #4 in the FEMA 386-4 guidance document[1]) to assist in the evaluation process.

The Armstrong County HMP Coordinator shall be responsible for preparing an HMP progress report based on the local progress reports provided by each jurisdiction, information presented at the Planning Team meeting, and other information as appropriate and relevant. These reports will provide data for the 5-year update of this HMP and will assist in identifying implementation challenges. By monitoring the implementation of the plan, the Planning Team will be able to assess which projects are completed, are no longer feasible, or may require additional funding.

This progress report shall apply to all planning partners who have provided input, and as such, shall be developed according to an agreed-upon format and with adequate allowance for input and comment of each planning partner prior to completion and submission to the State Hazard Mitigation Officer. Each planning partner will be responsible for providing this report to its governing body for their review.

During the Planning Team meeting, the planning partners shall establish a schedule for the development, review, comment, amendment, and submission of the HMP progress report to the State Hazard Mitigation Officer.

The plan will also be evaluated and revised following any major disasters to determine whether the recommended actions remain relevant and appropriate. The risk assessment will also be revisited to see if any changes are necessary based on the pattern of disaster damages or if data listed in the Section 4.3 (Hazard Profiles) of this plan have been collected over the performance period to facilitate the risk assessment. Revisiting the risk assessment is an opportunity to increase the community's disaster resistance and build a better and stronger community.

7.2.3 Updating

Section 44 CFR 201.6.d.3 requires that local hazard mitigation plans be reviewed, revised (as appropriate), and resubmitted for approval to remain eligible for benefits awarded under the Disaster Mitigation Act of 2000 (DMA 2000). The Armstrong County Hazard Mitigation Planning Team updates this plan on a 5-year cycle from the date of plan adoption.

To facilitate the update process, the Armstrong County HMP Coordinator (with support from the Planning Team) will hold a meeting 3 years from the date of plan approval to develop and commence with the implementation of a detailed plan update program. The Armstrong County HMP Coordinator will invite representatives from the Pennsylvania Emergency Management Agency (PEMA) to this meeting to provide guidance on plan update procedures. This program shall, at a minimum, establish (1) the parties responsible for managing and completing the plan update effort, (2) features needed to be included in the updated plan, and (3) a detailed timeline with milestones to ensure that the update is completed according to regulatory requirements.

At this meeting, the Planning Team shall determine the resources needed to complete the update. The Armstrong County HMP Coordinator shall be responsible for ensuring that needed resources are secured.

The Armstrong County HMP Coordinator is responsible for coordinating the plan evaluation portion of the meeting, soliciting feedback, collecting and reviewing the comments, and ensuring their incorporation in the 5-year plan update, as appropriate. Additional meetings may also be held as deemed necessary by the Planning Team. The purpose of these meetings would be to provide an opportunity for the public to express concerns, opinions, and ideas about the HMP.

7.3 CONTINUED PUBLIC INVOLVEMENT

Armstrong County and participating jurisdictions are committed to the continued involvement of the public in the hazard mitigation process. Therefore, the plan will be posted on the DPS website (https://www.armcodps.com/), and copies of the plan will be made available for review during normal business hours at DPS's main office. Armstrong County will make electronic copies of the plan available for local municipalies to provide public access.

Following each 5-year update of the HMP, the updated plan will be distributed for public comment. After all comments are addressed, the HMP will be revised and distributed to all Planning Team members and the Pennsylvania State Hazard Mitigation Officer.

The Armstrong County HMP Coordinator will be responsible for receiving, tracking, and filing public comments regarding this HMP. The public will have an opportunity to comment on the plan at the review meeting for the HMP and during the 5-year plan update. Armstrong County will maintain an active link on the DPS website to collect public comments.

The Planning Team representatives are responsible for ensuring the following:

- Public comment and input on the HMP (and hazard mitigation in general) are recorded and addressed, as appropriate. An opportunity to comment on the plan will be provided directly on the DPS website, and provisions for public comment submitted in writing will also be made. All public comments shall be addressed to:

  Becky Feracioly, Emergency Preparedness Coordinator
  Armstrong County Department of Public Safety
  131 Armsdale Road
  Kittanning, PA 16201
- Copies of the latest approved version of the plan are available for review at the municipal buildings along with instructions to facilitate public input and comment on the plan.
- Appropriate links to an Armstrong County HMP website (i.e., http://www.armstrongcountyhmp.com) will be maintained. The website will be monitored throughout the course of the HMP update process, and a draft copy of the plan will be posted for public comment. Upon conclusion of the update, appropriate links to the County HMP will be maintained on the DPS website (https://www.armcodps.com/).
- Public notices will be made, as appropriate, to inform the public of the availability of the plan, particularly during plan update cycles.

The Armstrong County HMP Coordinator shall ensure the following:

- Public comment and input on the HMP (and hazard mitigation in general) will be recorded and addressed, as appropriate.
- HMP content on the DPS website will be maintained and updated, as appropriate.
- All public and stakeholder comments received will be documented and maintained.
- Copies of the latest approved plan will be available for review at DPS, along with instructions to facilitate public input and comment on the plan.
- Public notices, including media releases, will be made (as appropriate) to inform the public of the availability of the plan, particularly during plan update cycles.

SECTION 8 PLAN ADOPTION

By adopting the Armstrong County Hazard Mitigation Plan (HMP), local governing bodies demonstrate their commitment to fulfill the mitigation goals and objectives outlined in the plan. Adoption of the HMP by Armstrong County and each participating jurisdiction legitimizes the HMP and authorizes responsible agencies to execute their responsibilities.

Each participating jurisdiction in Armstrong County will continue with formal adoption proceedings upon conditional approval of this HMP from the Federal Emergency Management Agency (FEMA), known as "Approval Pending Adoption (APA)". Each participating jurisdiction understands that conditional approval of the HMP will be provided for those municipalities that meet the planning requirements with the exception of the adoption requirement, as stated above.

Following adoption or formal action on the HMP, each participating jurisdiction must submit a copy of the resolution or other legal instrument showing formal adoption (acceptance) of the HMP to the Armstrong County Hazard Mitigation Coordinator. Armstrong County will forward the executed resolutions to the Pennsylvania Emergency Management Agency (PEMA), who will subsequently forward the resolutions to FEMA. Each participating jurisdiction understands that FEMA will transmit acknowledgement of verification of formal HMP adoption and the official approval of the HMP to the Hazard Mitigation Coordinator. Resolutions reflecting the formal adoption of this HMP by the County and participating jurisdictions are included in Appendix F of this HMP. A sample resolution to be used by the County and its jurisdictions is provided on the following pages.

Armstrong County Hazard Mitigation Plan

County Adoption Resolution

Resolution No. ___________________

Armstrong County, Pennsylvania

WHEREAS, the municipalities of Armstrong County, Pennsylvania, are 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 (DMA 2000) requires state and local 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, Armstrong County acknowledges the requirement of Section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving Hazard Mitigation Assistance funds, and

WHEREAS, the Armstrong County Hazard Mitigation Plan has been developed by Armstrong County Department of Public Safety in cooperation with other County departments, local municipal officials, and the citizens of Armstrong County, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Armstrong County Hazard Mitigation Plan, and

WHEREAS, the Armstrong County 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 County and its municipal governments,

NOW THEREFORE BE IT RESOLVED by the governing body for the County of Armstrong that:

- The 2019 Armstrong County Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the County, and
- The respective officials and agencies identified in the implementation strategy of the 2019 Armstrong County Hazard Mitigation Plan are hereby directed to execute the recommended activities assigned to them.

ADOPTED, this _________ day of ________________, 2019

ATTEST:

____

ARMSTRONG COUNTY COMMISSIONERS

By _______________________________

By _______________________________

By _______________________________

Armstrong County Hazard Mitigation Plan

Municipal Adoption Resolution

Resolution No. ___________________

< *Municipality Name*>, Armstrong County, Pennsylvania

WHEREAS, the <*Municipality Name*>, Armstrong County, 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 (DMA 2000) requires state and local 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 <*Municipality Name*> acknowledges the requirement of Section 322 of DMA 2000 to have an approved Hazard Mitigation Plan as a prerequisite to receiving Hazard Mitigation Assistance funds, and

WHEREAS, the Armstrong County Hazard Mitigation Plan has been developed by Armstrong County Department of Public Safety in cooperation with other County departments, and officials and citizens of <*Municipality Name*>, and

WHEREAS, a public involvement process consistent with the requirements of DMA 2000 was conducted to develop the Armstrong County Hazard Mitigation Plan, and

WHEREAS, the Armstrong County 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 County and its municipal governments,

NOW THEREFORE BE IT RESOLVED by the governing body for the <*Municipality Name*>:

- The 2019 Armstrong County Hazard Mitigation Plan is hereby adopted as the official Hazard Mitigation Plan of the <*Municipality Name*>, and
- The respective officials and agencies identified in the implementation strategy of the 2019 Armstrong County Hazard Mitigation Plan are hereby directed to execute the recommended activities assigned to them.

ADOPTED, this _________ day of ________________, 2019

ATTEST:

____

< *MUNICIPALITY NAME*> REPRESENTATIVES

By _______________________________

By _______________________________

By _______________________________