Crawford County 2025 Hazard Mitigation Plan

Prepared for:

Crawford County

Department of Public Safety

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Certification of Annual Review Meetings

YEAR	DATE OF MEETING	PUBLIC OUTREACH ADDRESSED? *	SIGNATURE
2024			
2025			
2026			
2027			
2028			

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

Record of Changes

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

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Acronyms

AACT: American Academy of Clinical Toxicology

ACHA: American College Health Association

ACMT: American College of Medical Toxicology

AHJ: Authority Having Jurisdiction

AMD: Acid Mine Drainage

ANSI: American National Standards Institute

ASAM: American Society of Addiction Medicine

ASHRAE: American Society of Heating, Refrigerating, and Air-Conditioning Engineers

ASIRT: Association for Safe International Road Travel

BFE: Base Flood Elevation

CBRNE: Chemical, Biological, Radiological, Nuclear, or Explosive

CDC: Centers for Disease Control and Prevention

CERT: Community Emergency Response Team

CFR: Code of Federal Regulations

CFS: Commodity Flow Study

CHSN: College Health Surveillance Network

CCIDRAP: Center for Infectious Disease Research and Policy

CRS: Community Rating System

DCNR: Department of Conservation and Natural Resources

DDAP: Department of Drug and Alcohol Programs

DEA: Drug Enforcement Administration

DFIRM: Digital Flood Insurance Rate Map

DMA: Disaster Mitigation Act

DPS: Department of Public Safety

EF: Enhanced Fujita

EIA: Energy Information Administration

EMA: Emergency Management Agency

EMPG: Emergency Management Performance Grant

EMS: Emergency Medical Services

EOP:	Emergency Operations Plan
EPA:	Environmental Protection Agency
EPCRA:	Emergency Planning and Community Right-To-Know Act
EPZ:	Emergency Planning Zone
FBI:	Federal Bureau of Investigations
FEMA:	Federal Emergency Management Agency
FMA:	Flood Mitigation Assistance Grant Program
FRA:	Federal Railroad Association
GIS:	Geographic Information Systems/Sciences
HAZUS:	Hazards U.S. Software
HMA:	Hazard Mitigation Assistance
HMEP:	Hazardous Material Emergency Planning Grant
HMGP:	Hazard Mitigation Grant Planning
HMP:	Hazard Mitigation Plan
HMRF:	Hazardous Material Response Fund
HSCA:	Hazardous Sites Cleanup Act
HSGP:	Homeland Security Grant Program
HVE:	Homegrown Violent Extremist
ICC:	International Code Council
IES:	Illuminating Engineering Society
LEPC:	Local Emergency Planning Committee
LGTBQ:	Lesbian, Gay, Bisexual, Trans & Queer
LPT:	Local Planning Team
MAT:	Medication-Assisted Treatment
MPC:	Municipalities Planning Code
NARM:	Notification and Resource Manual
NAS:	Neonatal Abstinence Syndrome
NCDC:	National Climatic Data Center
NCEI:	National Centers for Environmental Information
NFIP:	National Flood Insurance Program
NFPA:	National Fire Protection Association

NIH: National Institute of Health

NLD: National Levee Database

NOAA: National Oceanic and Atmospheric Administration

NTP: Narcotic Treatment Program

NWS: National Weather Service

OIH: Opioid-Induced Hyperalgesia

OUD: Opioid Use Disorder

PA DCED: Pennsylvania Department of Community and Economic Development

PA DEP: Pennsylvania Department of Environmental Protection

PA DOA: Pennsylvania Department of Agriculture

PA GWIS: Pennsylvania Groundwater Information System

PA HART: Pennsylvania Helicopter Aquatic Rescue Team

PAWNVCP: Pennsylvania West Nile Virus Control Program

PDMP: Prescription Drug Monitoring Program

PDSI: Palmer Drought Severity Index

PEMA: Pennsylvania Emergency Management Agency

PennDOT: Pennsylvania Department of Transportation

PHMSA: Pipeline and Hazardous Materials Safety Administration

PISC: Pennsylvania Invasive Species Council

POD: Points of Dispensing

PWSA: Public Water Service Area

RF: Risk Factor

SARA: Superfund Amendments and Reauthorization Act

SC: Steering Committee

SFHA: Special Flood Hazard Area

TRI: Toxic Release Inventory

UCC: Uniform Construction Code

US HHS: United States Department of Health and Human Services

USACE: Untied States Army Corp of Engineers

USDA: United States Department of Agriculture

USDA FS: United States Department of Agriculture Forest Service

USGS: United States Geological Survey

WL: Working Level

WMD: Weapon of Mass Destruction

WUI: Wildland Urban Interface

Executive Summary

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

In 2023, the Crawford County Department of Public Safety contracted the services of a consulting agency to revise and update the Crawford County Hazard Mitigation Plan. The plan was successfully updated in accordance with the requirements set forth by PEMA and FEMA. The 2020 Crawford County Hazard Mitigation Plan was adopted by the Crawford County Commissioners in 2021. Most municipalities adopted the 2020 Crawford County Hazard Mitigation Plan as the municipal hazard mitigation plan, and it is anticipated that all participating municipalities will adopt the 2025 Crawford County Hazard Mitigation Plan Update.

The Crawford County Commissioners secured a grant to complete the 2025 update to the Crawford County Hazard Mitigation Plan. MCM Consulting Group, Inc. was hired to assist the county with the update of the plan. The planning kick-off meeting was conducted on September 20, 2023.

The planning process for the 2025 Crawford County Hazard Mitigation Plan Update consisted of the following:

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

Throughout the planning process, the general public was given the opportunity to comment on the existing HMP and provide suggestions for the updated version. Several meetings were held in person with a virtual option, and participants were invited to submit surveys and other documents via an online survey.

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

Natural hazards:

- Drought
- Earthquake
- Extreme Temperatures
- Flooding, Flash Flooding, Ice Jam Flooding
- Hurricane and Tropical Storm
- Invasive Species
- Landslide
- Lightning Strike
- Pandemic and Infectious Disease
- Radon Exposure
- Tornado/Windstorm
- Wildfire
- Winter Storm

Human-caused hazards:

- Blighted Properties
- Civil Disturbance
- Dam Failure
- Disorientation
- *Emergency Services
- Environmental Hazards / Hazardous Materials
- Nuclear Incident
- Substance Use Disorder
- Terrorism/Cyberterrorism Incidents
- Transportation Accidents
- Urban Fire and Explosion
- Utility Interruption

A total of twenty-six hazards have been identified in the 2025 Crawford County Hazard Mitigation Plan. A total of thirteen identified hazards were listed in the previous 2020 plan update. The new hazards include extreme temperatures, hurricane and tropical storm, radon exposure, wildfire, blighted properties, civil disturbance, disorientation, emergency services, environmental hazards/hazardous materials, nuclear incident, substance use disorder, transportation accidents, and urban fire and explosion.

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

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

Mitigation actions are specific projects and activities that help achieve goals. A total of thirty-nine actions were developed for this plan update as they pertain to hazards identified by the local planning team. The 2020 Crawford County Hazard Mitigation Plan consisted of eighty-nine total actions. The individual objectives and actions that will be implemented are shown in Section 6.4. Each municipality was provided the opportunity to submit new project opportunity forms for this update. No project opportunity forms were submitted during the 2020 HMP update. A total of ninety-one project opportunities were submitted for this plan update.

The 2025 Crawford County Hazard Mitigation Plan is the cornerstone to reducing Crawford County's vulnerability to disasters. It is the commitment to reducing risks from hazards and serves as a guide for decision makers as they commit resources to reducing the effects of hazards. Hazard mitigation is the only phase of emergency management specifically dedicated to breaking the cycle of damage, reconstruction, and repeated damage.

The 2025 Crawford County Hazard Mitigation Plan is a living document that reflects ongoing hazard mitigation activities and requires monitoring, evaluating, and updating to ensure the mitigation actions are implemented. To facilitate the hazard mitigation planning process and adhere to regulatory requirements, the plan will be reviewed annually, and any major revisions will be incorporated into the five-year update.

1. Introduction

1.1. Background

The Crawford County Board of Commissioners, in response to the Disaster Mitigation Act of 2000 (DMA 2000), organized a countywide hazard mitigation planning effort to prepare, adopt, and implement a multi-jurisdictional Hazard Mitigation Plan (HMP) for Crawford County and all of its fifty-one municipalities. The Crawford County Department of Public Safety was charged by the County Board of Commissioners to prepare the 2025 plan. The 2020 HMP has been utilized and maintained during the five-year life cycle.

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

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

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

1.2. Purpose

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

- Protect life, safety, and property by reducing the potential for future damages and economic losses that result from hazards.
- Qualify for additional grant funding, in both the pre-disaster and the post-disaster environment.

- Speed recovery and redevelopment following future disaster events.
- Demonstrate a firm local commitment to hazard mitigation principles.
- Comply with both state and federal legislative requirements for local hazard mitigation plans.

1.3. Scope

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

A multi-jurisdictional planning approach was utilized for the Crawford County HMP update, thereby eliminating the need for each municipality to develop its own approach to hazard mitigation projects, common mitigation goals and objectives, and an evaluation of a broad capabilities assessment examining policies and regulations throughout the county and its municipalities.

1.4. Authority and References

Authority for this plan originates from the following federal sources:

- Robert T. Stafford Disaster Relief and Emergency Assistance Act, 42 U.S.C., Section 322, as amended
- Code of Federal Regulations (CFR), Title 44, Parts 201 and 206
- Disaster Mitigation Act of 2000, Public Law 106-390, as amended.
- National Flood Insurance Act of 1968, as amended, 42 U.S.C. 4001 et seq.

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

- Pennsylvania Emergency Management Services Code. Title 35, Pa C.S. Section 101
- Pennsylvania Municipalities Planning Code of 1968, Act 247 as reenacted and amended by Act 170 of 1988.
- Pennsylvania Stormwater Management Act of October 4, 1978. P.L. 864, No. 167

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

- FEMA 386-1: Getting Started. September 2002

- FEMA 386-2: Understanding Your Risks: Identifying Hazards and Estimating Losses. August 2001
- FEMA 386-3: Developing the Mitigation Plan. April 2003
- FEMA 386-4: Bringing the Plan to Life. August 2003
- FEMA 386-5: Using Benefit-Cost Review in Mitigation Planning. May 2007
- FEMA 386-6: Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning. May 2005
- FEMA 386-7: Integrating Manmade Hazards into Mitigation Planning. September 2003
- FEMA 386-8: Multijurisdictional Mitigation Planning. August 2006
- FEMA 386-9: Using the Hazard Mitigation Plan to Prepare Successful Mitigation Projects. August 2008
- FEMA Local Multi-Hazard Mitigation Planning Guidance. July 1, 2008
- FEMA National Fire Incident Reporting System 5.0: Complete Reference Guide. January 2008
- FEMA Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards. January 2013
- FEMA Rehabilitation of High Hazard Potential Dams: Grant Program Guidance, June 2020

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

- PEMA: Hazard Mitigation Planning Made Easy!
- PEMA Mitigation Ideas: Potential Mitigation Measures by Hazard Type: A Mitigation Planning Tool for Communities. March 6, 2009
- PEMA: All-Hazard Mitigation Planning Standard Operating Guide, 2020.

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

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

2. Community Profile

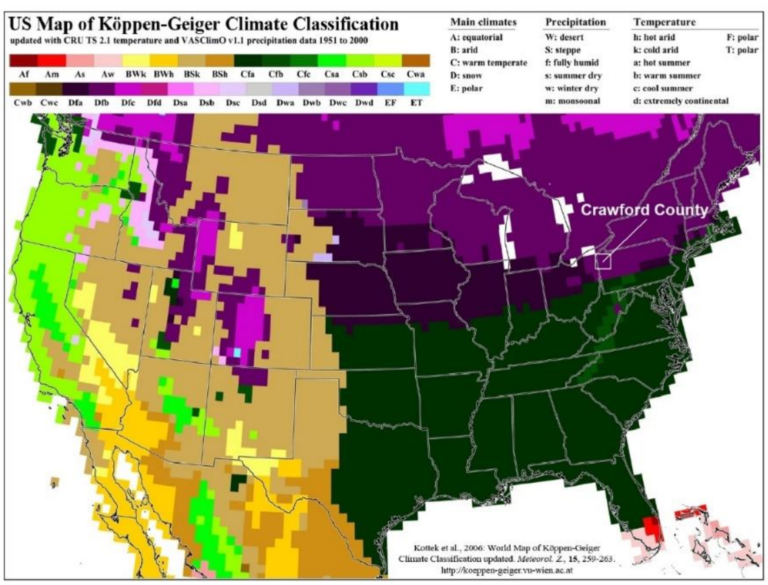
2.1. Geography and the Environment

Crawford County covers approximately 1,038 square miles and is situated in northwest Pennsylvania. The county is bordered by Trumbull County, Ohio to the southwest, and Ashtabula County, Ohio to the west, by Erie County to the north, by Warren County to the east, by Venango County to the southeast, and by Mercer County to the south. Crawford County lies within the Appalachian Plateaus Province of Pennsylvania. More specifically, Crawford County is almost entirely characterized by the Northwestern Glaciated Plateau Section, with a small section of the southeast of the county within the High Plateau Section. The county is the 35th ranked county in terms of population within the Commonwealth of Pennsylvania. There is a total of 1,012 square miles of land and 26 square miles of water.

Crawford County presents a wide range of topographic features. The surface ranges from almost level on plateaus and in valleys, to rolling and hilly in other areas. Elevations in the county range from a high of more than 1,900 feet in Sparta Township to the northeast to a low of less than 850 feet near the Conneautville Soybean Crushing LLC.

The Köppen-Geiger Climate Areas map classifies Crawford County, and the rest of Pennsylvania, as Humid Continental, which can be seen in *Figure 1 – Köppen-Geiger Climate Map*. While the counties of Pennsylvania share many weather similarities, there are also a few unique characteristics to the area.

Figure 1 - Köppen-Geiger Climate Map



According to current data, the climate in Crawford County is temperate, being characterized by moderately hot summers and moderately severe winters. In winter, the average temperature is 31.83˚F and the average daily minimum temperature is 24.65˚F. In summer, the average temperature is 69.40˚F and the average daily maximum temperature is 77.95˚F. The average amount of snowfall each winter is 104 inches.

River and stream valleys dominate the landscape of Crawford County. Crawford County is home to the largest natural lake in Pennsylvania, Conneaut Lake. There are also two other natural lakes in Crawford County, Canadohta Lake and Sugar Lake. Along with the largest natural lake, Crawford County is also home to the largest artificial lake in Pennsylvania, Pymatuning Lake. Crawford County is comprised of four watersheds:

Table 1 - Watersheds in Crawford County

Watersheds in Crawford County
Shenango River Watershed
French Creek Watershed
Oil Creek Watershed
Lake Erie Watershed

2.2. Community Facts

Crawford County is located in the northwest portion of Pennsylvania. The county was founded in March of 1800 from a portion of Allegheny County. Crawford County was named after Colonel William Crawford, who is said to have been a close friend of the first President of the United States, George Washington. The county seat for Crawford County is Meadville. Meadville was incorporated as a city in 1866 and became the county seat in 1880. Prior to becoming the county seat, in 1807 Meadville organized one of the first U.S. Chambers of Commerce.
The following cities, boroughs and townships are located in Crawford County:

- Cities: Meadville and Titusville
- Boroughs: Blooming Valley, Cambridge Springs, Centerville, Cochranton, Conneaut Lake, Conneautville, Hydetown, Linesville, Saegertown, Spartansburg, Springboro, Townville, Venango, and Woodcock
- Townships: Athens, Beaver, Bloomfield, Cambridge, Conneaut, Cussewago, East Fairfield, East Fallowfield, East Mead, Fairfield, Greenwood, Hayfield, North Shenango, Oil Creek, Pine, Randolph, Richmond, Rockdale, Rome, Sadsbury, South Shenango, Sparta, Spring, Steuben, Summerhill, Summit, Troy, Union, Venango, Vernon, Wayne, West Fallowfield, West Mead, West Shenango, and Woodcock

There are four museums, and one historical society located in Crawford County. The museums are the Crawford County Historical Society, the Baldwin Reynolds House Museum, the Johnson-

Shaw Stereoscopic Museum, the Cambridge Springs Historical Society, the Conneaut Valley Historical Society, and the Conneaut Lake Historical Society.

The National Park Service's (NPS) National Register of Historic Places lists ten locations in Crawford County that are considered historic properties or buildings. These buildings can be found in *Table 2 – Crawford County National Historic Places*, including the year that the building was added to the list and the municipality where it is located.

Table 2 - Crawford County National Historic Places

Crawford County National Historic Places		
Building/Location Name	**Date Added to NRHP**	**Municipality**
Amos Kelly House	July 23rd, 1980	Cambridge Springs Borough
Balwin-Reynolds House	December 30th, 1974	City of Meadville
Bently Hall	May 6th, 1977	City of Meadville
Dr. J.R. Mosier Office	June 13th, 1976	City of Meadville
Edward Saeger House	August 22nd, 1980	Saegertown Borough
Independent Congregational Church	March 8th, 1978	City of Meadville
Judge Henry Shippen House	June 6th, 1984	City of Meadville
Roueche House	March 4th, 1982	City of Meadville
Ruter Hall	September 18th, 1978	City of Meadville
Titusville City Hall	March 31st, 1975	City of Titusville
Source: NPS NRHP, 2024		

2.3. Population and Demographics

The total population for Crawford County is 83,938 based on 2020 United States Census Bureau. The total change in population for Crawford County from 2010 to 2020 was a decrease of 4,827 and a change of -5.44%. The most populous municipality is the City of Meadville with 13,050 residents. The municipalities in the county that had the largest percentage of decrease from 2010 to 2020 were Springboro Borough (-21.17%), Centerville Borough (-19.27%), Union Township (-15.15%), and Troy Township (-14.74%). The municipalities that had the highest percentage of increase for the period from 2010 to 2020 were Rome Township (8.32%), Sparta Township (4.26%), Blooming Valley Borough (1.48%), and Townville Borough (0.93%). *Table 3 – Population Change in Crawford County* illustrates the trends and data from United States Census Bureau. These figures are based off data from the United States Census Bureau in 2020. *Figure 4 – Crawford County Population Density* illustrates the average population density values per census track in the various municipalities of Crawford County.

Table 3 - Population Change in Crawford County

Population Change in Crawford County from 2010-2020			
Municipality	**2010 Census**	**2020 Census**	**Percent of Change 2010-2020**
Athens Township	734	638	-13.08
Beaver Township	902	795	-11.86
Bloomfield Township	1,919	1,861	-3.02
Blooming Valley Borough	337	342	+1.48
Cambridge Township	2,595	2,583	-0.46
Cambridge Springs Borough	1,563	1,448	-7.36
Centerville Borough	218	176	-19.27
Cochranton Borough	1,136	1,121	-1.32
Conneaut Township	1,476	1,334	-9.62
Conneaut Lake Borough	653	625	-4.29
Conneautville Borough	774	736	-4.91
Cussewago Township	1,559	1,430	-8.27
East Fairfield Township	922	836	-9.33
East Fallowfield Township	1,620	1,516	-6.42
East Mead Township	1,493	1,321	-11.52
Fairfield Township	1,023	1,011	-1.17
Greenwood Township	1,454	1,424	-2.06
Hayfield Township	2,940	2,776	-5.58
Hydetown Borough	526	526	0
Linesville Borough	1,040	961	-7.60
Meadville, City of	13,388	13,050	-2.52
North Shenango Township	1,410	1,274	-9.65
Oil Creek Township	1,877	1,702	-9.32
Pine Township	462	432	-6.49
Randolph Township	1,782	1,718	-3.59
Richmond Township	1,475	1,352	-8.34
Rockdale Township	1,506	1,363	-9.50
Rome Township	1,840	1,993	+8.32
Sadsbury Township	2,933	2,752	-6.17
Saegertown Borough	997	869	-12.84
South Shenango Township	2,037	1,831	-10.11
Sparta Township	1,832	1,910	+4.26
Spartansburg Borough	305	277	-9.18
Spring Township	1,548	1,407	-9.11
Springboro Borough	477	376	-21.17

Population Change in Crawford County from 2010-2020			
Municipality	**2010 Census**	**2020 Census**	**Percent of Change 2010-2020**
Steuben Township	804	773	-3.86
Summerhill Township	1,236	1,197	-3.16
Summit Township	2,027	1,902	-6.17
Titusville, City of	5,601	5,262	-6.05
Townville Borough	323	326	+0.93
Troy Township	1,235	1,053	-14.74
Union Township	1,010	857	-15.15
Venango Borough	239	210	-12.13
Venango Township	997	941	-5.62
Vernon Township	5,630	5,310	-5.68
Wayne Township	1,539	1,408	-8.51
West Fallowfield Township	605	577	-4.63
West Mead Township	5,249	5,040	-3.98
West Shenango Township	504	435	-13.69
Woodcock Borough	157	140	-10.83
Woodcock Township	2,856	2,756	-3.50
Crawford County	**88,765**	**83,938**	**-5.44**
Source: United States Census Bureau (2023), 2020 Census Data			

During this hazard mitigation planning period, socially vulnerable populations were reviewed for Crawford County. For the purposes of this hazard mitigation plan, socially vulnerable populations include the unhoused and unsheltered populations of Crawford County, individuals who have mobility challenges, and those populations which may have not had an active role in hazard mitigation planning in the past. Social vulnerability can also include portions of the population that may not have access to specific resources or community lifelines. In Crawford County, this includes, but is not limited to, populations with limited internet access, those individuals who do not have easy access to public transportation, and those populations that are not near grocery or food community lifelines. In Crawford County, populations located far from grocery stores or food locations are at increased vulnerability to natural and human-caused hazards.

Vulnerable populations in Crawford County are represented by a variety of different groups. The Meadville Housing Authority represents individuals located or utilizing low-income housing. The local planning team for this hazard mitigation plan made efforts to include individuals from the Meadville Housing Authority in the planning process.

There are approximately 42,234 housing units in Crawford County, Pennsylvania. Of these housing units, there are an estimated 33,191 occupied households within the county, with an average size of 2.42 persons. Married couples make up a plurality of households in the county at

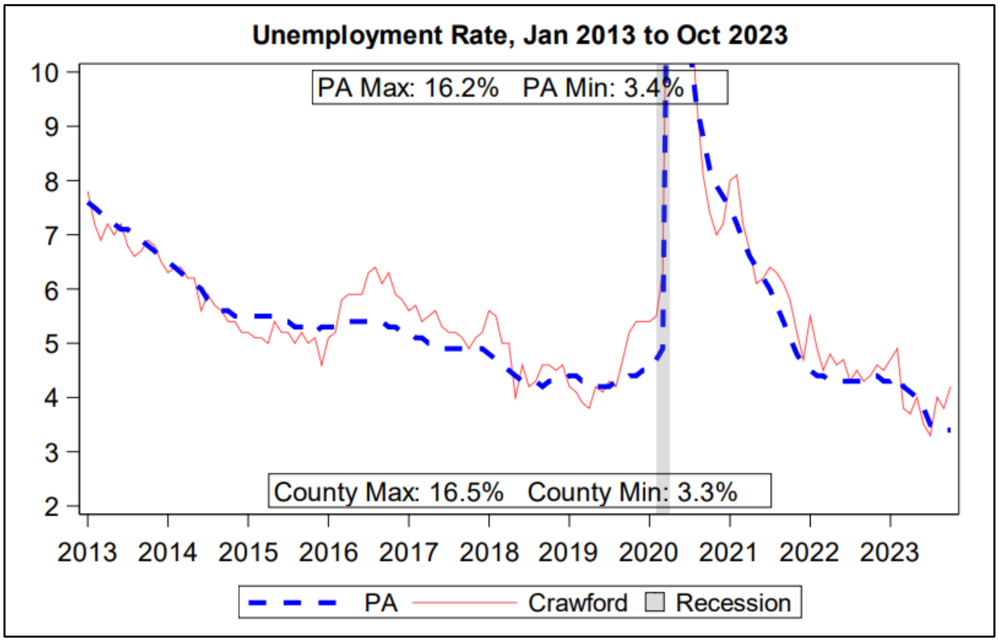
49.0%. The estimated owner-occupied housing rate from 2018 to 2022 for Crawford County is 73.8%. The median value of the owner-occupied housing units in Crawford County from 2018 to 2022 is $136,000.00. The median monthly owner's costs for a structure with a mortgage was $1,187.00 and the median monthly owner's costs for a structure without a mortgage was $480.00. The median gross rent for rental properties in Crawford County was $769.00 for the same date range.

The racial composition of the county is 95.7% White, 1.9% Black or African American, 1.6% Hispanic or Latino, 0.3% American Indian and Alaska Native, 0.6% Asian, 0% native Hawaiian and other Pacific Islander, and 1.5% two or more races. The median age of Crawford County is 43.6 years of age, which is higher than the median age of Pennsylvania at 40.8 years of age and lower than the national median of 38.1 years of age. The percentage of Crawford County under the age of 5 years old is 5.2%, between the ages of 18 and 64 years old is 51.8%, and aged 65 years old and older is 22.6%.

The median household income for households in Crawford County is $58,734.00 and the poverty rate of Crawford County is 13.9% of the total population. The poverty rate for the Commonwealth of Pennsylvania as a whole is 11.8%. There are approximately 6,298 veterans in Crawford County. The median veteran income in Crawford County as of 2021 was $36,296.00, with 6.7% of Crawford County veterans living below the poverty level in the past twelve months. The veteran unemployment rate in the county was approximately 4.4%.

The Covid-19 Pandemic created an increase in unemployment and interruptions in employment throughout the United States, including Pennsylvania and Crawford County. According to Pennsylvania Department of Labor and Industry data, there was a large spike in unemployment both across the Commonwealth and Crawford County. At the height of the Covid-19 Pandemic in the spring of 2020, the unemployment rate for Crawford County hit 16.5% of the working population of the county. That is higher than the peak unemployment percentage for Pennsylvania, which peaked at 16.2% of the working population of the entire state. *Figure 4 – Unemployment Rate Jan. 2013 to Oct. 2023* illustrates the trend and large spike in unemployment. The unemployment rate for Crawford County in October 2023 was 4.2%, which roughly accounted for 1,600 working age adults (ages 16 to 65). The total estimated workforce for Crawford County was 37,200 working age adults (ages 16 to 65) in October 2023.

Table 4 - Unemployment Rate Jan. 2013 to Oct. 2023



Source: Pennsylvania Department of Labor & Industry

Crawford County's leading industries include healthcare, retail trade, education, and manufacturing. The primary employment providers within Crawford County are displayed below in *Table 5 - Crawford County Top Employers.*

Table 5 - Crawford County Top Employers

Crawford County Top Employers (Excluding State Employers)	
Ranking	**Company**
1	Meadville Medical Center
2	Crawford County
3	Wal-Mart Associates Inc
4	Crawford Central School District
5	Acutec Precision Aerospace Inc
6	Allegheny College
7	The Arc of Crawford County Inc
8	Penncrest School District
9	Channellock Inc
10	Lord Corporation
Source: Pennsylvania Department of Labor & Industry, 2023	

The top employers' data was obtained through the Pennsylvania Department of Labor and Industry, Center for Workforce Information and Analysis. This data only provided a list of employers, their ranking, and North American Industry Classification System (NAICS) descriptions. *Table 6 – Quarterly Census of Employment and Wages, 2021 Annual Averages in Crawford County* only calls out how many locations per NAICS description and total number of employees.

Table 6 - Quarterly Census of Employment and Wages, 2021 Annual Averages in Crawford County

Quarterly Census of Employment and Wages, 2021 Annual Averages in Crawford County					
NAICS	**Description**	**Number of Locations**	**Number of Employees**	**Employment Percentage (%)**	**Average Wages ($)**
11	Agriculture, Forestry, Fishing, and Hunting	47	418	1.4	42,723.00
21	Mining, Quarrying, and Oil & Gas	16	219	0.8	71,271.00
22	Utilities	13	152	0.5	75,368.00
23	Construction	161	966	3.3	50,521.00
31-33	Manufacturing	274	7,070	24.5	56,483.00
42	Wholesale Trade	65	547	1.9	49,466.00
44-45	Retail Trade	266	3,248	11.3	32,277.00
48-49	Transportation and Warehousing	68	696	2.4	38,971.00
51	Information	37	374	1.3	46,382.00
52	Finance and Insurance	94	578	2.0	57,337.00
53	Real Estate, Rental, and Leasing	31	118	0.4	44,462.00
54	Professional and Technical Services	113	596	2.1	56,454.00
55	Management of Companies and Enterprises	13	150	0.5	66,000.00
56	Administrative and Waste Services	88	745	2.6	34,831.00
61	Educational Services	60	2,043	7.1	55,405.00

Quarterly Census of Employment and Wages, 2021 Annual Averages in Crawford County					
NAICS	**Description**	**Number of Locations**	**Number of Employees**	**Employment Percentage (%)**	**Average Wages ($)**
62	Healthcare and Social Assistance	324	5,653	19.6	52,138.00
71	Arts, Entertainment, and Recreation	29	214	0.7	18,113.00
72	Accommodation and Food Services	178	2,204	7.6	17,225.00
81	Other Services (Except Public Administration)	188	1,219	4.2	31,945.00
92	Public Administration	84	1,655	5.7	55,948.00
-	**Total, All Industries**	**2,148**	**28,863**	**100**	**47,071.00**
Source: PA DLI, 2021, NAICS (North American Industry Classification System)					

2.4. Land Use and Development

Crawford County is composed of fifty-one municipalities, which include:

- Thirty-five townships
- Fourteen boroughs
- Two cities

The majority of acreage in Crawford County is forested, while approximately 29.27% (or 194,447 acres) of the acreage is agriculture. As of 2022, there are 1,022 farms in Crawford County with an average farm size of 200 acres. 129,791 acres of land in farms in Crawford County are for cropland, 15,888 acres are used for pastureland, 47,976 acres are woodland, and 11,062 acres are for other uses. Crawford county has a total acreage of 664,320 acres.

Crawford County has approximately 647,680 acres of total land area, and 16,640 acres of water area, with a population per square mile of 82.9 persons based on 2020 data estimates. Forested areas make up approximately 25.2% of the county, while agriculture makes up approximately 29.27% of the total land area in Crawford County, and high density urban, low density urban, water, transitional, resource extraction, quarries, and wetlands each account for 2.6% of the land area.

Systems

The specific systems in Crawford County must also be considered when discussing the community characteristics. Food, water, and shelter are of primary concern when looking at a community's lifelines. As Crawford County is a rural county, food areas and grocery stores are spread over a wide geographic area. Specific grocery stores can be found in the City of Meadville, Saegertown Borough, Cochranton Borofugh, City of Titusville, Pine Township, and Conneaut Lake Borough. Water in Crawford County is primarily provided by small, local water authorities and public water suppliers. Local domestic water wells are also prevalent throughout the entire community. Shelter features in Crawford County during emergencies can include municipal borough and township buildings and any buildings that are currently part of emergency response and recovery planning for Crawford County.

2.5. Data Sources

The following data sources were used during the update process:

- United States Census Bureau.
- National Climatic Data Center (NCDC).
- National Oceanic and Atmospheric Administration (NOAA).
- Pennsylvania Department of Conservation and Natural Resources (PA DCNR).
- Pennsylvania Department of Environmental Protection (PA DEP).
- Pennsylvania Department of Labor and Industry (PA DLI).
- Pennsylvania Groundwater Information System (PaGWIS).
- Pennsylvania Emergency Incident Reporting System. (PEIRS)
- Pennsylvania Emergency Management Agency (PEMA).
- Crawford County Comprehensive Plan 2014.

The countywide Digital Flood Insurance Rate Maps (DFIRM) were used for all flood risk analysis and estimation of loss. The Crawford County DFIRMs were approved and effective in 2013. The DFIRM database provides flood frequency and elevation information used in the flood hazard risk assessment. Other Crawford County GIS datasets including road centerlines, structures, and municipalities were utilized in conjunction with the DFIRM data.

In order to assess the vulnerability of different jurisdictions to the hazards, data on past occurrences of damaging weather events was compiled. A large number of natural-hazard events were gathered from the National Climatic Data Center (NCDC) database. The NCDC is a division of the United States Department of Commerce's National Oceanic and Atmospheric Administration (NOAA). Information on hazard events is compiled by the NCDC from data gathered by the National Weather Service (NWS), another division of NOAA. The data is then presented by the NCDC as tabular data that can be queried in the United States Storm Events database, which "documents the occurrences of storms and other significant weather phenomena having sufficient intensity to cause loss of life, injuries, significant property damage, and/or disruption to commerce" (NOAA, 2006). The classification of storm events in the database is based off of data collected from around the United States and the Commonwealth of Pennsylvania, so the data may not be filed under the correct storm category due to user input error. The reason for this data issue results from some storm events falling under multiple categories, including but not limited to winter storm, ice storm, tornado, hurricane / tropical storm, flooding, and flash flooding. Many of the events listed in the United States Storm Events database can fall under multiple of these categories. In an effort to include a comprehensive list of prior storm events for Crawford County, search queries with multiple storm classifications were conducted for each hazard.

Throughout the risk and vulnerability assessment included in Section 4 of this Hazard Mitigation Plan, descriptions of limited data indicate some areas in which the county and the municipalities can improve their ability to identify vulnerable structures and improve loss estimates. As the county and municipal governments work to increase their overall technical capacity and implement comprehensive planning goals, they will also attempt to improve the ability to identify areas of increased vulnerability.

This hazard mitigation plan evaluates the vulnerability of the county's community lifelines. For the purposes of this plan, critical infrastructure facilities are those entities that are essential to the health, welfare, and safety of the community. This includes but is not limited to airports, emergency medical service (EMS) stations, communication facilities and towers, day care centers and preschools, fire departments, hospitals and medical facilities, police departments, schools, and senior living facilities. The locations of these facilities were provided by the Crawford County GIS Department.

Geographic Information Systems (GIS) Data

GIS data was utilized in risk assessment, estimation of loss and the development of map products for the hazard mitigation plan update. A foundation of data was available from the Crawford County GIS Department. Some of the utilized data was downloaded from the Pennsylvania Spatial Data Access (PASDA). A large portion of the plan utilizes census data from the United States Census Bureau, but the 2020 census data collection and dissemination was disrupted due to the Covid-19 Pandemic in 2020 and 2021. The 2020 census was delayed, and the information received during the census was spread out due to social distancing and the limiting of census takers going door to door to gather information.

The Crawford County GIS Department provided the following layers for use in the development of hazard profiles and hazard profile mapping for the 2025 Hazard Mitigation Plan Update:

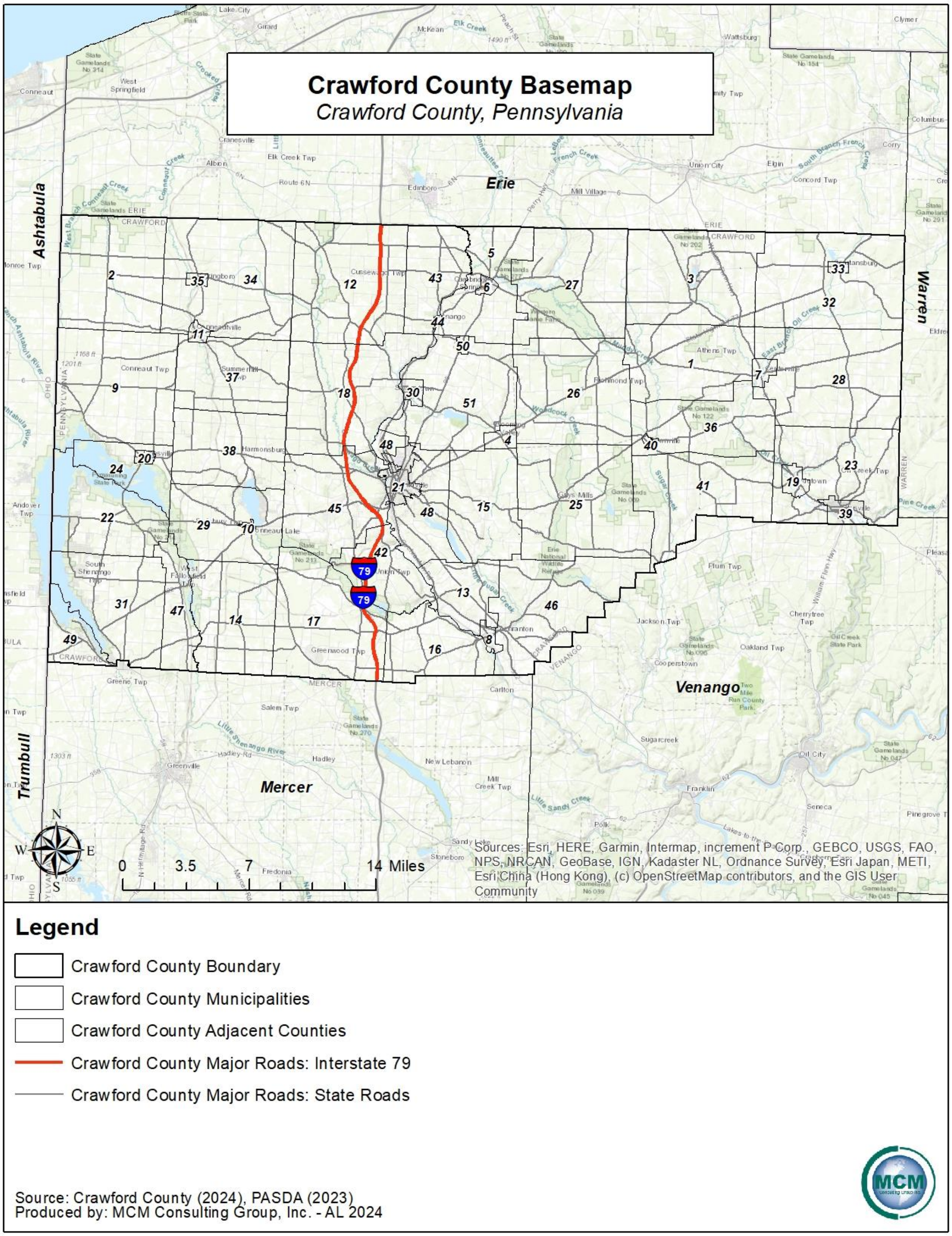
- Crawford County ALS Coverage Zones (EMS)
- Crawford County BLS Coverage Zones (EMS)
- Crawford County Boundaries

- Crawford County EHS Facilities
- Crawford County Fire Department Coverage Zones
- Crawford County Police Department Coverage Zones
- Crawford County Site Structure Address Points
- Crawford County Street Centerlines
- Crawford County Tier II Facilities

The following GIS Data layers were developed for use in the 2025 Hazard Mitigation Plan Update:

- Crawford County Abandoned Mine Inventory
- Crawford County Airports
- Crawford County Bridges
- Crawford County Community Lifelines
- Crawford County Conventional Oil and Gas Locations
- Crawford County Courthouse
- Crawford County Dam Inventory
- Crawford County Electric Substations
- Crawford County Fire Departments
- Crawford County Historic Buildings
- Crawford County Historic Streams
- Crawford County Hospitals
- Crawford County Large Watersheds
- Crawford County Levee Area
- Crawford County Levee Centerlines
- Crawford County Slope Products
- Crawford County Tornado Impacted Municipalities
- Crawford County Traffic Information
- Crawford County Unconventional Oil and Gas Locations
- Crawford County Wildland Urban Interface (WUI)
- Crawford County Zip Codes

Figure 2 - Crawford County Basemap



Crawford County Community Lifelines

Crawford County, Pennsylvania

Legend

- Crawford County Boundary
- Crawford County Municipalities
- Crawford County Adjacent Counties
- Crawford County Major Roads: Interstate 79
- Crawford County Major Roads: State Roads

Municipalities:

1. Athens Township
2. Beaver Township
3. Bloomfield Township
4. Blooming Valley Borough
5. Cambridge Township
6. Cambridge Springs Borough
7. Centerville Borough
8. Cochranton Borough
9. Conneaut Township
10. Conneaut Lake Borough
11. Conneautville Borough
12. Cussewago Township
13. East Fairfield Township
14. East Fallowfield Township
15. East Mead Township
16. Fairfield Township
17. Greenwood Township
18. Hayfield Township
19. Hydetown Borough
20. Linesville Borough
21. City of Meadville
22. North Shenango Township
23. Oil Creek Township
24. Pine Township
25. Randolph Township

Municipalities Continued:

26. Richmond Township
27. Rockdale Township
28. Rochdale Township
29. Rome Township
30. Sadsbury Township
31. Saegertown Borough
32. South Shenango Township
33. Sparta Township
34. Spartansburg Borough
35. Spring Township
36. Springboro Borough
37. Steuben Township
38. Summerhill Township
39. Summit Township
40. City of Titusville
41. Townville Borough
42. Troy Township
43. Union Township
44. Venango Borough
45. Venango Township
46. Vernon Township
47. Wayne Township
48. West Fallowfield Township
49. West Mead Township
50. West Shenango Township
51. Woodcock Borough
52. Woodcock Township

Source: Crawford County (2024), PASDA (2023)
Produced by: MCM Consulting Group, Inc. - AL 2024

Figure 3 - Crawford County Watersheds

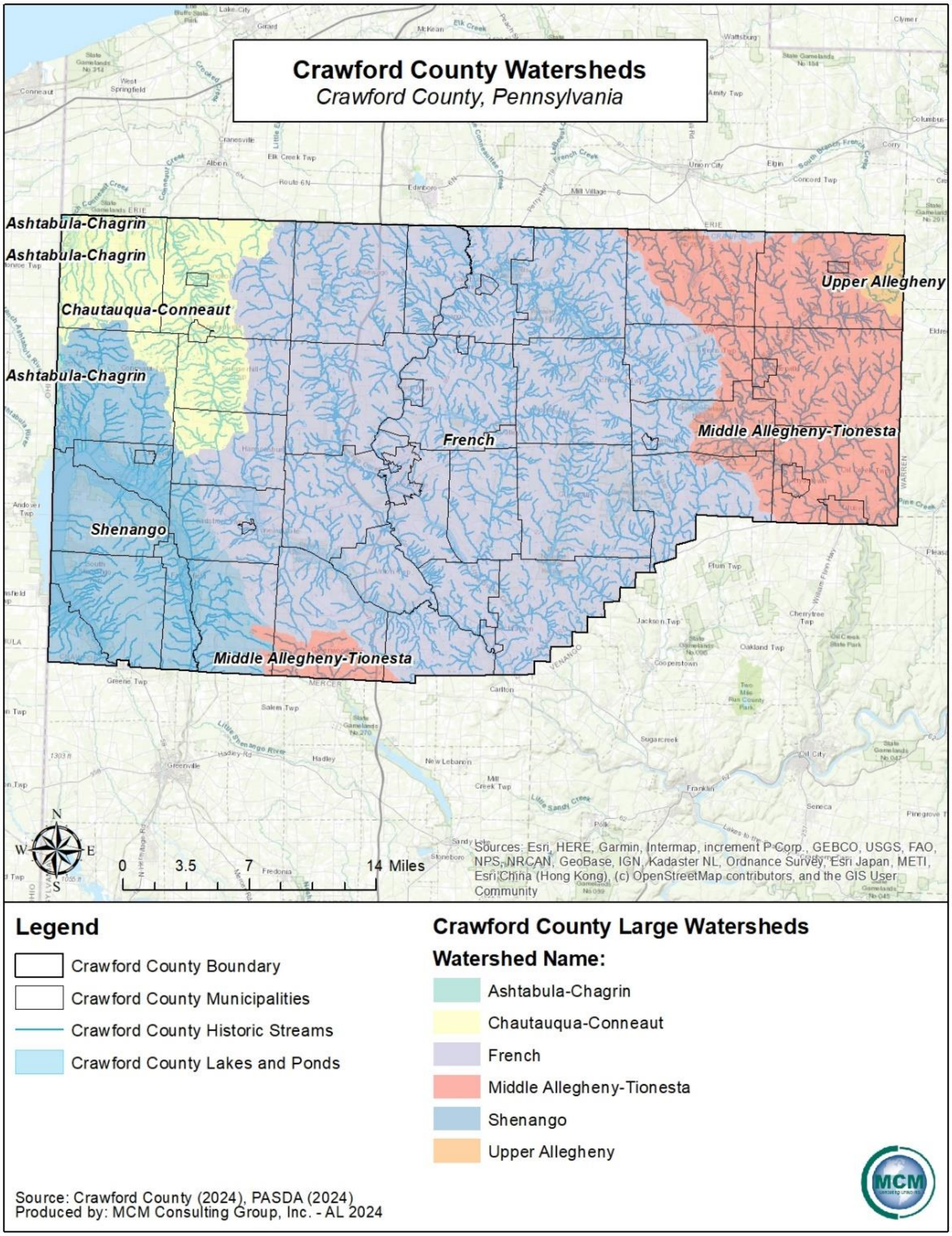


Figure 4 - Crawford County Population Density

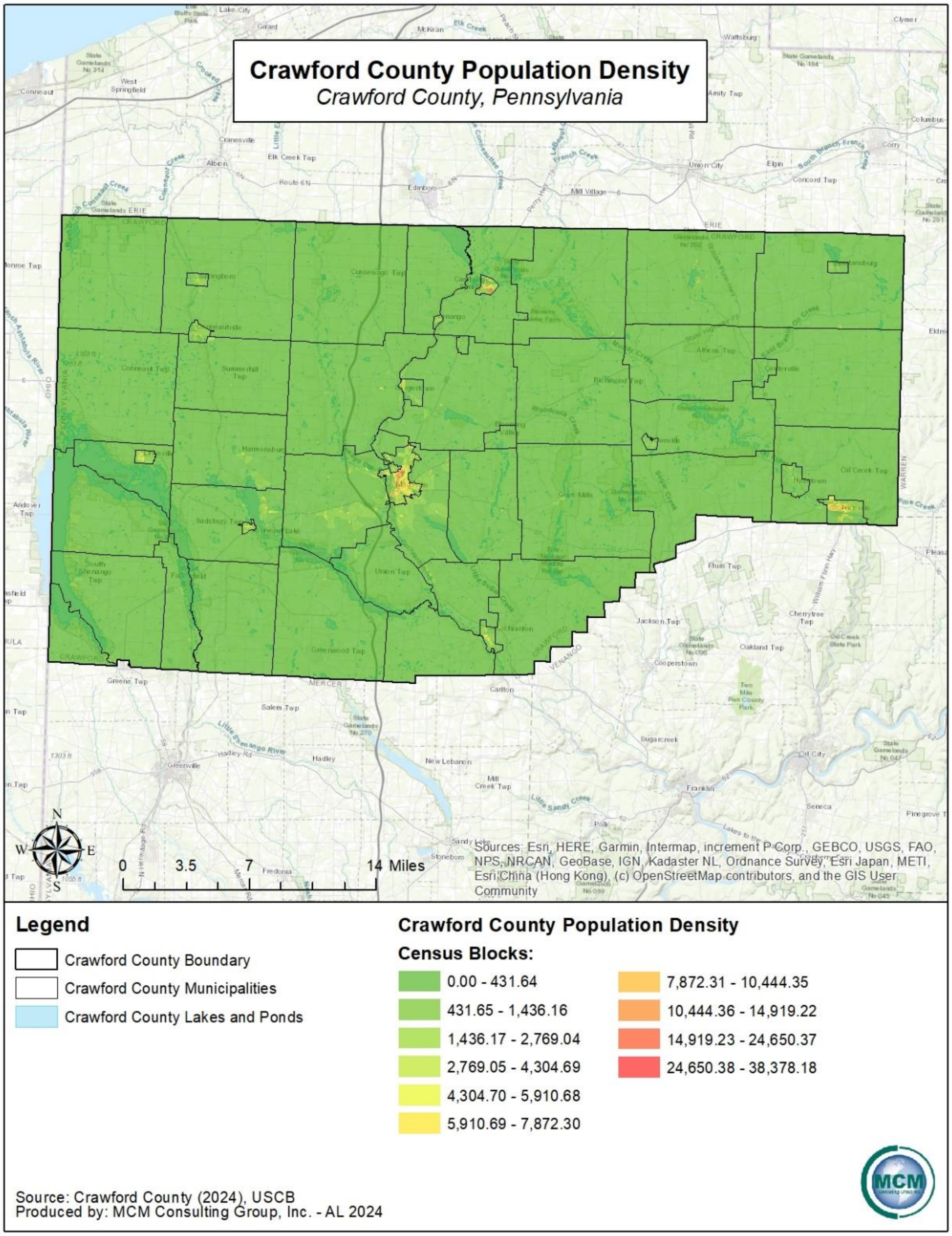
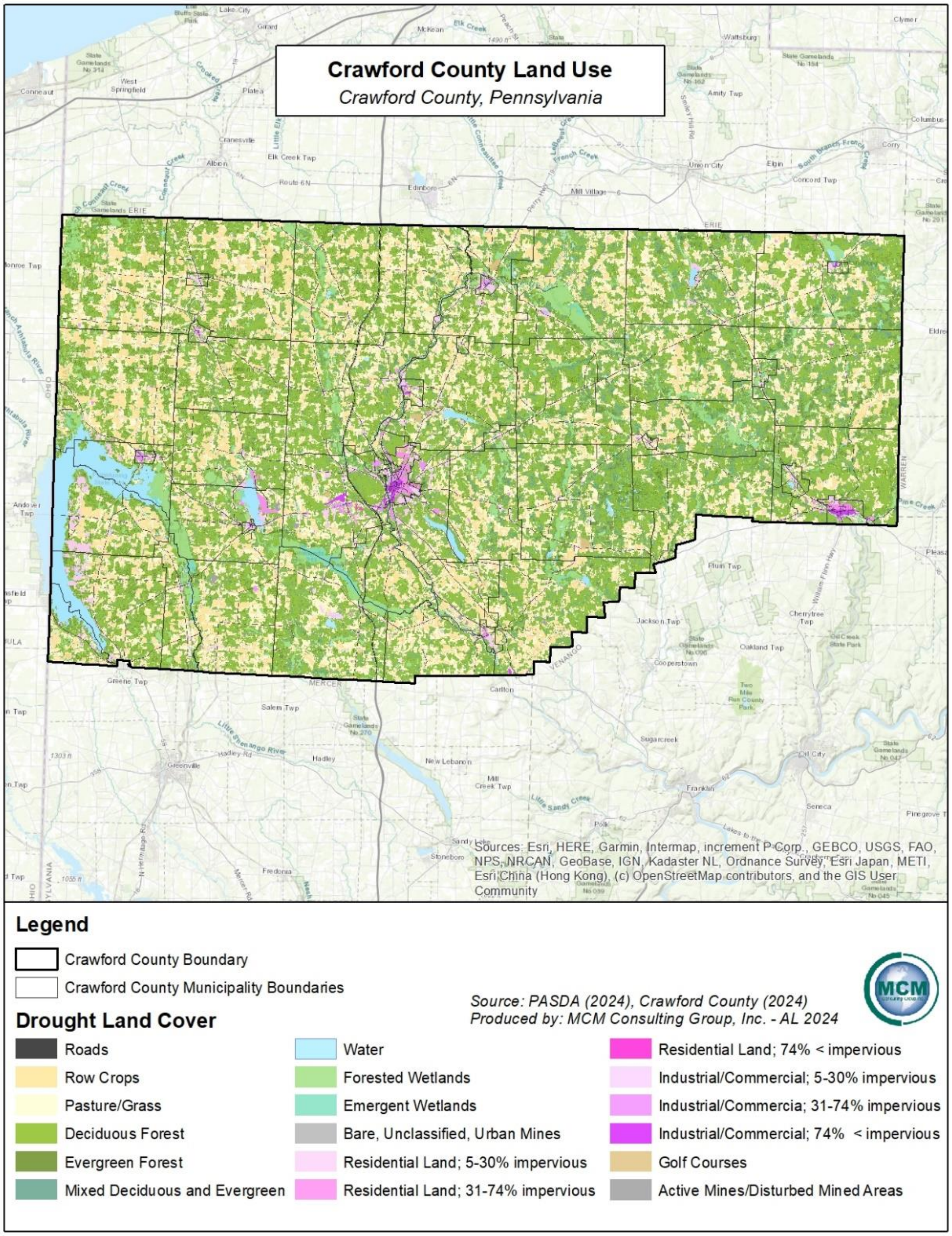


Figure 5 - Crawford County Land Use



3. Planning Process

3.1. Update Process and Participation Summary

The Crawford County Hazard Mitigation Plan update began September 20, 2023. The Crawford County Commissioners were able to secure a hazard mitigation grant to start the process. The Crawford County Department of Public Safety was identified as the lead agency for the Crawford County Hazard Mitigation Plan update. The planning process involved a variety of key decision makers and stakeholders within Crawford County. Crawford County immediately determined that the utilization of a contracted consulting agency would be necessary to assist with the plan update process. MCM Consulting Group, Inc. was selected as the contracted consulting agency to complete the update of the hazard mitigation plan. The core hazard mitigation team, which was referred to as the steering committee, included officials from the Crawford County Department of Public Safety and MCM Consulting Group, Inc. (MCM).

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

MCM Consulting Group, Inc. assisted Crawford County Department of Public Safety in coordinating and leading public involvement meetings, local planning team meetings, analysis, and the writing of the updated HMP. The Crawford County Local Planning Team (LPT) worked closely with MCM in the writing and review of the HMP. MCM conducted project meetings and local planning team meetings throughout the update process. Meeting agendas, meeting minutes and sign-in sheets were developed and maintained for each meeting conducted by MCM. These documents are detailed in Appendix C of this plan.

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

The HMP planning process consisted of:

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

The 2025 Crawford County HMP was completed in December 2024. The 2025 plan follows an outline developed by PEMA which provides a standardized format for all local HMPs in the Commonwealth of Pennsylvania. The 2025 HMP format is consistent with the PEMA recommended format. The 2025 Crawford County HMP combined dam failure and levee failure profiles; and has added additional hazard profiles to the HMP, and these additional profiles increased the subsections in section 4.3 of the HMP.

3.2. The Planning Team

The 2025 Crawford County Hazard Mitigation Plan update was led by the Crawford County Steering Committee. The Crawford County Steering Committee provided guidance and leadership for the overall project. The steering committee assisted MCM Consulting Group, Inc. with dissemination of information and administrative tasks. *Table 7 – Steering Committee* outlines the individuals that comprised this team.

Table 7 - Steering Committee

Crawford County Hazard Mitigation Plan Update Steering Committee		
Name	**Organization**	**Position**
Allen Clark	Crawford County Department of Public Safety	EMA Coordinator
Don Bovard	Crawford County Department of Public Safety	Operations and Training Officer
Tracey Crawford	Crawford County Conservation District	District Manager
Zack Norwood	Crawford County Planning	Director
Michael Rearick	MCM Consulting Group, Inc.	Director of Operations
Daniel Becker	MCM Consulting Group, Inc.	Consultant
Alyssa Rusnock	MCM Consulting Group, Inc.	Project Coordinator

Crawford County Hazard Mitigation Plan Update Steering Committee		
Name	**Organization**	**Position**
Adam Leister	MCM Consulting Group, Inc.	Senior Consultant
Valerie Zents	MCM Consulting Group, Inc.	Senior Consultant
Ashley Day	MCM Consulting Group, Inc.	Project Coordinator

In order to represent the county, the Crawford County Steering Committee developed a diversified list of potential local planning team (LPT) members. Members that participated in the 2020 hazard mitigation plan were highly encouraged to join the 2025 team. The steering committee then provided invitations to the prospective members and provided a description of duties to serve on the LPT. The invitations for members of the LPT were disseminated by the Crawford County Department of Public Safety utilizing letters, email, and telephone calls. The LPT worked throughout the process to plan and hold meetings, collect information, and conduct public outreach.

The stakeholders listed in *Table 8 – Local Planning Team* served on the 2025 Crawford County Hazard Mitigation Local Planning Team, actively participated in the planning process by attending meetings, completing assessments, surveys, and worksheets and/or submitting comments. All potential local planning team members were presented with an email invitation prior to the local planning team kickoff meeting on 10/31/2023. Those invitation letters for the local planning team are included in Appendix C – Support Documentation of this hazard mitigation plan update.

Individuals representing local interests in dams were presented with the opportunity to participate in the local planning team. Emails were sent to officials involved in the ownership of dams.

Table 8 - Local Planning Team

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Eric Henry	Crawford County	Commissioner	October 6, 2023
Francis Weiderspahn	Crawford County	Commissioner	October 6, 2023
Chris Soff	Crawford County	Commissioner	October 6, 2023
Allen Clark	Crawford County Public Safety	EMA Coordinator	October 6, 2023
Don Bovard	Crawford County Public Safety	Operations & Training Officer	October 6, 2023
Greg Beveridge	Crawford County Public Safety	Public Safety Director	October 6, 2023
Zach Norwood	Crawford County Planning	Director	October 6, 2023
Joe Galbo III	Crawford County Assessment	Director	October 6, 2023
Tracey Crawford	Crawford County Conservation District	District Manager	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Brian Pilarcik	Crawford County Conservation District	Watershed Specialist	October 6, 2023
Andrew Parkin	Crawford County GIS	GIS Manager	October 6, 2023
David Amy	Crawford County GIS	GIS Technician	October 6, 2023
Brian Mesaros	Erie County Public Safety	EMA Coordinator	October 6, 2023
Ken McCorrison	Warren County Public Safety	Public Safety Director	October 6, 2023
Mike Fitchet	Ashtabula County Public Safety	EMA Coordinator	October 6, 2023
Frank Jannetti	Mercer County Public Safety	Public Safety Director	October 6, 2023
Jim Becker	Economic Progress Alliance of Crawford County	Executive Director	October 6, 2023
	Meadville Housing Authority		October 6, 2023
Marisa Lines	United Way of Western Crawford County	Director	October 6, 2023
Stacey Ross	Titusville United Way	Director	October 6, 2023
Charles Hughes	PA Emergency Management Agency - Western Area Office	Emergency Management Specialist	October 6, 2023
Connie McIntyre	Associated Charities Titus	Executive Director	October 6, 2023
Rose Hilliard	Women's Services	Medical Advocate	October 6, 2023
Sue Watkins	Crawford County Human Services	Director	October 6, 2023
Lynn McUmber	CHAPS	Director	October 6, 2023
Mark Weindorf	ARC of Crawford County	Executive Director	October 6, 2023
Krista Geer	Active Aging	Executive Director	October 6, 2023
Paul Wotus	PA 2-1-1 NW	Database Coordinator	October 6, 2023
Christa Lundy	Meadville - Western Crawford County Chamber of Commerce	Executive Director	October 6, 2023
Emily Altomare	Titusville Area Chamber of Commerce	Executive Director	October 6, 2023
Sue Anderson	Dog Therapy	Coordinator	October 6, 2023
Suzy Quinn	PA Human Services Licensing		October 6, 2023
Jason Nesbitt	Center for Family Services	Executive Director	October 6, 2023
Heather Palm	PA Department of Agriculture	State Veterinarian	October 6, 2023
Sarah Yurisic	PA Department of Agriculture	Domestic Animal Health Inspector	October 6, 2023
Jody Lasko	US Department of Agriculture - NRCS	District Conservationist	October 6, 2023
Brook Tolbert	PA Fish and Boat Commission	Waterways Conservation Officer	October 6, 2023
Jay Lindemuth	PA DCNR - Forestry	Fire Forester	October 6, 2023
Erin Blood	US Department of Agriculture - NRCS	County Executive Director	October 6, 2023
Ruth Thompson	ANNA Shelter	Founder	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Sue Gionti	Penn State Extension - Crawford	Administrative Assistant	October 6, 2023
Scott Sjolander	Penn State Extension - Crawford	Extention Educator - Urban and Community Forestry	October 6, 2023
Paula Lucas	Penn State Extension - Crawford	Extention Educator - 4-H Youth Development	October 6, 2023
Cecile Stelter	PA DCNR - Forestry	Forest District Manager	October 6, 2023
Mark Lewis	PA DCNR - Forestry	Forester	October 6, 2023
Doug Hering	County Beef/Dairy	Chairman	October 6, 2023
Dustin Wyant	PA DEP	Emergency Response Program Manager	October 6, 2023
Justin Rogers	PA DEP		October 6, 2023
Cathy McCracken	Greenleaf Corporation	EHS Coordinator	October 6, 2023
Tom Waterloo	Vitro Meadville Flat Glass	Engineering and Maintenance Manager	October 6, 2023
Sharon Levkus	Parker LORD - Saegertown	EHS Manager	October 6, 2023
Chauncey Miller	Parker LORD - Cambridge Springs	EHS Manager	October 6, 2023
Eric Mosbacher	PA DEP	West Nile Virus Coordinator	October 6, 2023
Brian Feist	McCutcheon Enterprises, Inc.	Emergency Response Coordinator	October 6, 2023
Dawn Mosbacher	PA Department of Health	Community Health Nurse	October 6, 2023
Bill McClincy	EMMCO West, Inc.	Executive Director	October 6, 2023
Terry Beck	Meadville Medical Center	Radiology Manager	October 6, 2023
Scott Beach	Titusville Area Hospital	Facilities Manager	October 6, 2023
Tom Perry	Meadville Medical Center	Director of Campus Safety	October 6, 2023
Eric Henry	Meadville Area Ambulance Service	Owner	October 6, 2023
Melinda Carbaugh	Northern Tier Healthcare Coalition	Healthcare Coalition Coordinator	October 6, 2023
Scott Schell	Crawford County Coroner	Coroner	October 6, 2023
Alison Piatt	Crawford County Coroner	Assistant to the Coroner	October 6, 2023
Stephanie Ace	Crawford County Emergency Behavioral Health	Mental Health Program Specialist	October 6, 2023
Michael Jung	Salvation Army	Ministry Associate	October 6, 2023
Michael Reimer	Salvation Army	Regional Director	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Andrew Tomer	Salvation Army	Assistant Director of Emergency Services	October 6, 2023
Geoffrey Domowicz	American Red Cross	Disaster Services Program Manager	October 6, 2023
Sue Watkins	Crawford County Human Services	Director	October 6, 2023
Devon Heberling	PA Department of Human Services	Director, Bureau of Administrative Services	October 6, 2023
Dustin LeGoullon	Titusville Fire Department	Public Safety Commissioner	October 6, 2023
Pat Wiley	Meadville Fire Department	Fire Chief	October 6, 2023
Bob Winters	US DHS CISA	Protective Security Advisor	October 6, 2023
Joe Arnett	US Army Corps of Engineers	Park Ranger	October 6, 2023
Dave Powers	Crawford County Sheriff	Sheriff	October 6, 2023
Adam Blashock	PA State Police - Meadville	Sergeant - Station Commander	October 6, 2023
Tad Acker	Cambridge Springs Borough Police Department	Police Chief	October 6, 2023
Matthew Bly	PA State Police - Corry	Sergeant - Station Commander	October 6, 2023
Scott White	US Army Reserve	Command Sergeant Major	October 6, 2023
Christopher Repin	PA Army National Guard	Captain - Operations/Training	October 6, 2023
Anthony Digiacomo	Crawford County Veterans Services	Director	October 6, 2023
Dale Johnston	Crawford County SCUBA Team	President	October 6, 2023
Matt Scowden	EMMCO West, Inc.	EMS Medical Systems Specialist	October 6, 2023
Tracy Labow	CATA	Crawford Division Manager	October 6, 2023
Bill Jones	CATA		October 6, 2023
Aaron Fox	PennDOT	Assistant District Executive of Maintenance	October 6, 2023
Ryan Wescoat	PennDOT	Maintenance Manager	October 6, 2023
Matt Semian	PennDOT	Highway Equipment Manager	October 6, 2023
Jason Warner	PennDOT	Senior Highway Maintenance Manager	October 6, 2023
Travis Mitcham	PennDOT	Assistant Highway Maintenance Manager	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Adam Reddinger	PennDOT	Assistant Highway Maintenance Manager	October 6, 2023
David Dickson	PENNCREST School District	Director of Facilities and Transportation	October 6, 2023
Tom Washington	Crawford Central School District	Superintendent	October 6, 2023
Matthew Tarr	Crawford Central School District	Director of Buildings, Grounds, and Transportation	October 6, 2023
Stephanie Keebler	Titusville Area School District	Superintendent	October 6, 2023
John Cowan	Titusville Area School District	Director of Buildings and Grounds	October 6, 2023
Tracy Reiser	Jamestown Area School District	Superintendent	October 6, 2023
Mike Munsee	Corry Area School District	Director of Buildings and Grounds	October 6, 2023
Jarrin Sperry	Conneaut School District	Superintendent	October 6, 2023
Frank Kimmel	Conneaut School District	Director of Buildings and Grounds	October 6, 2023
Mark Phelan	Crawford County Maintenance	Director	October 6, 2023
Mike Goss	Port Meadville Airport	Airport Manager	October 6, 2023
Neil Fratus	Titusville Municipal Airport	City Manager	October 6, 2023
Rick Bridge	Anderson Bus		October 6, 2023
Greg Palmer	Canadian National RR	Dangerous Goods Officer	October 6, 2023
Chris Hunsicker	Norfolk Southern RR	Regional Manager – Environmental Operations	October 6, 2023
Kylie McLaughlin	Western NY & PA RR	Assistant Vice President and General Manager	October 6, 2023
Ben Dutchess	AT&T First Net	Senior Client Solutions Executive	October 6, 2023
Chuck Evanoff	First Energy		October 6, 2023
Ben Wagner	First Energy SW	Regional External Affairs Consultant	October 6, 2023
Keri Fleet	NW Rural Electric	Director of Human Resources	October 6, 2023
Joe Bernier	NW Rural Electric	Superintendent	October 6, 2023
Amy Wellington	NW Rural Electric	Director of Communications	October 6, 2023
Jacob Specht	National Fuel	Damage Prevention Supervisor	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Scott Kerr	National Fuel	Emergency Response Coordinator	October 6, 2023
Mike Young	National Fuel	President	October 6, 2023
Billy Raymond	National Fuel	Field Operations Supervisor	October 6, 2023
Casey Christie	Tennessee Gas Pipeline	Operations Supervisor	October 6, 2023
Nick Greenawalt	NWS Cleveland	Meteorologist	October 6, 2023
Freddie Zeigler	NWS Cleveland	Warning Coordination Meteorologist	October 6, 2023
Amanda Bruce	MMC WIC Program	Director	October 6, 2023
Angela Gerics	Bethany Christian Services - Pregnancy	Post Permanency Specialist	October 6, 2023
Angela Morton	Hamot Health Foundation/UPMC Safe Harbor	Consortium Director	October 6, 2023
Annette Wilkins	The Special Kids Network - Elks	Coordinator	October 6, 2023
Becky Pears	Crawford County Drug and Alcohol Commission	Prevention Specialist	October 6, 2023
Becky Seigworth	Bethany Christian Services - Pregnancy	Pregnancy Counselor	October 6, 2023
Beth Mallory	Bethesda Children's Home	Director	October 6, 2023
Brian Pilarcik	Crawford County Conservation	Watershed Specialist	October 6, 2023
Brittany Eiler	Crawford County Drug & Alcohol Executive Commission	Drug and Alcohol Treatment Specialist	October 6, 2023
Caitlin Bartic	Center for Family Services	Supervisor	October 6, 2023
Carrie Dinsmore	MMC WIC Program	Director	October 6, 2023
Caryl Waggett	Allegheny College - Healthy Homes-Healthy Children	Director	October 6, 2023
Christian Smith	Early Learning Resource Center / WIC		October 6, 2023
Cindy Schick	PA State Police	Public Information Officer	October 6, 2023
Conni Calfo	Crawford County Human Services	Program Specialist	October 6, 2023
Dave Powers	Crawford County Sheriff		October 6, 2023
Donna Johnson	ARC of Crawford, Warren, & Forest Counties		October 6, 2023
Emily Chase	Families First Early Head Start/CSVC		October 6, 2023
Erin Hanna	Bayada Pediatrics		October 6, 2023
Jaime McGuire	AmeriHealth Carita Pennsylvania		October 6, 2023
Jamie McKalip	Meadville Medical Center - Pediatrics		October 6, 2023
Jan Anderson	NW District PA Dept. of Health		October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Jayme Ferry			October 6, 2023
Jessica Glenn	IU5 ELECT Program		October 6, 2023
Jessie Brocklehurst	CC Drug & Alcohol Executive Commission		October 6, 2023
Jill Staaf	Meadville Fire Department		October 6, 2023
Joe Barnhart	Crawford County Human Services		October 6, 2023
John Hartnett	Not One More / NWPA		October 6, 2023
Joshua Kaufer	PennDOT Safety Press Officer		October 6, 2023
Joy Henry	NW PA Region Medical Reserve Corps		October 6, 2023
Julia Covert	CC Drug & Alcohol Executive Commission		October 6, 2023
Kelly Lucas	Children Health Network		October 6, 2023
Kelly Schreck	Families First Early Head Start/CSVC		October 6, 2023
Kelly Schwab	CC Human Services		October 6, 2023
Kerry Risco	Penn State Shenango		October 6, 2023
Kim Schell	Titusville Area Hospital	Vice President Patient Services/CNO	October 6, 2023
Leah Endres	Crawford County Drug and Alcohol Commission		October 6, 2023
Lee Scandinaro	CC System of Care, MARC, Meadville Neighborhood Ctr		October 6, 2023
Lisa Snyder	NW District PA Dept. of Health		October 6, 2023
Mary Lakari	PA Chapter American Academy of Pediatrics		October 6, 2023
Melisaa Knapp	Families First Early Head Start/CSVC		October 6, 2023
Missy Winkler	Women's Services		October 6, 2023
Nicolas Mogel	Meadville Police Department		October 6, 2023
Pamela Smith	Crawford County Sheriff		October 6, 2023
Paula Di Gregory	Tobacco & Nicotine Services Coordinator		October 6, 2023
Raymond Ferry	Independent Consumer Advocate		October 6, 2023
Rosamond Learn	Fairview / Fairmont Outreach Center		October 6, 2023
Rose Hilliard	Women's Services		October 6, 2023
Sara Watson	Families First Early Head Start/CSVC		October 6, 2023
Sarah Miller	Fairview / Fairmont Outreach Center		October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Stacey Walbridge	Bethany Christian Services - Pregnancy		October 6, 2023
Stacie Hiott	Meadville Family YMCA		October 6, 2023
Stephanie Nye	Women's Services		October 6, 2023
Tori Gatto	Meadville Medical Center - Trauma		October 6, 2023
Jen Brancho	Buffalo District US Army Corps of Engineering	Biologist / Planner	October 6, 2023
Laura Ortiz	Buffalo District US Army Corps of Engineering	Emergency Manager	October 6, 2023
Patricia Usher	Pittsburgh District US Army Corps of Engineering	Planner	October 6, 2023
Emily Houdeshell	Pennsylvania Emergency Management	Acting State NFIP Manager	October 6, 2023
Matthew McCullough	FEMA Region III	Community Planner	October 6, 2023
Shelby Clark	Pennsylvania Dept. of Environmental Protection	Coastal Resource Coordinator	October 6, 2023
Anthony Schneider	Pittsburgh District US Army Corps of Engineering	Planner	October 6, 2023
Angela Lindgren	PA Game Commission - High Hazard Dam	Civil Engineer	October 6, 2023
Joseph Premozix	US Army Corps of Engineers - Pittsburgh District	Dam Safety Program Manager	October 6, 2023
Don Henderson	Vernon Township Water Authority	Water Operator	October 6, 2023
John Winkler	Vernon Township Sanitary Authority	Plant Manager	October 6, 2023
Craig Schlosher	Connneautville Water System	Water Operator	October 6, 2023
Mike Malone	Springboro Area Water Authority	Operator	October 6, 2023
Mike Kelly	Bloomfield Township Sewer Authority	Operator	October 6, 2023
Ken Dine	Cambridge Springs Borough Water Department	Water Plant Supervisor	October 6, 2023
Lewis Walker	Conneaut Lake Joint Municipal Authority	Manager	October 6, 2023
Kevin McGrath	Linesville Borough Municipal Authority	Water Superintendent	October 6, 2023
Dan Whalen	Linesville Pine Joint Municipal Authority	Operator	October 6, 2023
Robert Harrington	Meadville Area Water Authority	Project Manager	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Robert Morrow	Municipal Authority of Conneaut Lake Borough	Superintendent	October 6, 2023
Susan Warner	Northwest Crawford County Sewer Authority	Secretary	October 6, 2023
Adam Foreman	Saegertown Area Sewer Authority	Operator	October 6, 2023
Scott Brown	Titusville City Public Works Department	Director	October 6, 2023
Kimberly Mourer	Meadville Area Sewer Authority	Executive Director	October 6, 2023
Buffy Kornman	North and South Shenango Joint Municipal Authority	Business Manager	October 6, 2023
Leslie Burton	Athens Township	Secretary	October 6, 2023
Brenda Braden	Beaver Township	Secretary	October 6, 2023
Karen Brozell	Bloomfield Township	Secretary	October 6, 2023
Brenda Jo Wetsell	Blooming Valley Borough	Secretary	October 6, 2023
Debra Merritt	Cambridge Township	Secretary	October 6, 2023
Sandra Pude	Cambridge Springs Borough	Borough Manager	October 6, 2023
Gina Thomas	Centerville Borough	Secretary	October 6, 2023
Susan Armburger	Cochranton Borough	Borough Manager	October 6, 2023
Telce Varee	Conneaut Township	Secretary	October 6, 2023
Christine Morian	Conneaut Lake Borough	Secretary	October 6, 2023
Deana Seitz	Conneautville Borough	Secretary	October 6, 2023
Allen Clark	Conneautville Borough	Mayor	October 6, 2023
Deborah Acker	Cussewago Township	Secretary	October 6, 2023
Lori Guianen	East Fairfield Township	Secretary	October 6, 2023
Donna Kean	East Fallowfield Township	Secretary	October 6, 2023
Amy Prenatt	East Mead Township	Secretary	October 6, 2023
Amanda Allen	Fairfield Township	Secretary	October 6, 2023
Brenda Braden	Greenwood Township	Secretary	October 6, 2023
Jennifer McClymonds	Hayfield Township	Secretary	October 6, 2023
Patricia Myer	Hydetown Borough	Secretary	October 6, 2023
Amanda Harper	Linesville Borough	Secretary	October 6, 2023
Maryann Menanno	Meadville City	City Manager	October 6, 2023
Donna Kean	North Shenango Township	Secretary	October 6, 2023
April Averill	Oil Creek Township	Secretary	October 6, 2023
Anne Blood	Pine Township	Secretary	October 6, 2023
Joi Fultz	Randolph Township	Secretary	October 6, 2023
Rhonda Phillips	Richmond Township	Secretary	October 6, 2023
Jill Reese	Rockdale Township	Secretary	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Elizabeth Donovan	Rome Township	Secretary	October 6, 2023
Rose Mumau	Sadsbury Township	Secretary	October 6, 2023
Chuck Lawrence	Saegertown Borough	Borough Manager	October 6, 2023
Rebecca Andrew	South Shenango Township	Secretary	October 6, 2023
Chris Jewell	Sparta Township	Secretary	October 6, 2023
Amanda Slaney	Spartansburg Borough	Secretary	October 6, 2023
Shelby Field	Spring Township	Secretary	October 6, 2023
Tiffany McCray	Springboro Borough	Secretary	October 6, 2023
Tina Kuhns	Steuben Township	Secretary	October 6, 2023
Andrew McClymonds	Summerhill Township	Secretary	October 6, 2023
Robert Moore	Summit Township	Secretary	October 6, 2023
Neil Fratus	Titusville City	City Manager	October 6, 2023
Leslie Battin	Townville Borough	Secretary	October 6, 2023
Joy Strain	Troy Township	Secretary	October 6, 2023
Roxie Fucci	Union Township	Secretary	October 6, 2023
Tiffany McCray	Venango Borough	Secretary	October 6, 2023
Mary Lou Schuler-Karr	Venango Township	Secretary	October 6, 2023
Robert Horvat	Vernon Township	Township Manager	October 6, 2023
Mary Kennedy	Wayne Township	Secretary	October 6, 2023
Brenda Braden	West Fallowfield Township	Secretary	October 6, 2023
Jill Dunlap	West Mead Township	Secretary	October 6, 2023
Carrie McElhaney	West Shenango Township	Secretary	October 6, 2023
Sharron Diley	Woodcock Borough	Secretary	October 6, 2023
Renee Hayes	Woodcock Township	Secretary	October 6, 2023
Gary Rankin	Athens Township	Emergency Management Coordinator	October 6, 2023
Jerry Kalkbrenner	Bloomfield Township	Emergency Management Coordinator	October 6, 2023
David Birchard	Cambridge Township	Emergency Management Coordinator	October 6, 2023
Patrick Mahon	Cambridge Springs Borough	Emergency Management Coordinator	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Peter Collins	Centerville Borough	Emergency Management Coordinator	October 6, 2023
Jerry Vettorel	Cochranton Borough	Emergency Management Coordinator	October 6, 2023
John Treacy	Conneaut Lake Borough	Emergency Management Coordinator	October 6, 2023
Cathy McCracken	Cussewago Township	Deputy EMC	October 6, 2023
Martin Jones	East Fairfield Township	Emergency Management Coordinator	October 6, 2023
Jack Mahoney	Hayfield Township	Deputy EMC	October 6, 2023
Donald Sutter	Randolph Township	Emergency Management Coordinator	October 6, 2023
William Taylor	Richmond Township	Emergency Management Coordinator	October 6, 2023
Terry Long	Spartansburg Borough	Emergency Management Coordinator	October 6, 2023
Peter Collins	Steuben Township	Emergency Management Coordinator	October 6, 2023
Michael Wonderling	Titusville City	Emergency Management Coordinator	October 6, 2023
Justin Sullivan	Townville Borough	Emergency Management Coordinator	October 6, 2023
Jim Walsh	Venango Borough	Emergency Management Coordinator	October 6, 2023
Ralph Eakin	Venango Township	Emergency Management Coordinator	October 6, 2023
Steve Hastings	Wayne Township	Emergency Management Coordinator	October 6, 2023

Crawford County Hazard Mitigation Plan Local Planning Team			
Name	**Organization**	**Position**	**Invitation Date (email)**
Adam Valesky	West Fallowfield Township	Emergency Management Coordinator	October 6, 2023
Robert Shartle	West Mead Township	Emergency Management Coordinator	October 6, 2023
David Ross	Woodcock Borough	Deputy EMC	October 6, 2023
Daniel Norton	Woodcock Township	Deputy EMC	October 6, 2023
Tim Latta	Lakeland Area Joint EMA	Emergency Management Coordinator	October 6, 2023
Tom Stewart	Northwest Crawford County EMA	Emergency Management Coordinator	October 6, 2023
Jennifer Galdon			October 6, 2023

3.3. Meetings and Documentation

Meetings with local elected officials and the local planning team were held as needed. At each of the meetings, municipal officials were strongly encouraged to submit hazard mitigation project opportunity forms, complete their respective portions of the capability assessment, review and eventually adopt the multi-jurisdictional HMP. *Table 9 – HMP Process Timeline* lists the meetings held during the HMP planning process, which organizations and municipalities attended and the topic that was discussed at each meeting. All meeting agendas, sign-in sheets, presentation slides, and other documentation is in Appendix C.

The draft plan was made available for public review on September 25, 2024. The draft was advertised on Crawford County's social media page and was made available digitally on the Crawford County website at: https://www.crawfordcountypa.net/PublicSafety/Pages/home.aspx

The public comment period remained open until October 27, 2024. All public comments were submitted via an online survey or in writing to Allen Clark the Crawford County Emergency Management Coordinator. Public commenting was available during the public comment period via a Survey Monkey link that was advertised on the county website and social media pages. No public comments were received for this planning period, so no comments are included in Appendix C of this hazard mitigation plan update.

Table 9 - HMP Process Timeline

Crawford County HMP Process Timeline		
Date	**Meeting**	**Description**
09/20/2023	Crawford County Hazard Mitigation Steering Committee Kickoff Meeting	This meeting was used to determine individuals to invite to the local planning team and to review the draft project schedule.
10/31/2023	Crawford County Local Planning Team Kickoff Meeting	This meeting was used to review the project schedule and discuss roles and responsibilities for the hazard mitigation plan. Initial worksheets were introduced and reviewed (Hazard ID, capability assessments, project opportunity, and NFIP survey).
10/31/2023	Municipality Kickoff Meetings	This meeting was used to review the project schedule and discuss roles and responsibilities for the hazard mitigation plan at the municipal level. Initial worksheets were introduced and reviewed (Hazard ID, capability assessment, project opportunity, and NFIP survey).
11/20/2023	Ad Hoc Municipality Meeting	This meeting was used to review the project schedule and discuss roles and responsibilities for the hazard mitigation plan at the municipal level. Initial worksheets were introduced and reviewed (Hazard ID, capability assessment, project opportunity, and NFIP survey).
12/13/2023	Local Planning Team Meeting – Risk Assessment	This meeting was used to discuss the results of the initial documentation request. Selection of hazards for the 2025 hazard mitigation plan was conducted. Risk factor scores were also updated based on changing conditions in Crawford County since the 2020 HMP.
04/03/2024	Local Planning Team Meeting – Capability Assessment	This meeting was used to develop the capability assessment section of the 2025 HMP. Plans were reviewed and integration discussed.
06/26/2024	Local Planning Team Meeting – Mitigation Strategy	This meeting was used to review the goals and objectives from the 2020 plan, as well as the mitigation actions.
06/26/2024	Draft risk assessment public presentation	This meeting was used to provide the public an opportunity to view the draft risk assessment portion of the HMP.
07/18/2024	Local Planning Team Meeting – Mitigation Strategy	This meeting was used to continue the review of the 2020 mitigation actions, as well as to develop the goals, objectives, and actions of the 2025 plan.

Crawford County HMP Process Timeline		
Date	**Meeting**	**Description**
07/24/2024	Local Planning Team Meeting – Mitigation Strategy	This meeting was used to finalize the review of mitigation goals and objectives, and to continue the review of the 2020 mitigation action plan during the development process of the 2025 action plan.
07/31/2024	Local Planning Team Meeting – Mitigation Strategy	This meeting was used to continue the development of the 2025 mitigation action plan.
08/14/2024	Local Planning Team Meeting – Mitigation Strategy	This meeting was used to finalize the 2025 mitigation action plan and to complete an evaluation and prioritization of all 2025 mitigation actions.
09/25/2024	Draft plan public presentation	This meeting was offered to provide the public an opportunity to review the draft hazard mitigation plan, initiating a 30 day public comment period.

3.4. Public and Stakeholder Participation

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

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

1. **Risk Assessment Hazard Identification and Risk Evaluation Worksheet**: Capitalizes on local knowledge to evaluate the change in the frequency of occurrence, magnitude, or impact and/or geographic extent of existing hazards and allows communities to evaluate hazards not previously profiled using the Pennsylvania Standard List of Hazards.
2. **Capability Assessment Survey**: Collects information on local planning, regulatory, administrative, technical, fiscal, and political capabilities that can be included in the countywide mitigation strategy.

3. **Municipal Project Opportunity Forms and Mitigation Actions**: Copies of the 2020 mitigation opportunity forms that were included in the current HMP were provided to the municipalities for review and amendment. These opportunities are located in Appendix G. The previous mitigation actions were provided and reviewed at update meetings. New 2025 municipal project opportunity forms are included as well, located in Appendix G.

In an effort to capture public input, the Crawford County LPT held in person meetings and offered on-line surveys. Members of the public were also encouraged to contact Crawford County Department of Public Safety or MCM Consulting Group, Inc. with any comments or questions regarding this update. Any public comment that was received during public meetings or during the draft review of the plan were documented and included in the plan. Copies of newspaper public meeting notices, website posted public notices, and other correspondence are included in Appendix C of this plan.

Crawford County invited all contiguous counties to review the 2025 draft hazard mitigation plan. A letter was sent to the emergency management coordinator in Erie, Warren, Venango, and Mercer counties in Pennsylvania. Copies of these letters are included in Appendix C Support Documentation.

3.5. Multi-Jurisdictional Planning

Crawford County used an open, public process to prepare this HMP. Meetings and letters to municipal officials were conducted to inform and educate them about hazard mitigation planning and its local requirements. Municipal officials provided information related to existing codes and ordinances, the risk and impacts of known hazards on local infrastructure and critical facilities and recommendations for related mitigation opportunities. The pinnacle to the municipal involvement process was the adoption of the final plan. *Table 10 – Municipality Worksheets, Surveys, and Forms Participation* reflects the municipalities participation by completing worksheets, surveys, and forms.

Table 10 - Municipality Worksheets, Surveys, and Forms Participation

Crawford County HMP Worksheets, Surveys, and Forms Participation					
Municipality	**Capability Assessment Survey**	**Risk Assessment Hazard Identification and Risk Evaluation Worksheet**	**NFIP**	**Risk Factor**	**Hazard Mitigation Opportunity Form Review and Updates**
Athens Township	X	X	X		
Beaver Township	X	X	X		
Bloomfield Township	X	X	X		
Blooming Valley Borough	X	X	X	X	1 New

Crawford County HMP Worksheets, Surveys, and Forms Participation					
Municipality	**Capability Assessment Survey**	**Risk Assessment Hazard Identification and Risk Evaluation Worksheet**	**NFIP**	**Risk Factor**	**Hazard Mitigation Opportunity Form Review and Updates**
Cambridge Township	X	X	X		
Cambridge Springs Borough	X	X	X		
Centerville Borough	X	X	X	X	1 New
Cochranton Borough	X	X	X	X	2 New
Conneaut Township	X	X	X		2 New
Conneaut Lake Borough	X	X	X	X	3 New
Conneautville Borough	X	X	X		
Cussewago Township	X	X	X		
East Fairfield Township	X	X	X		
East Fallowfield Township	X	X	X		
East Mead Township	X	X	X		
Fairfield Township	X	X	X	X	1 new
Greenwood Township	X	X	X		
Hayfield Township	X	X	X		
Hydetown Borough	X	X	X		
Linesville Borough	X	X	X		
Meadville, City of	X	X	X		
North Shenango Township	X	X	X		
Oil Creek Township	X	X	X		
Pine Township	X	X	X		
Randolph Township	X	X	X		
Richmond Township	X	X	X		
Rockdale Township	X	X	X	X	4 new
Rome Township	X	X	x		
Sadsbury Township	X	X	X		
Saegertown Borough	X	X	X		1 New
South Shenango Township	X	X	X		
Sparta Township	X	X	X		
Spartansburg Borough	X	X	X		
Spring Township	X	X	X	X	
Springboro Borough	X	X	X		

Crawford County HMP Worksheets, Surveys, and Forms Participation					
Municipality	**Capability Assessment Survey**	**Risk Assessment Hazard Identification and Risk Evaluation Worksheet**	**NFIP**	**Risk Factor**	**Hazard Mitigation Opportunity Form Review and Updates**
Steuben Township	X	X	X	X	1 New
Summerhill Township	X	X	X		
Summit Township	X	X	X		
Titusville, City of	X	X	X		
Townville Borough	X	X	X		
Troy Township	X	X	X		
Union Township	X	X	X		
Venango Borough	X	X	X		
Venango Township	X	X	X		
Vernon Township	X	X	X		
Wayne Township	X	X	X	X	1 New
West Fallowfield Township	X	X	X		
West Mead Township	X	X	X		1 New
West Shenango Township	X	X	X		
Woodcock Borough	X	X	X		
Woodcock Township	X	X	X	X	1 New
Meadville Medical Center				HVA	
NorthernTier Healthcare				HVA	

The majority of the 51 municipalities within Crawford County adopted the 2020 Crawford County Hazard Mitigation Plan as the municipal hazard mitigation plan. The goal of the Crawford County Local Planning Team is to have 100% participation by municipalities in adopting the 2025 Crawford County Hazard Mitigation.

The table above was completed with the most accurate information available at the time of the writing of this Hazard Mitigation Plan Update. Since the writing of this plan, some of the municipalities listed above have provided information to Crawford County which updates their participation status.

4. Risk Assessment

4.1. Update Process Summary

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

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

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

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

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

The Crawford County Local Planning Team (LPT) reviewed and assessed the change in risk for all natural and human-caused hazards identified in the 2020 hazard mitigation plan. The mitigation planning team then identified hazards that were outlined within the Pennsylvania Hazard Mitigation Plan but not included in the 2020 Crawford County Hazard Mitigation Plan that could impact Crawford County. The team utilized the hazard identification and risk evaluation worksheet that was provided by the Pennsylvania Emergency Management Agency.

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

Once the natural and human-caused hazards were identified and profiled, the local planning team then completed a vulnerability assessment for each hazard. An inventory of vulnerable assets was completed utilizing GIS data and local planning team knowledge. The team used the most recent Crawford County assessment data to estimate loss to particular hazards. Risk factor was then assessed to each of the twenty-one hazards utilizing the hazard prioritization matrix. This assessment allows the county and its municipalities to focus on and prioritize local mitigation efforts on areas that are most likely to be damaged or require early response to a hazard event.

4.2. Hazard Identification

4.2.1. Presidential and Gubernatorial Disaster Declarations

Table 11 – Presidential & Gubernatorial Disaster Declaration contains a list of all Presidential and Gubernatorial disaster declarations that have affected Crawford County and its municipalities from 1955 through 2023, according to the Pennsylvania Emergency Management Agency.

Table 11 - Presidential & Gubernatorial Disaster Declaration

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	**Hazard Event**	**Action**
January, 1966	Heavy Snow	Gubernatorial Proclamation of Emergency
February, 1972	Heavy Snow	Gubernatorial Proclamation of Emergency
June, 1972	Flood Agnes	Presidential Disaster Declaration
February, 1974	Truckers Strike	Gubernatorial Proclamation of Emergency
January, 1977	Gas Shortage / Severe Winter Weather	Presidential Proclamation of Emergency
July, 1977	Flash Flood	Presidential Disaster Declaration

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	**Hazard Event**	**Action**
January, 1978	Heavy Snow	Gubernatorial Proclamation of Emergency
February, 1978	Blizzard	Gubernatorial Proclamation of Emergency
June, 1981	Flash Flood	Presidential Disaster Declaration
May, 1985	Tornado	Presidential Disaster Declaration
March, 1993	Blizzard	Presidential Proclamation of Emergency
January, 1994	Severe Winter Storms	Presidential Disaster Declaration
January, 1996	Flooding	Presidential Disaster Declaration
June, 1996	Flooding	Presidential Disaster Declaration
July, 1996	Flooding	Presidential Disaster Declaration
December, 1998	Drought	Gubernatorial Proclamation of Emergency
September, 1999	Hurricane Floyd	Presidential Disaster Declaration
September, 2003	Hurricane Isabel/Henri	Presidential Disaster Declaration
August, 2003	High Winds and Heavy Rain	Presidential Disaster Declaration
September, 2004	Tropical Depression Frances	Presidential Disaster Declaration
September, 2004	Tropical Depression Ivan	Presidential Disaster Declaration
September, 2005	Hurricane Katrina	Presidential Proclamation of Emergency - to render mutual aid and receive and house evacuees
September, 2005	Hurricane Katrina	Gubernatorial Proclamation of Emergency
September, 2006	Tropical Depression Ernesto	Gubernatorial Proclamation of Emergency
April, 2007	Severe Winter Storm	Gubernatorial Proclamation of Emergency
February, 2007	Regulations	Gubernatorial Proclamation of Emergency
February, 2007	Severe Winter Storm	Gubernatorial Proclamation of Emergency
April, 2007	Severe Storm	Gubernatorial Proclamation of Emergency

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	**Hazard Event**	**Action**
February, 2010	Severe Winter Storm	Gubernatorial Proclamation of Emergency
January, 2011	Severe Winter Storm	Gubernatorial Proclamation of Emergency
August, 2011	Severe Storms and Flooding (Lee/Irene)	Gubernatorial Proclamation of Emergency
April, 2012	Spring Winter Storms	Gubernatorial Proclamation of Emergency
October, 2012	Hurricane Sandy	Presidential Proclamation of Emergency
June, 2013	High Winds, Thunderstorms, Heavy Rain, Tornado, and Flooding	Gubernatorial Proclamation of Emergency
October, 2013	Severe Storms, Tornadoes, and Flooding	Presidential Disaster Declaration
January, 2014	Extreme Weather, Utility Interruption	Gubernatorial Proclamation of Disaster Emergency
February, 2014	Severe Winter Storm	Gubernatorial Proclamation of Disaster Emergency
February, 2014	Severe Winter Storm	Gubernatorial Proclamation of Disaster
January, 2015	Severe Winter Storm	Gubernatorial Proclamation of Emergency
August, 2015	Severe Storms	Gubernatorial Proclamation of Emergency
January, 2016	Severe Winter Storm	Gubernatorial Proclamation of Emergency
March, 2017	Severe Winter Storm	Gubernatorial Proclamation of Emergency
January, 2018	Opioid Crisis	Gubernatorial Proclamation of Emergency
August, 2018	Severe Weather	Gubernatorial Proclamation of Emergency
January, 2019	Severe Winter Event	Gubernatorial Proclamation of Emergency
March, 2020	COVID-19 Pandemic	Presidential Proclamation of Emergency

Presidential Disaster Declarations and Gubernatorial Declarations and Proclamations		
Date	**Hazard Event**	**Action**
March, 2020	COVID-19 Pandemic	Presidential Disaster Declaration
March, 2020	COVID-19 Pandemic	Gubernatorial Proclamation of Emergency
February, 2021	Severe Winter Event	Gubernatorial Proclamation of Emergency
April, 2021	Civil Disturbance	Gubernatorial Proclamation of Emergency
August, 2021	Hurricane Ida	Gubernatorial Proclamation of Emergency
Source: Pennsylvania Emergency Management Agency and Federal Emergency Management Agency		

4.2.2. Summary of Hazards

The Crawford County LPT was provided the Pennsylvania Standard List of Hazards to be considered for evaluation in the 2025 HMP Update. Following a review of the hazards considered in the 2020 HMP and the standard list of hazards, the local planning team decided that the 2025 plan should identify, profile, and analyze twenty-six hazards. These twenty-six hazards include all of the hazards profiled in the 2020 plan. The list below contains the hazards that have the potential to impact Crawford County as identified through previous risk assessments, the Crawford County Hazard Vulnerability Analysis and input from those who participated in the 2025 HMP update. Hazard profiles are included in Section 4.3 for each of these hazards.

Identified Natural Hazards

Drought

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

Earthquake

An earthquake is the motion or trembling of the ground produced by sudden displacement of rock usually within the upper 10-20 miles of the Earth's crust. Earthquakes result from crustal strain, volcanism, landslides, or the collapse of underground caverns. Earthquakes can affect hundreds of thousands of square miles, cause damage to property measured in the tens of billions of dollars, result in loss of life and injury to hundreds of thousands of persons and disrupt the social and economic functioning of the affected area.

Flooding, Flash Flooding, and Ice Jam Flooding

Flooding is the temporary condition of partial or complete inundation of normally dry land, and it is the most frequent and costly of all-natural hazards in Pennsylvania. Flash flooding is usually a result of heavy localized precipitation falling in a short time period over a given location, often along mountain streams and in urban areas where much of the ground is covered by impervious surfaces. Winter flooding can include ice jams which occur when warm temperatures and heavy rain cause snow to melt rapidly. Snow melt combined with heavy rains can cause frozen rivers to swell, which breaks the ice layer on top of a river. The ice layer often breaks into large chunks, which float downstream, piling up in narrow passages and near other obstructions such as bridges and dams.

Hurricane/Tropical Storm

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

Invasive Species

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

Landslide

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

Pandemic and Infectious Disease

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

Radon Exposure

Radon is a radioactive gas produced by the breakdown of uranium in soil and rock that can lead to lung cancer in people exposed over a long period of time. Most exposure comes from breathing in radon gas that enters homes and buildings through foundation cracks and other openings. According to the DEP, approximately 40% of Pennsylvania homes have elevated radon levels.

Subsidence/Sinkhole

Land subsidence is a gradual settling or sudden sinking of the ground surface due to the movement of subsurface materials. A sinkhole is a subsidence feature resulting from the sinking of surficial material into a pre-existing subsurface void. Subsidence and sinkholes are geologic hazards that can impact roadways and buildings and disrupt utility services. Subsidence and sinkholes are most common in areas underlain by limestone and can be exacerbated by human activities such as water, natural gas, and oil extraction.

Tornadoes/Windstorm

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

Wildfire

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

Winter Storm

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

Identified Human Caused Hazards

Building/Structural Collapse/Blighted Properties

Buildings and other engineered structures, including bridges, may collapse if their structural integrity is compromised, especially due to effects from other natural or human-made hazards. Older buildings or structures, structures that are not built to standard codes, or structures that have been weakened are more susceptible to being affected by these hazards.

Civil Disturbance

A civil disturbance is defined by FEMA as a civil unrest activity (such as a demonstration, riot, or strike) that disrupts a community and requires intervention to maintain public safety.

Dam Failure/ Levee Failure

Dam failure is the uncontrolled release of water (and any associated waste) from a dam. This hazard often results from a combination of natural and human causes, and can follow other hazards such as hurricanes, earthquakes, and landslides. The consequences of dam failures can include property and environmental damage and loss of life.

A levee is a human-made structure, usually an earthen embankment, designed and constructed in accordance with sound engineering practices to contain, control, or divert the flow of water to provide protection from temporary flooding (FEMA, 2016). A levee failure or breach occurs when a levee fails to prevent flooding on the landside of the levee. The consequences of a sudden levee failure can be catastrophic, with the resulting flooding causing loss of life, emergency evacuations, and significant property damage.

Emergency Services

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

Environmental Hazards/Hazardous Materials

Environmental hazards are hazards that pose threats to the natural environment, the built environment and public safety through the diffusion of harmful substances, materials, or products. Environmental hazards include the following:

- Hazardous material releases: at fixed facilities or as such materials are in transit and including toxic chemicals, infectious substances, biohazardous waste and any materials that are explosive, corrosive, flammable, or radioactive (PL 1990-165, § 207(e)).
- Air or Water Pollution; the release of harmful chemical and waste materials into water bodies or the atmosphere, for example (National Institute of Health Sciences, July 2009; Environmental Protection Agency, Natural Disaster PSAs, 2009).
- Superfund Facilities: hazards originating from abandoned hazardous waste sites listed on the National Priorities List (Environmental Protection Agency, National Priorities List, 2009).
- Manure Spills: involving the release of stored or transported agricultural waste, for example (Environmental Protection Agency, Environmental Impacts of…, 1998).
- Product Defect or Contamination; highly flammable or otherwise unsafe consumer products and dangerous foods (Consumer Product Safety Commission, 2003).

Hazardous material releases can contaminate air, water, and soils and have the potential to cause injury or death. Dispersion can take place rapidly when transported by water and wind. While often accidental, releases can occur as a result of human carelessness, intentional acts, or natural hazards. When caused by natural hazards, these incidents are known as secondary events.

Terrorism/Cyberterrorism Incidents

Terrorism is the use of force or violence against persons or property with the intent to intimidate or coerce. Acts of terrorism include threats of terrorism; assassinations; kidnappings; hijackings; bomb scares and bombings; cyber-attacks (computer-based); and the use of chemical, biological, nuclear, and radiological weapons. Cyber-attacks have become an increasingly pressing concern. Cyberterrorism refers to acts of terrorism committed using computers, networks, and the internet. The most widely cited definition comes from Denning's Testimony before the Special Oversight Panel on Terrorism: "Cyberterrorism…is generally understood to mean unlawful attacks and threats of attack against computers, networks, and the information stored therein when done to intimidate or coerce a government or its people in furtherance of political or social objectives. Further, to qualify as cyberterrorism, an attack should result in violence against persons or property, or at least cause enough harm to generate fear".

Transportation Accidents

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

Urban Fire and Explosions

Urban fires and explosions include those fires and explosions that occur within urban, or developed, regions, and often pose an increased threat due to their tendency to easily spread to neighboring structures. The effects may be minor or severe and include injury, loss of life, property damage, and residential or economic disruption/displacement.

Utility Interruption

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

- Geomagnetic Storms; including temporary disturbances of the Earth's magnetic field resulting in disruptions of communication, navigation, and satellite systems (National Research Council et al., 1986).
- Fuel or Resource Shortage; resulting from supply chain breaks or secondary to other hazard events, for example.
- Electromagnetic Pulse; originating from an explosion or fluctuating magnetic field and causing damaging current surges in electrical and electronic systems (Institute for Telecommunications Sciences, 1996).
- Information Technology Failure; due to software bugs, viruses, or improper use (Rainer Jr., et al, 1991).
- Ancillary Support Equipment; electrical generating, transmission, system-control, and distribution-system equipment for the energy industry (Hirst & Kirby, 1996).
- Public Works Failure; damage to or failure of highways, flood control systems, deep-water ports and harbors, public buildings, bridges, dams, for example (Unit-ed States Senate Committee on Environment and Public Works, 2009).
- Telecommunications System Failure; Damage to data transfer, communications, and processing equipment, for example (FEMA, 1997)
- Transmission Facility or Linear Utility Accident; liquefied natural gas leakages, explosions, facility problems, for example (United States Department of Energy, 2005)
- Major Energy, Power, Utility Failure; interruptions of generation and distribution, power outages, for example (United States Department of Energy, 2000).

4.2.3. Climate Change

Impacts of Climate Change on Identified Hazards

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

The most obvious change is in regard to extreme temperature. As average atmospheric temperatures rise, extreme high temperatures become more threatening, with record high temperatures outnumbering record low temperatures 2:1 in recent years. As climate change intensifies, it is expected that the risk of extreme heat will be amplified whereas the risk of extreme cold will be attenuated. Some studies show increased insect activities during a similar rapid warming event in Earth's history. Other studies make projections that with the warming temperatures and lower annual precipitation that are expected with climate change, there will be an expansion of the suitable climate for mosquitos, potentially increasing the risk of infectious disease.

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

While it may seem counterintuitive considering the increased risk of drought, there is also an increased risk of flooding associated with climate change (Section 4.3.3). Warmer temperatures mean more precipitation will fall as rain rather than snow. Combined with the fact that warmer air holds more moisture, the result is heavier and more intense rainfalls and dam and levee failures. Similarly, winter storms are expected to become more intense, if possibly less frequent. Climate change is also expected to result in more intense hurricanes and tropical storms. With the rise of atmospheric temperatures, ocean surface temperatures are rising, resulting in warmer and more moist conditions where tropical storms develop (Stott et al., 2010). A warmer ocean stores more energy and is capable of fueling stronger storms. It is projected that the Atlantic hurricane season is elongating, and there will be more category 4 and 5 hurricanes than before (Trenberth, 2010).

Climate change is contributing to the introduction of new invasive species (Section 4.3.6). As maximum and minimum seasonal temperatures change, non-native species are able to establish themselves in previously inhospitable climates where they have a competitive advantage. This may shift the dominance of ecosystems in the favor of non-native species, contributing to species loss and the risk of extinction.

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

Where applicable, climate change will be discussed for each hazard profile in this hazard mitigation plan. All natural hazards will have a discussion on climate change vulnerability, while certain human-caused hazards may not experience significant vulnerabilities from climate change adaptation and will not have direct narrative addressing those impacts.

Climate change was also taken into account when capabilities were being reviewed and mitigation actions were being developed and updated.

4.3. Hazard Profiles

4.3.1. Drought

4.3.1.1 Location and Extent

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

There are three types of droughts:

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

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

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

Droughts are often the leading contributing factor to wildfires, as they leave areas with little to no moisture.

4.3.1.2 Range of Magnitude

The average annual precipitation of 40.06" occurs primarily during the spring and summer months. This value is derived from an average of ten years of mean annual precipitation data for Crawford County. Rural farming areas of Crawford County are most at risk when a drought occurs. A drought can create a significant financial burden for the community. Wildfires are often the most severe secondary effect associated with drought. Wildfires can devastate wooded and agricultural areas, structures near high wildfire loads, and farm production facilities, and threaten natural resources. Prolonged drought conditions can have a lasting impact on the economy and can cause major ecological changes, such as increases in scrub growth, flash flooding, and soil erosion.

Long-term water shortages during severe drought conditions can have a significant impact on agribusiness, public utilities, and other industries reliant on water for production services.

Crawford County also has a growing agritourism business that would be threatened by long-term drought.

Local municipalities may, with the approval of the Pennsylvania Emergency Management Council, implement local water rationing. These individual water rationing plans, authorized through provisions of 4 PA code Chapter 120, will require specific limits on individual water consumption to achieve significant reductions in use. Under mandatory water usage restrictions imposed by the commonwealth and/or local municipalities, procedures are provided for granting of variances to consider individual hardships and economic dislocations. *Table 12 – Drought Preparation Phases* shows the FEMA-defined levels of drought severity along with suggested actions, requests, and goals.

Table 12 - Drought Preparation Phases

Drought Preparation Phases				
Phase	**General Activity**	**Actions**	**Request**	**Goal**
Drought Watch	Early stages of planning and alert for drought possibility.	Increased water monitoring, awareness, and preparation for response among government agencies, public water suppliers, water users, and the public.	Voluntary water conservation.	Reduce water use by 5%.
Drought Warning	Coordinate a response to imminent drought conditions and potential water shortages.	Reduce shortages – relieve stressed sources, develop new sources if needed.	Continue voluntary water conservation, impose mandatory water use restrictions if needed.	Reduce water use by 10 – 15%.
Drought Emergency	Management of operations to regulate all available resources and respond to emergency.	Support essential and high priority water uses and avoid unnecessary uses.	Possible restrictions on all nonessential water uses.	Reduced water use by 15%.
Source: Pennsylvania Department of Environmental Protection, 2017				

The commonwealth uses five parameters to assess drought conditions:

- Stream flows (compared to benchmark records)
- Precipitation (measured as the departure from normal, thirty-year average precipitation)
- Reservoir storage levels in a variety of locations such as three New York City reservoirs in the upper Delaware River Basin
- Groundwater elevations in a number of counties (comparing to past month, past year, and historic records)
- Soil moisture via the Palmer Drought Index as seen in *Table 13 – Palmer Drought Severity Index*, which is a soil moisture algorithm calibrated for relatively homogenous regions which measures dryness based on recent precipitation and temperature.

Table 13 – Palmer Drought Severity Index

Palmer Drought Severity Index (PDSI)	
Severity Category	**PDSI Value**
Extremely Wet	4.0 or more
Very Wet	3.0 to 3.99
Moderately Wet	2.0 to 2.99
Slightly Wet	1.0 to 1.99
Incipient Wet Spell	0.5 to 0.99
Near Normal	0.49 to -0.49
Incipient Dry Spell	-0.5 to -0.99
Mild Drought	-1.0 to -1.99
Moderate Drought	-2.0 to -2.99
Severe Drought	-3.0 to -3.99
Extreme Drought	-4.0 or less

The effects of a drought can be far-reaching both economically and environmentally. Economic impacts include reduced productivity of aquatic resources, mandatory water use restrictions, well failures, cutbacks in industrial production, agricultural losses, and limited recreational opportunities. Environmental impacts of drought include those found in *Table 14 – Economic and Environmental Impacts of Drought Events* and qualifies the potential economic and environmental impacts from a drought event.

Table 14 - Economic and Environmental Impacts of Drought Events

Economic and Environmental Impacts of Drought Events	
Economic	**Environmental**
- Reduced productivity of aquatic resources - Mandatory water use restrictions - Well failures - Cutbacks in industrial production - Agricultural losses - Limited recreational opportunities	- Hydrologic effects - Adverse effects on animal populations - Damage to plant communities - Increased number and severity of fires - Reduced soil quality - Air quality effects - Loss of quality in landscape

4.3.1.3 Past Occurrence

The Pennsylvania Department of Environmental Protection (PA DEP) maintains the most comprehensive data on drought occurrences across the commonwealth. Descriptions of drought status categories (i.e., watch, warning, and emergency) are included in the "Range of Magnitude" section above. The declared drought status from 1980 to 2021 is shown in *Table 15 – Past Drought Events in Crawford County*.

The National Oceanic and Atmospheric Administration (NOAA) has archived records showing extreme droughts for the commonwealth in 1931 and a prolonged event in the 1960s as seen in *Table 16 – Pennsylvania Palmer Drought Index 1900 – 1999.*

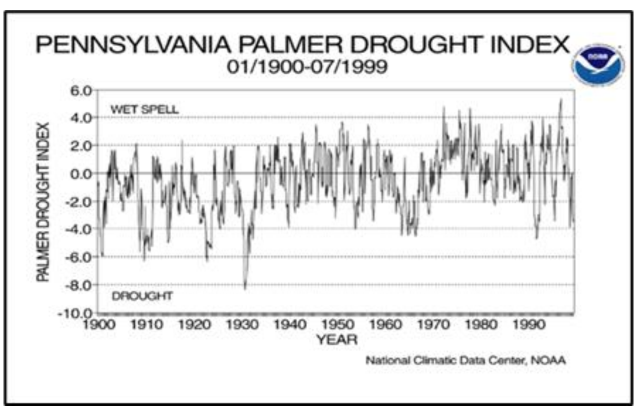
Based on the county's more recent disaster history and other drought occurrence data, the worst drought event in Crawford County occurred in the summer of 1999. Extended dry weather spurred Governor Thomas Ridge to declare a drought emergency in fifty-five counties. During this event, precipitation deficits for that summer averaged five to seven inches below normal; the Susquehanna River hit record low flows, streams were dry, and many wells were depleted. Crop damage losses totaled over $500 million statewide, and those losses equated to 70% to 100% of crop production. There were additional losses from the decline of milk production. Also, the state asked municipal and private water suppliers to restrict local water use.

Table 15 - Past Drought Events in Crawford County

Past Drought Events in Crawford County			
Start Date	**End Date**	**Event Duration (Days)**	**Event Type**
07/07/1988	08/24/1988	48	Watch
08/24/1988	12/12/1988	110	Warning
06/28/1991	07/24/1991	26	Watch
07/24/1991	08/16/1991	23	Warning
08/16/1991	04/20/1992	248	Emergency

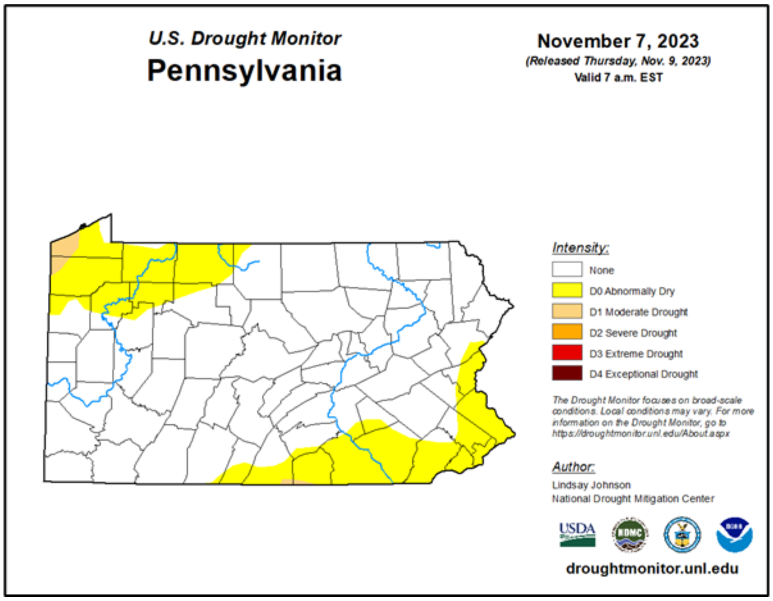
Past Drought Events in Crawford County			
Start Date	**End Date**	**Event Duration (Days)**	**Event Type**
04/20/1992	06/23/1992	64	Warning
06/23/1992	09/11/1992	80	Watch
09/01/1995	12/18/1995	108	Watch
12/03/1998	12/16/1998	13	Warning
12/16/1998	03/15/1999	89	Emergency
03/15/1999	09/30/1999	199	Watch
09/30/1999	02/25/2000	148	Warning
02/25/2000	05/05/2000	70	Watch
08/24/2001	05/13/2002	262	Watch
09/05/2002	06/18/2003	286	Watch
04/11/2006	06/30/2006	80	Watch
08/06/2007	09/05/2007	30	Watch
11/07/2008	01/26/2009	80	Watch
09/16/2010	12/17/2010	92	Watch
08/05/2011	09/02/2011	28	Watch
07/19/2012	08/31/2012	43	Watch
06/15/2023	08/24/2023	70	Watch
Source: Pennsylvania Department of Environmental Protection, 2023			

Table 16 - Pennsylvania Palmer Drought Index 1900 – 1999



The warmest July on record in Pennsylvania occurred in 2020, and sixteen counties entered Drought Watch status on August 21 of that year. In June 2021, dry conditions were again affecting the commonwealth. *Figure 6 – U.S. Drought Monitor, Pennsylvania* illustrates the conditions of drought in Pennsylvania at the time of the report.

Figure 6 - U.S. Drought Monitor, Pennsylvania



4.3.1.4 Future Occurrence

It is difficult to forecast the exact severity and frequency of future drought events. Climate change will lead to increased uncertainty and extremity of climate events. Crawford County has experienced severe drought between 5% to 10% of the time between 1895 and 1995 as seen in *Figure 7 – Palmer Drought Severity Index*. This report can be used to make a rough estimate of the future probability of drought in Crawford County, although it does not account for changes introduced by climate change. Drought conditions are expected to become more severe with climate change, as evaporation and transpiration will increase with higher temperatures.

The potential for a drought to occur in Crawford County is high. Given the frequency of drought watches issued for Crawford County and its municipalities, the county can reasonably expect to be under a drought watch at least once per year. While some form of drought condition frequently exists in Crawford County, the impact depends on the duration of the event, severity of conditions, and area affected. The map above, *Figure 6 – U.S. Drought Monitor*, Pennsylvania shows that Crawford County is under abnormally dry conditions, as of the writing of this plan.

As stated above in Section 4.2.3, climate change will influence the frequency of droughts in the future. As global temperatures rise, weather patterns will change, increasing the number of dry days an area experiences. This could result in more drought periods for a local or regional area. Droughts could also become longer in duration, compared with pre-climate change patterns.

4.3.1.5 Vulnerability Assessment

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

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

Land use and major development is a factor that has the potential to impact the vulnerability to drought in Crawford County. Land use, especially agricultural land use, can exacerbate dry conditions, and these agricultural areas can be damaged by drought. There are 194,447 acres of agriculture in Crawford County. If the number of agricultural acres increases, that increases the potential vulnerability for drought impacts. Conversely, if the agricultural acres decrease, the potential vulnerability of agriculture to drought decreases. Drought can also have an adverse effect on forested areas. Approximately 47% of Crawford County is forest areas, including deciduous, evergreen, mixed deciduous and evergreen, forested wetlands, and emergent wetlands. There are also fourteen state game lands, one state forest, and two state parks that make up a large portion of the county. Long periods of drought can increase the potential for wildfires and invasive species that could damage these forested areas. Economic benefits through the provision of wood products would also be affected.

There are many hazards that can be considered cascading hazards related to drought events. Wildfire is the most severe cascading hazard effect associated with drought. Wildfires can devastate wooded and agricultural areas, threatening natural resources and farm production facilities. With drought events, water infiltration into the ground becomes more difficult. This lack of infiltration can result in flash flooding events in areas of steep slopes, canyons, and rolling hills. A loss of vegetation from a drought can also increase the occurrence of landslides in areas of steep slopes with loose packed soil profiles. A discussion on the county's vulnerability to wildfire, flash floods, and landslides can be found in Section 4.3.11.5, 4.3.3.5, and 4.3.6.5 respectively.

Droughts can have adverse effects on farms and other water-dependent industries resulting in local economic loss. Areas of extensive agriculture use are particularly vulnerable to drought; 194,447 acres of Crawford County, or roughly 30% of the 647,680 total land acreage, make up farmland (United States Department of Agriculture [USDA], 2017 Census). The total number of farms for Crawford County is 1,091 and the average acreage for farms in Crawford County is 178 acres. Approximately 97% of Crawford County farms are family-owned and operated. Additionally, 40% of the county farmland use is devoted to crop cultivation and 60% to livestock and poultry. Crawford County ranks 19th of sixty-seven counties in the commonwealth for agricultural production, totaling over $107 million annually. Agricultural production from crops, including nursery and greenhouse crops, accounts for more than $42 million in commerce annually. Production from livestock, poultry, and their products accounts for just under $65 million annually. The livestock that has the greatest potential to be impacted are the cattle, the calves, the sheep, and the lambs. There are approximately 32,216 cattle and calves, and 2,902 sheep and lambs in Crawford County. Acreage for farming has decreased since the 2012 USDA Census when there was a reported total of 194,462 farming and drought vulnerable acres.

Crawford County also has 1,469 domestic wells and four large-scale irrigation wells which would be adversely impacted by drought events. This impact would lead to lower water levels for at least 1,469 locations and potentially four large irrigation areas. This well information was obtained by using the PA GEOCODE application to find well information from January 1st, 2000 to October 17th, 2023.

Additionally, emergency services can be adversely impacted by drought as a cascading hazard. Local fire departments often utilize ponds, creeks, and streams for water onboard fire apparatus. With low water levels in waterbodies, responders may be unable to draft enough water to efficiently respond to and extinguish a fire. Also, with an increased number of potential wildfires due to drought conditions, agencies may not have the personnel to efficiently respond to all fires in a timely manner.

A map of properties with tillable agricultural land use, forestry, and other land in the county vulnerable to drought is shown below in *Figure 8 – Drought-Vulnerable Land Use and Public Water Supply*.

Municipalities with high risk due to drought:

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Township
- Cambridge Springs Borough
- Centerville Borough
- Cochranton Borough
- Conneaut Township
- Conneaut Lake Borough
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Linesville Borough
- Meadville, City of
- North Shenango Township
- Oil Creek Township
- Pine Township

- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Spartansburg Borough
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Townville Borough
- Troy Township
- Union Township
- Venango Borough
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township
- West Shenango Township
- Woodcock Borough
- Woodcock Township

Populations in Crawford County, including the socially vulnerable, underserved, and unserved populations, are at different levels of vulnerability. The socially vulnerable have an increased risk due to the unsheltered or homeless not having access to reliable sources of water. Also, those individuals who are considered socially vulnerable because of location in rural areas are also at an increased risk because of agricultural and well status.

As seen in *Table 3 – Population Change in Crawford County*, forty-six of the fifty-one municipalities in Crawford County have experienced a population loss since the 2010 decennial census. Four municipalities have seen a net population increase from the 2010 decennial census to the 2020 decennial census, and one municipality did not have a population change. Based on this information, it can be speculated that these four municipalities with population increases may have an increased risk to drought conditions, since 2010, due to the increase in population. The municipalities that have experienced population increase are Blooming Valley Borough, Rome Township, Sparta Township, and Townville Borough.

Drought also has the potential to impact historic and cultural resources in Crawford County. Crawford County has six bridges as historic structures and ten historic buildings on the National Register of Historic Places. They are the Baldwin-Reynolds House, Bently Hall, Independent Congregational Church, Amos Kelly House, Dr. J.R. Mosier Office, Roueche House, Ruter Hall, Edward Saeger House, Judge Henry Shippen House, and the Titusville City Hall and drought could impact utility delivery to those locations. Drought events in Crawford County can impact certain systems and community lifelines that are tied into the historic or cultural properties. Water utilities can be directly impacted by drought events when prolonged dry weather lowers the available water in reservoirs and water systems used by a county or a community. Drought could impact electric utilities if moving water is used in electric generation. When water is used for electric generation, drought events could cause lower utilization and efficiency. This is more common in the western United States, but it could occur if any counties in Pennsylvania utilize water for power generation. Currently, Crawford County does not use waterpower for electric generation. Other systems that could potentially be impacted by a drought event are wastewater utilities and any nuclear power generation that uses water in its process.

Figure 7 - Palmer Drought Severity Index

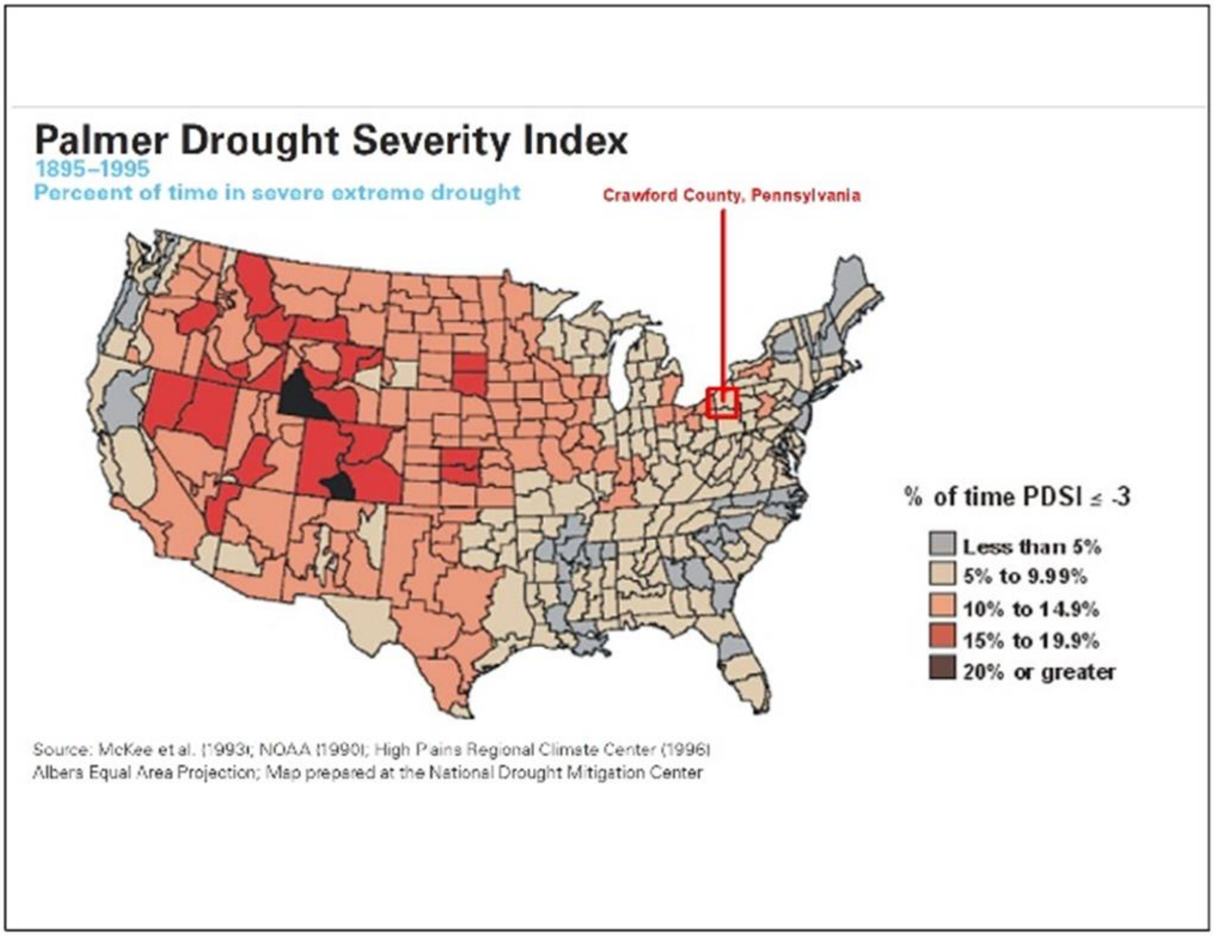
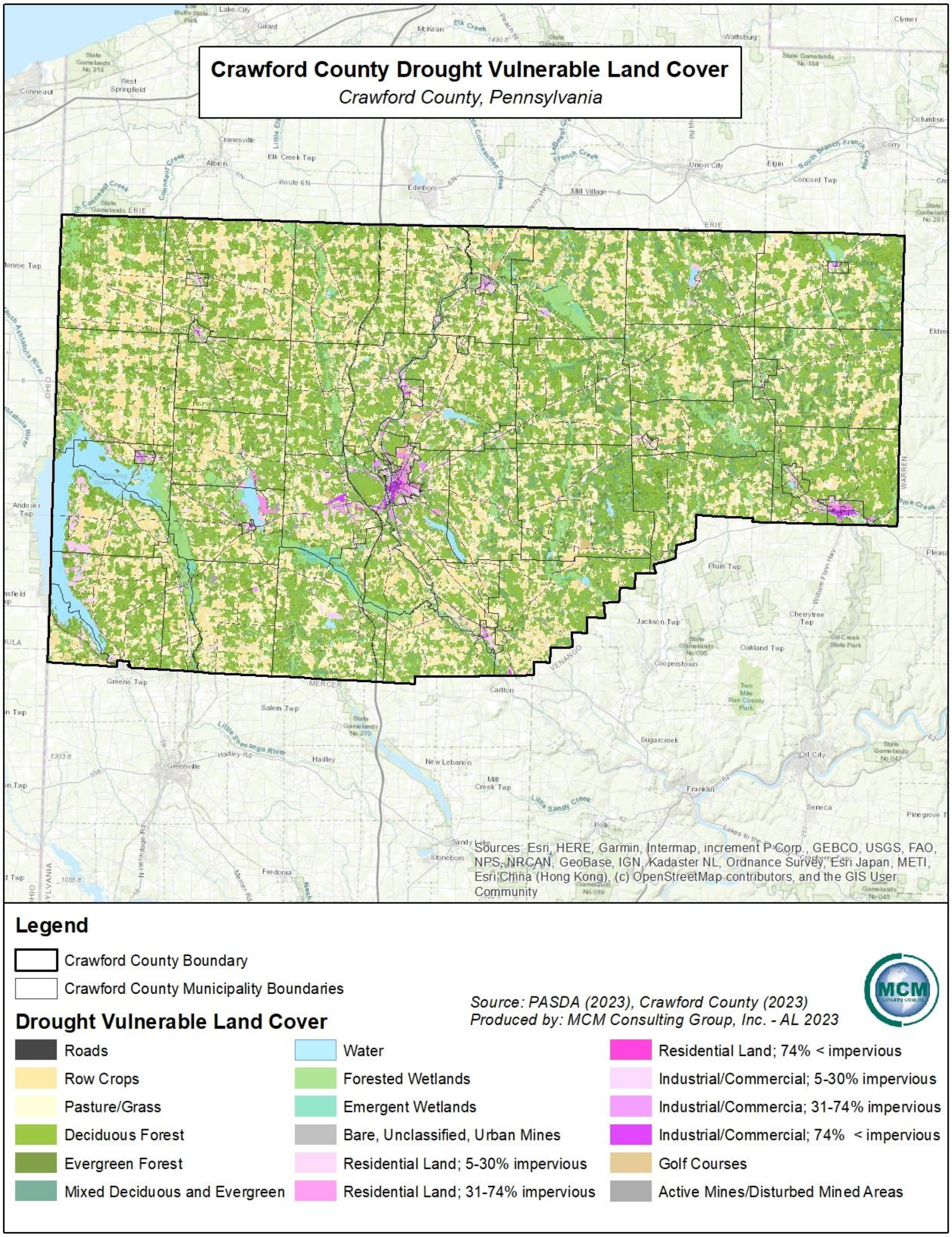


Figure 8 - Drought-Vulnerable Land Use and Public Water Supply



4.3.2. Disorientation

4.3.2.1 Location and Extent

Many people are attracted to Pennsylvania's rural areas for recreational purposes such as hiking, camping, hunting, and fishing. People can become lost or trapped in remote and rugged wilderness areas, as a result. Crawford County has a few parks and large forested areas that may attract locals and tourists due to the natural appeal of the landscape and the expanses of land, both state-owned and otherwise. Crawford County is home to one state parks which is Pymatuning State Park. In the event of disorientation, search and rescue may be required for people who suffer from medical problems or injuries and those who become accidentally or intentionally disoriented. Search and rescue efforts are often focused in and around state forest and state park lands as they contain numerous miles of hiking and biking trails.

4.3.2.2 Range of Magnitude

Approximately 25.2% of Crawford County is undeveloped forest land. A wide variety of factors can contribute to the outcome of a search and rescue mission, but the most common dangers associated with disorientation are lack of food, water, and shelter. Crawford County generally has a significant amount of water (twenty-six square miles of total land area is surface water), and during the warmer summer months shelter is less of a necessity than during winter months when extreme cold poses a threat. Age, physical fitness, and familiarity with the area can also have a bearing on the outcome.

Initial search and rescue efforts are often made with teams of dogs, people on horseback, and or volunteers from fire departments, and for longer term incidents drones may be employed.

4.3.2.3 Past Occurrence

Wilderness search and rescue often requires considerable resources, sometimes resulting in the expenditure of hundreds of man-hours, both paid and volunteer. Crawford County utilizes a database system called WebEOC to track various incidents within the county. However, no such data was available to refence for disorientation during the development of this report, and as such no detailed list of past disorientation events can be displayed at this time.

4.3.2.4 Future Occurrence

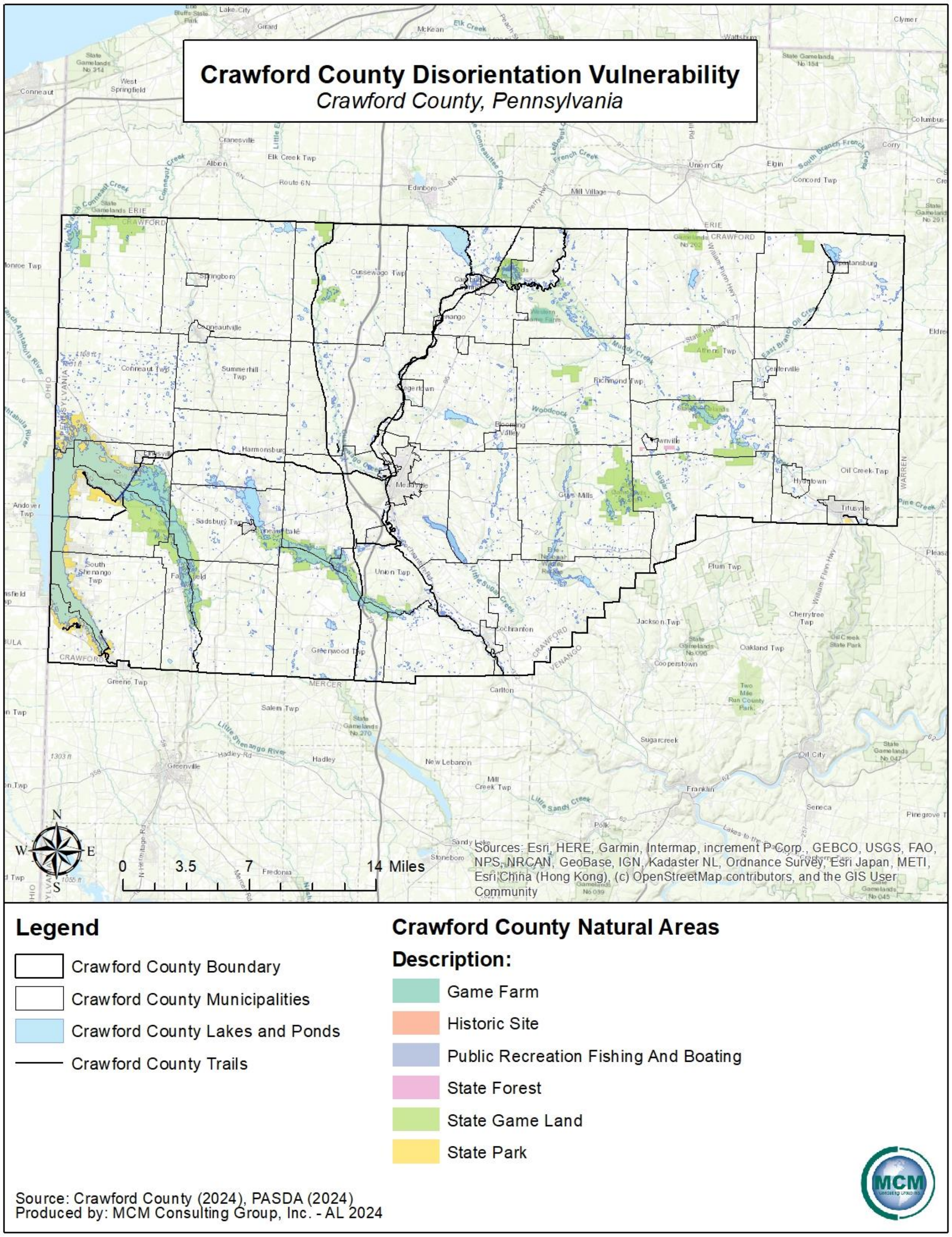
During the warm summer months, as activities such as hiking, biking, and camping increase, so does the likelihood of individuals becoming disoriented. Many search and rescue events also occur in November due to individuals getting lost during hunting season. Disorientation occurs most often in state parks and state forests where outdoor recreation is most abundant, and the woods are most dense. Additionally, medical emergencies occur regularly in the county, especially among the elderly, which could result in disorientation events.

4.3.2.5 Vulnerability Assessment

Individuals are most likely to become disorientated in areas of vast, open wilderness. Children and the elderly are most vulnerable to exposure to the elements. The elderly tend to be more vulnerable to disorientation due to medical/mental related issues that may occur outside of rugged tertian. Often, an individual with dementia or Alzheimer's may become disoriented in residential or wilderness locations.

The most dangerous period to become lost outdoors is during the winter months when heat and shelter are vital. Crawford County regularly experiences winter storms and temperatures below freezing, so persons participating in outdoor recreational activities in the winter are at a higher risk in the event of disorientation. *Figure 9 – Crawford County Disorientation Vulnerability* identifies areas within the county that are most vulnerable to disorientation.

Figure 9 - Crawford County Disorientation Vulnerability

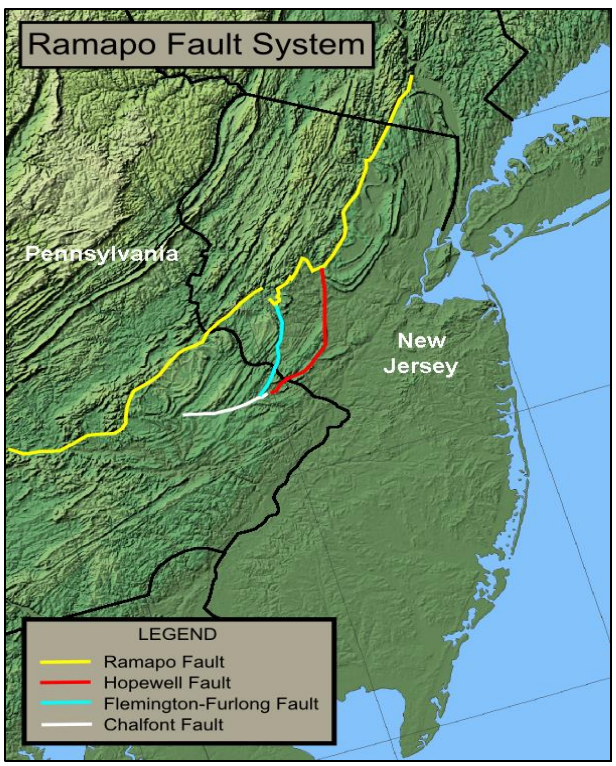


4.3.3. Earthquake

4.3.3.1 Location and Extent

An earthquake is sudden movement of the earth's surface caused by the release of stress accumulated within or along the edge off the earth's tectonic plates, a volcanic eruption, or by a human induced explosion (DCNR, 2007). Earthquake events in Pennsylvania, including Crawford County, are usually mild events, impacting areas no greater than 62 miles in diameter from the epicenter. A majority of earthquakes occur along boundaries between tectonic plates, and some earthquakes occur at faults on the interior of plates. Today, Eastern North America, including Crawford County, Pennsylvania, is far from the nearest plate boundary. That plate boundary is the Mid-Atlantic Ridge and is approximately 2,000 miles to the east, under the Atlantic Ocean. The Ramapo Fault System runs through New York, New Jersey, and eastern Pennsylvania (See *Figure 10 – Ramapo Fault System*). This fault system is associated with some small earthquakes, and it is thought unlikely to produce significant disruption.

Figure 10 - Ramapo Fault System



When the supercontinent of Pangaea broke apart about 200 million years ago, the Atlantic Ocean began to form. Since then, many faults have developed. Locating all the faults would be an ideal approach to identifying the region's earthquake hazard; however, many of the fault lines in this region have no seismicity associated with them. The best way to determine earthquake history for Crawford County is to conduct a probabilistic earthquake-hazard analysis with the earthquakes that have already happened in and around the county. (See *Figure 11 – Pennsylvania Earthquake Hazard Zones*). Nevertheless, the United States Geological Survey (USGS) indicates that Crawford County has a low earthquake risk, and three historical earthquake events have occurred.

Natural gas extraction of the Marcellus/Utica Shale formation (see *Figure 12 – Crawford County Oil and Gas Locations*) has occurred in many regions of the commonwealth, but eastern and southeastern Pennsylvania are not among them. Hydraulic fracturing, or fracking, is used to extract the gas, and the process is thought to lead to an increase in seismic activity (Meyer, 2016).

However, fracking does not appear to be linked to the increased rate of magnitude three and larger earthquakes (USGS 2014). In recent years, permits for extraction of the natural gas and oil in the commonwealth have been issued by the Pennsylvania Department of Environmental Protection, but records were not published by the PA DEP at the time of this writing for Crawford County.

4.3.3.2 Range of Magnitude

Earthquakes result in the propagation of seismic waves, which are detected using seismographs. These seismograph results are measured using the Richter Scale, an open-ended logarithmic scale that describes the energy release of an earthquake. *Table 17 – Richter Scale* summarizes Richter Scale magnitudes as they relate to the spatial extent of impacted areas. The Modified Mercalli Intensity Scale (*Table 18 – Modified Mercalli Intensity Scale*) is an alternative measure of earthquake intensity that is scaled by the impacts of the earthquake event. Earthquakes have many secondary impacts, including disrupting critical facilities, transportation routes, public water supplies and other utilities.

Table 17 - Richter Scale

Richter Scale	
Richter Magnitude	**Earthquake Effects**
Less than 3.5	Not generally felt but recorded.
3.5-5.4	Often felt, but rarely causes damage.
Under 6.0	At most, slight damage to well-designed buildings; can cause major damage to poorly constructed buildings over small regions.

Richter Scale	
Richter Magnitude	**Earthquake Effects**
6.1-6.9	Can be destructive in areas where people live up to about 100 kilometers across.
7.0-7.9	Major earthquake; can cause serious damage over large areas.
8.0 or greater	Great earthquake; can cause serious damage in areas several hundred kilometers across.

Table 18 - Modified Mercalli Intensity Scale

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

Modified Mercalli Intensity Scale			
Scale	**Intensity**	**Earthquake Effects**	**Richter Scale Magnitude**
XII	**Catastrophic**	Total destruction, trees fall, ground rises and falls in waves.	>8.1

4.3.3.3 Past Occurrence

According to USGS, three known earthquakes have had an epicenter within Crawford County since 1724, before which local seismology cannot be known. However, several seismic events that occurred outside the county boundary may have been felt in the region.

On August 23, 2011, a 5.9 earthquake occurred in Virginia, and a 2.2 earthquake shook Reading, Pennsylvania (Berks County), on July 19, 2019. Further, a 3.4 earthquake struck Mifflintown (Juniata County) on June 13, 2019, and Bolivar (Westmoreland County) experienced a 2.9 event on October 6, 2020. Parts of the county may have experienced some of the shock waves from these minor earthquakes and others that have occurred around the region, most notably New Jersey. The strongest recorded earthquake in Pennsylvania history (5.2) occurred on September 25, 1998 in northwestern Pennsylvania and is known as the Pymatuning Earthquake for its epicenter near Pymatuning Lake. The effects of the earthquake were felt across the commonwealth and were blamed for many wells in the region near the epicenter losing their water, while new springs appeared, and old wells reemerged. A three-month date range revealed 120 dry household-supply wells on the ridge of Jamestown and Greenville, Pennsylvania. Declines of up to 100 feet were observed on a ridge where at least eighty of the wells resided. The degree of the damage varied. Some of the wells lost all power or could barely hold their yields and some of the water in wells turned black or began to smell of sulfur.

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

Because the effects of large earthquakes can be felt hundreds of miles away, the historical earthquake epicenters near Crawford County are shown below at *Figure 13 – Pennsylvania Earthquake Activity*. A wider depiction of earthquake occurrences in the northeastern United States may be found here: https://earthquake.usgs.gov/earthquakes/map/?extent=14.26438,-141.32813&extent=56.51102,-48.60352

4.3.3.4 Future Occurrence

Earthquake activity and intensities are difficult to predict, but a probabilistic analysis of prior earthquakes can assist in gauging the likelihood of future occurrences. *Figure 11 – Earthquake Hazard Zones* shows that Crawford County is in a low hazard zone for earthquake activity according to the FEMA's National Risk Inventory (NRI), suggesting a low probability of earthquake occurrence. However, according to the USGS, there has been a recent trend increasing the frequency of magnitude three and larger earthquakes in the central and eastern U.S. (*Table 19 – Recent Earthquake Trends in Northeastern United States*). This uptick in seismicity may be due to hydraulic fracturing activities, and specifically occurs due to wastewater from the fracking process being injected into the earth (Meyer, 2016). Recent studies have moved towards being able to predict such induced seismicity by looking at uplift after injections, but more work needs to be done to confirm uplift as a reliable indicator of induced seismicity (Shirzei et al., 2016). It is important to note that seismicity can occur even after wells become inactive and injection rates decline (Shirzaei et al., 2016).

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

The chances of a devastating earthquake are low, but do exist, according to Scharnberger, His calculations on the probability of a severe earthquake based on the historic record indicate it is about a one in 200 chance in any given year.

Climate change has the potential to increase the earthquake activity felt in the United States, including in Crawford County. Although not a direct cause of earthquakes, climate change can worsen droughts and their duration. Droughts can exacerbate the fault lines in an area, resulting in a greater potential for seismology events. During droughts, groundwater is also increasingly pumped, which could cause changes in fault areas. This effect is more common on the west coast of the United States, but with climate change, these impacts can become more common across the country and the world.

Table 19 - Recent Earthquake Trends in Northeastern United States

Earthquake Trends in Northeastern U.S.	
Year	**Number of Magnitude 3+ Earthquakes**
2015	0
2016	3
2017	4
2018	0
2019	5
2020	3
Source: USGS, 2020	

4.3.3.5 Vulnerability Assessment

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

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

There are 876 bridges publicly documented by the Pennsylvania Department of Transportation that could be damaged and made unusable by a major earthquake event. These locations are evenly distributed throughout the county and damage to any of them would be detrimental to transportation and emergency response in Crawford County.

Impact of earthquakes on historic properties in Crawford County

Crawford County has a high number of historic and cultural properties that could be adversely impacted by earthquakes. The vulnerability of each is related to the construction practices of the property at the time that it was constructed. Many of the historic properties in Crawford County were constructed before 1900 and are of a type of construction vulnerable to increased seismic events (brick, stone, and wood). There are ten historic properties in Crawford County that are registered with the National Register of Historic Places and six historic structures.

These locations are listed in the table (*Table 20 – Crawford County National Register of Historic Places – Buildings*) below and the includes type of foundation construction, wall construction, and roof construction if available.

Table 20 - Crawford County National Register of Historic Places – Buildings

Crawford County National Register of Historic Places - Buildings				
Number	**Name**	**Foundation**	**Walls**	**Roof**
1	Baldwin-Reynolds House	N/A	N/A	Shingles
2	Bentley Hall	Stone	Brick	Shingles
3	Independent Congregational Church	N/A	Brick	N/A
4	Amos Kelly House	Stone	Wooden	Shingles
5	Dr. J. R. Mosier Office	Stone	Wooden	Shingles
6	Roueche House	N/A	Brick	Shingles
7	Ruter Hall	Stone	Brick	Shingles
8	Edward Saeger House	Stone	Wooden	Shingles
9	Judge Henry Shippen House	N/A	Brick	Shingles
10	Titusville City Hall	Stone	N/A	N/A
Source: National Register of Historic Places, 2023, PA GIS CRGIS, 2023				

With the information collected above, any structure with a stone, concrete, or limestone foundation is at an increased vulnerability of earthquake damage. There are at least six historic buildings in Crawford County that have stone foundations. Also, five buildings are of brick wall construction, which would be at an increased risk of seismic damage.

There are also two historic districts that are in Crawford County. Those locations are the Meadville Downtown Historic District and the Titusville Historic District. There are eighty-one buildings contributing to the Meadville Downtown Historic District and those locations are around Diamond Park in Meadville, Pennsylvania. Some of the important buildings in the area are the Crawford County Courthouse, the Ralston Block, the Crawford County Trust Building, the Crawford County U.S. Post Office for Meadville, and the Academy of Music. The Titusville Historic District comprises approximately 472 buildings and are a mix of residential, commercial, and industrial buildings. Some of the notable buildings in this historic district are the First National Bank, the Universalist Church, the Pennsylvania Bank & Trust Company, and the Swedish Congregational Church.

Municipalities with high risk due to earthquake:

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Township
- Cambridge Springs Borough

- Centerville Borough
- Cochranton Borough
- Conneaut Township
- Conneaut Lake Borough
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Linesville Borough
- Meadville, City of
- North Shenango Township
- Oil Creek Township
- Pine Township
- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Spartansburg Borough
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Townville Borough
- Troy Township
- Union Township
- Venango Borough
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township
- West Shenango Township
- Woodcock Borough
- Woodcock Township

All of the socially vulnerable populations in Crawford County are at an increased vulnerability to earthquakes. The homeless and the unsheltered populations are at risk if they are living in structurally unsound buildings and locations. Also, the economically vulnerable of Crawford County may not have the capability to fix or rebuild if their homes are damaged from an earthquake event.

As seen in *Table 3 – Population Change in Crawford County*, forty-six of the fifty-one municipalities in Crawford County have experienced a population loss since the 2010 decennial census. Four municipalities have seen a net population increase from the 2010 decennial census to the 2020 decennial census and one municipality experienced no population change. Based on this information, it can be speculated that these four municipalities with an increase in population may have an increased/equivalent vulnerability to earthquakes, since 2010, due to the increase in population.

Land use is a factor that has the potential to impact earthquake severity. Land use, in the form of a built environment, such as residential expansion, can cause earthquake impact severity to increase. Impact severity increases because as the built environment expands and becomes more complex, the impact the event will have on that area also increases because there is an influx of people, infrastructure, and critical infrastructure in the hazard area. With only four municipalities seeing population increases between the 2010 decennial census and the 2020 decennial census, there has not been a significant increase in residential construction in Crawford County.

The seismic forces associated with an earthquake pose an immediate threat to telecommunication infrastructure, or other critical infrastructure in a community. When an earthquake occurs, the resulting ground instability can lead to telephone pole collapse, disruption of fiber or copper cables systems, and in severe cases, cellular tower failure. The disruption to these networks, if the earthquake event is significant, can also result in a loss of communication capabilities, hindering response coordination, and leaving communities impacted by the earthquake vulnerable to other natural or human-caused hazards.

Earthquakes can also damage power distribution systems, leading to localized power outages or even widespread blackouts. Fallen power lines, damaged substations, and disrupted transformers may further contribute to the breakdown of the electrical grid surrounding the epicenter of the earthquake, and the consequences can include cascading pressure on essential services and other community lifelines, further impeding emergency operations and the capabilities within the impacted jurisdictions.

Earthquake events can also pose a threat to natural gas, water, and the numerous other materials and chemicals transported through underground water systems in Crawford County. During significant earthquakes, underground pipelines may crack, causing the transported material to leak into the ground and contaminating water sources in the county. In severe cases, water line bursts can cause cascading hazards to subsidence and sinkholes, when left unchecked. However, even in more contained scenarios, a small leak can have profound impact if the transported material is toxic or hazardous in nature, leading to degradation of the natural resources in the impacted communities.

Figure 11 - Pennsylvania Earthquake Hazard Zones

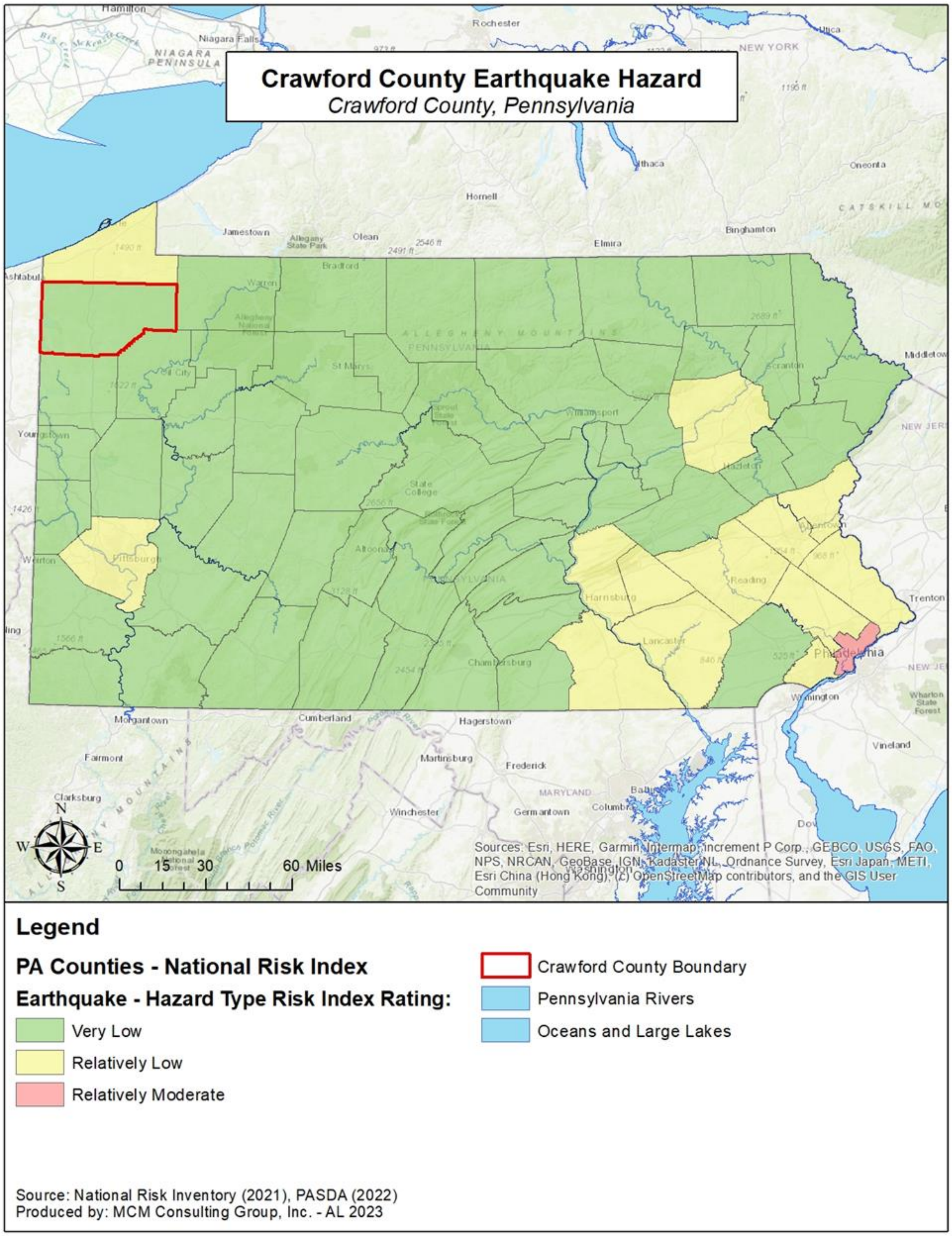


Figure 12 - Crawford County Oil and Gas Locations

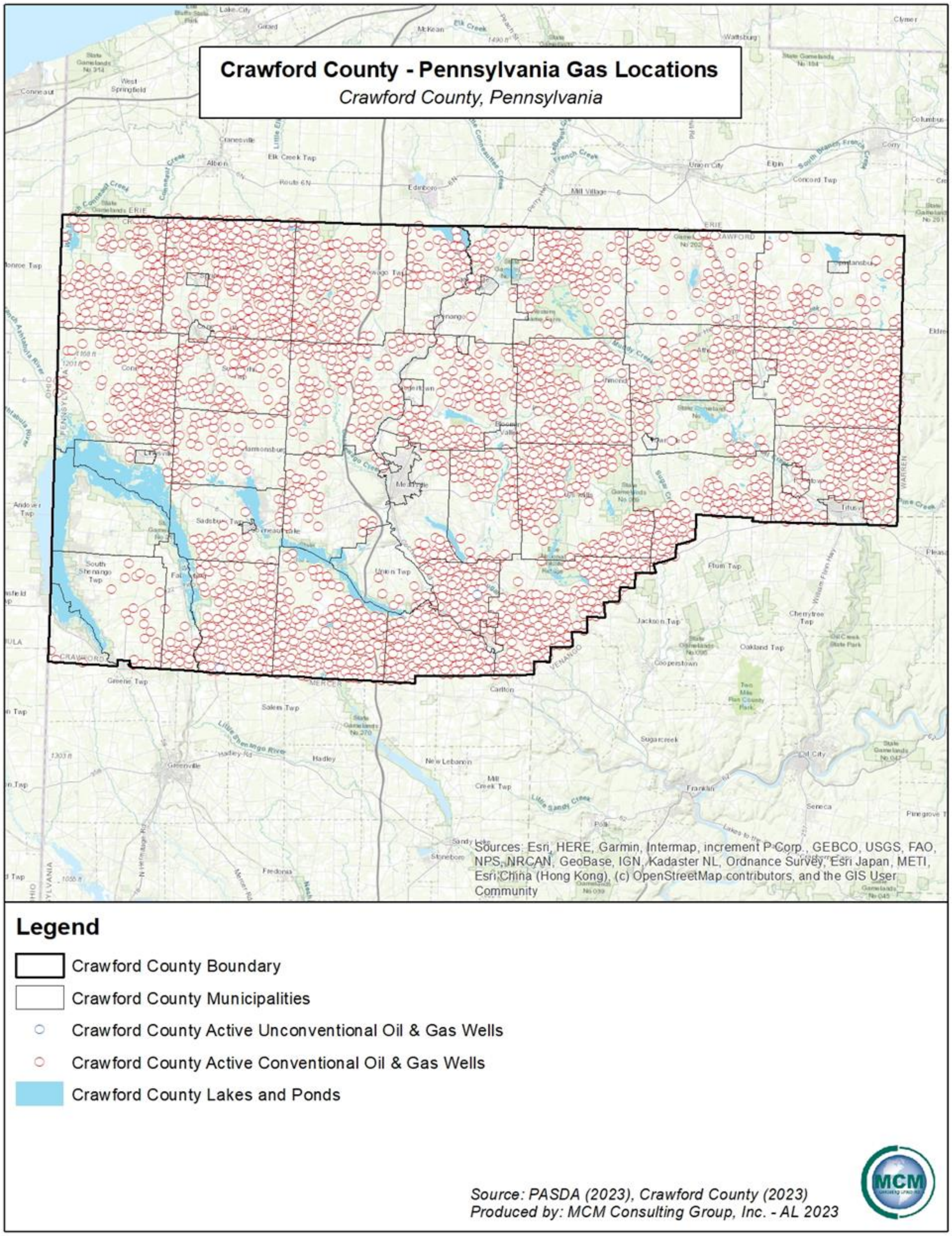
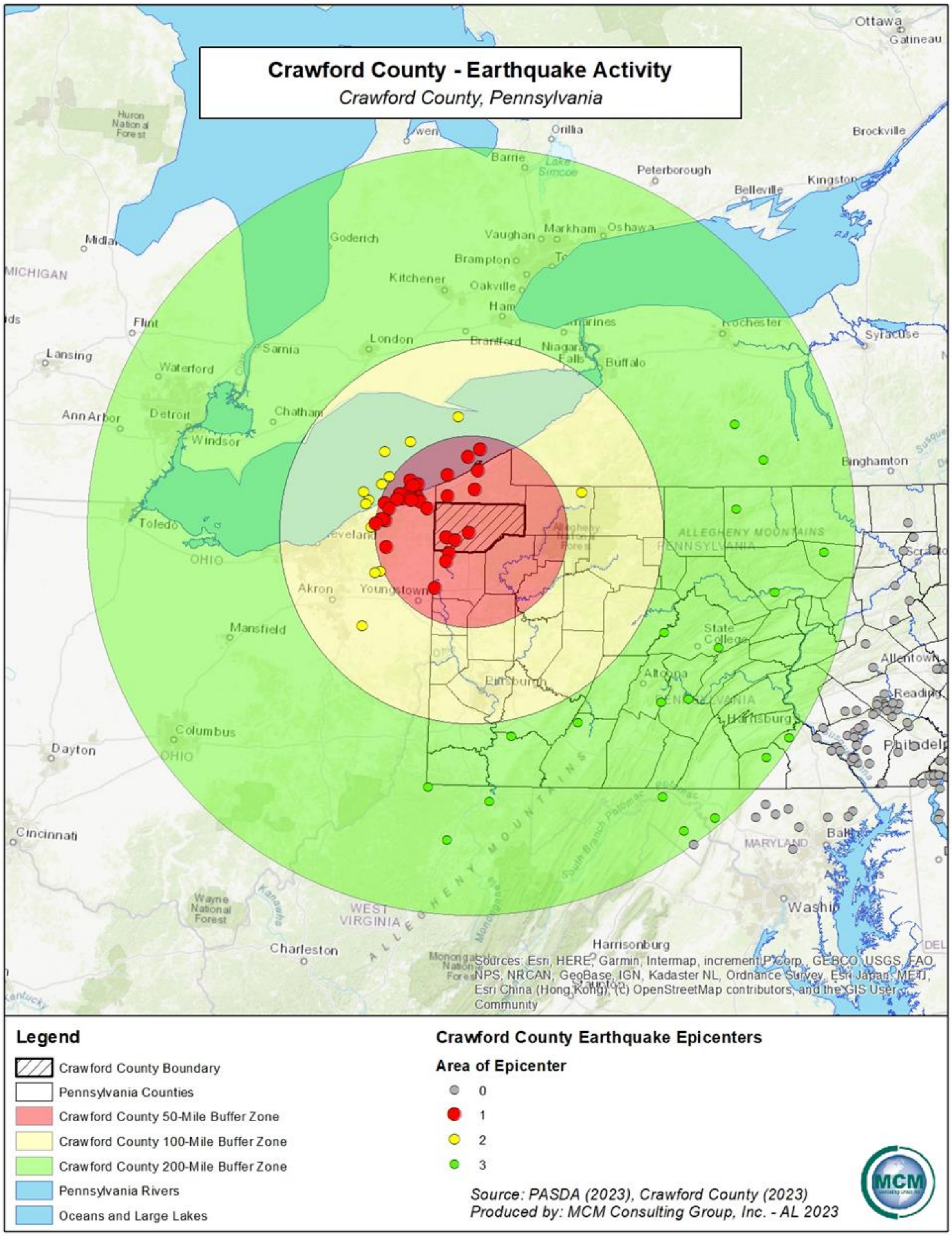


Figure 13 - Pennsylvania Earthquake Activity



4.3.4. Extreme Temperatures

4.3.4.1 Location and Extent

Pennsylvania, and more specifically, Crawford County can experience many different temperature extremes. High temperatures occur about ten days per year at any location in Pennsylvania. However, southern parts of the state experience more than twice this number. Freezing temperatures occur on an average of 100 or more days per year with longest freeze-free period at near sea level locations such as northwest Pennsylvania (adjacent to Lake Erie). Extreme temperatures can be devastating – extreme heat can cause sunburn, heat cramps, heat exhaustion, heat stroke, and dehydration, while extreme cold can cause hypothermia and frostbite. Both can potentially cause long-lasting disabilities. January is typically the coldest month for Crawford County, with average temperatures of 25.8°F. *Figure 17 - Average Minimum Temperature Trends for Pennsylvania* shows the average minimum temperatures in Pennsylvania with Crawford County identified. July has typically been the warmest month for Crawford County, with an average temperature of 70.8°F. *Figure 18 - Average Maximum Temperature Trends for Pennsylvania* shows the average maximum temperatures in Pennsylvania with Crawford County identified. Temperatures can vary across Crawford County due to elevation changes in topography.

4.3.4.2 Range of Magnitude

When extreme temperature events occur, they typically impact the entirety of Crawford County, including the surrounding region. Extreme heat is described as temperatures that hover at least 10ºF above the average high temperature for a region during the summer months. Extreme heat is responsible for more deaths in Pennsylvania than all other natural disasters combined. Temperature advisories, watches, and warnings are issued by the National Weather Service relating impacts to the range of temperatures typically experienced in Pennsylvania. Heat advisories are issued when the heat index temperature is expected to be equal to 100°F, but less than 105°F. Excessive heat warnings are issued when heat indices are expected to reach or exceed 105°F and are issued within twelve hours of the onset. Excessive heat watches are issued when there is a possibility that excessive heat warning criteria may be experienced within twenty-four to seventy-two hours, but their occurrence and timing are still uncertain. A potential worst-case extreme temperature scenario would occur if widespread areas of the Commonwealth experienced 90°F or higher temperatures for an extended number of days. The heat could overwhelm the power grid and cause widespread blackouts, cutting off vital HVAC services for residents. It could create crisis management issues for senior citizens on fixed incomes, the homeless, and other vulnerable populations. The heat index is a measurement that takes into account both the temperature and relative humidity, and it is calculated as shown in *Figure 14 - National Weather Service's Heat Index Matrix*.

Figure 14 - National Weather Service's Heat Index Matrix

Temperature (°F)

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

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

Caution | Extreme Caution | Danger | Extreme Danger

Extreme cold temperatures drop well below typical temperatures and are often associated with winter storm events. Wind can make the apparent temperature drop further, and exposure to such extreme cold temperatures can cause hypothermia, frost bite, and death. Wind chill warnings are issued when wind chills drop to -25°F or lower. While this threshold applies to the entire state, the threshold for advisories varies based on regions. Wind chill advisories are issued in the south and western sections of Pennsylvania, when wind chill values drop to -10°F to -24°F. Wind chill advisories are issued in the southern-central to northern sections of the Commonwealth when wind chills drop to -15°F to -24°F. The National Weather Service created a wind chill chart which shows the time frostbite takes to set in depending on temperature and wind speed as shown in *Figure 15 - National Weather Service's Wind Chill Matrix*.

Figure 15 - National Weather Service's Wind Chill Matrix

Wind Chill Chart

Wind (mph) \ Temperature (°F)	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
Calm	40	35	30	25	20	15	10	5	0	-5	-10	-15	-20	-25	-30	-35	-40	-45
5	36	31	25	19	13	7	1	-5	-11	-16	-22	-28	-34	-40	-46	-52	-57	-63
10	34	27	21	15	9	3	-4	-10	-16	-22	-28	-35	-41	-47	-53	-59	-66	-72
15	32	25	19	13	6	0	-7	-13	-19	-26	-32	-39	-45	-51	-58	-64	-71	-77
20	30	24	17	11	4	-2	-9	-15	-22	-29	-35	-42	-48	-55	-61	-68	-74	-81
25	29	23	16	9	3	-4	-11	-17	-24	-31	-37	-44	-51	-58	-64	-71	-78	-84
30	28	22	15	8	1	-5	-12	-19	-26	-33	-39	-46	-53	-60	-67	-73	-80	-87
35	28	21	14	7	0	-7	-14	-21	-27	-34	-41	-48	-55	-62	-69	-76	-82	-89
40	27	20	13	6	-1	-8	-15	-22	-29	-36	-43	-50	-57	-64	-71	-78	-84	-91
45	26	19	12	5	-2	-9	-16	-23	-30	-37	-44	-51	-58	-65	-72	-79	-86	-93
50	26	19	12	4	-3	-10	-17	-24	-31	-38	-45	-52	-60	-67	-74	-81	-88	-95
55	25	18	11	4	-3	-11	-18	-25	-32	-39	-46	-54	-61	-68	-75	-82	-89	-97
60	25	17	10	3	-4	-11	-19	-26	-33	-40	-48	-55	-62	-69	-76	-84	-91	-98

Frostbite Times: 30 minutes, 10 minutes, 5 minutes

$$\text{Wind Chill (°F)} = 35.74 + 0.6215T - 35.75(V^{0.16}) + 0.4275T(V^{0.16})$$

Where, T = Air Temperature (°F) V = Wind Speed (mph)

Effective 11/01/01

Source: NOAA NWS, 2001

4.3.4.3 Past Occurrence

Crawford County has had more past occurrences of extreme cold incidents than extreme heat due to the geographic location of the county. *Table 21 - Past Extreme Temperature Occurrences for Crawford County* shows the past occurrence events associated with extreme temperature (hot and cold) that have occurred in Crawford County. The data in the table was reported from 2000 to September 2024. Due to the source used, storm data is not made available until sixty days after an incident occurs according to NOAA, however, events most likely have occurred without being documented. With a total of eight different extreme temperature events that have occurred, all eight of the events were extreme cold related while none were extreme heat related. There were no reports of death or injury related to the occurrences. However, numerous sources have provided information regarding past occurrences and losses associated with extreme temperature in Crawford County and the Commonwealth as a whole. Due to the number of sources available with information, number of events and losses could vary slightly in number.

Data from the National Climatic Data Center reports that there have been 787 extreme temperature episodes in Pennsylvania from 2000 to 09/03/2024, resulting in a total of ninety-seven deaths and 103 injuries. Out of the 787 events, 525 of them were extreme cold related with four deaths. The other 262 events were extreme heat related with ninety-three deaths and 103 injuries across the state. The biggest event began on July 21, 2011, and ended on July 24, 2011. In the 2011 event, there was a total of twenty-two deaths and forty-eight injuries during the course of the event across the Commonwealth. Record-breaking heat temperatures were experienced in over thirty different counties. While this record-breaking event did not have a significant impact on Crawford County itself, it is still noteworthy due to the impacts it had across the Commonwealth as a whole.

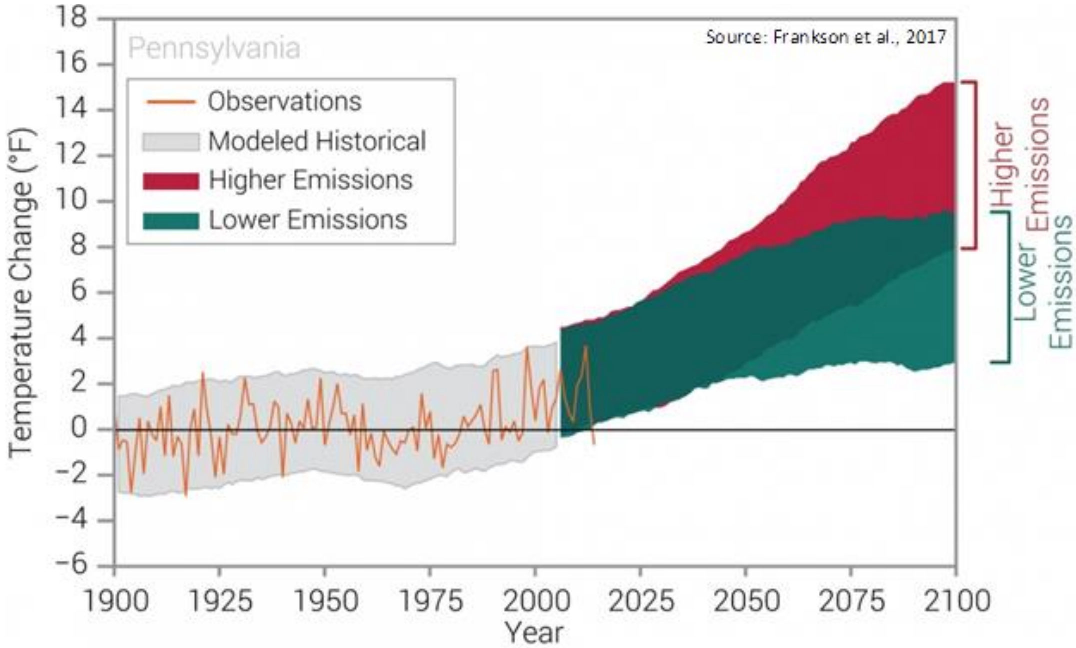
Table 21 - Past Extreme Temperature Occurrences for Crawford County

Past Extreme Temperature Occurrences for Crawford County		
Location	**Date**	**Type**
Crawford County	01/15/2009	Extreme Cold/ Wind Chill
Crawford County	04/29/2012	Extreme Cold/ Wind Chill
Crawford County	01/06/2014	Extreme Cold/ Wind Chill
Crawford County	01/28/2014	Extreme Cold/ Wind Chill
Crawford County	02/15/2015	Extreme Cold/ Wind Chill
Crawford County	02/20/2015	Extreme Cold/ Wind Chill
Crawford County	01/30/2019	Extreme Cold/ Wind Chill
Crawford County	12/23/2022	Extreme Cold/ Wind Chill
Source: NOAA, 2024		

4.3.4.4 Future Occurrence

Extreme temperatures will continue to impact Crawford County in the future. Anthropogenic climate change is causing extreme climatic events to occur more frequently, suggesting that extreme temperatures are becoming a more threatening hazard as the impacts of climate change intensify. The annual average temperature has increased by 1.2˚F across the continental United States during the years 1986 to present compared to the time period 1901 to 1960, and temperatures are expected to continue rising. *Figure 16 - Observed and Projected Temperature Change for Pennsylvania* shows these projected changes in temperature for Pennsylvania based on climate models considering the possibilities of increased and decreased levels of greenhouse gas emissions. In recent years, record high temperatures have outnumbered record low temperatures 2:1, so it is expected that the risk of extreme heat will be amplified whereas the risk of extreme cold will be attenuated. The Northeastern United States is expected to experience twenty to thirty more days with temperatures above 90˚F, and twenty to thirty fewer days below freezing by approximately 2050. While there may be fewer extreme cold events, those that do occur are expected to reach record-setting low temperatures more often. Historically, Crawford County has had more extreme cold events than extreme heat events due to the geographic location of the county; however, this balance is expected to shift somewhat in the coming years to include a greater proportion of extreme heat events.

Figure 16 - Observed and Projected Temperature Change for Pennsylvania



Source: Frankson et al., 2017

4.3.4.5 Vulnerability Assessment

Extreme temperatures are usually a regional hazard when they occur. The very old (sixty-five years or older, accounting for 21.6% of Crawford County population) and the very young (five years or younger, accounting for 5.3% of Crawford County population) are most vulnerable to extreme temperatures due to risk factors, mobility challenges, and disabilities. Extreme temperatures can increase the demand for utility services, often resulting in an increased cost which some consumers may be unable to afford. The increased demand for services may cause a decrease in availability of these services or failure of the system. A decrease or failure of the utility system during extreme temperature events would put a large population at great risk. Extreme temperature events can also drastically increase the volume of emergency calls, potentially overwhelming the public safety communications center. Extreme heat events can also contribute to drought conditions, which in turn increase the risk of wildfire, as discussed in Section 4.3.14.

All properties in Crawford County that are part of the National Register of Historic Places have the same risk to extreme temperature. No one property has a greater risk than the others, but each of the historic and cultural properties is vulnerable at some level.

Municipalities with high risk due to extreme temperature:

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Springs Borough
- Cambridge Township
- Centerville Borough
- Cochranton Borough
- Conneaut Lake Borough
- Conneaut Township
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Linesville Borough
- Meadville City
- North Shenango Township
- Oil Creek Township
- Pine Township
- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Spartansburg Borough
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville City
- Townville Borough
- Troy Township
- Union Township
- Venango Borough
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township
- West Shenango Township
- Woodcock Borough
- Woodcock Township

Extreme temperatures can have a significant impact on land use within Crawford County. Higher temperatures can affect the mountain snowpacks and vegetation land. It is important to note that higher land use and irrigation can cause more intense extreme temperatures. Based on this information it can be speculated that higher land use within the municipalities in Crawford County will be impacted.

As seen in *Table 3 – Population Change in Crawford County*, forty-six of the fifty-one municipalities in Crawford County have experienced a population loss since the 2010 decennial census. Four municipalities have seen a net population increase from the 2010 decennial census to the 2020 decennial census, and one municipality did not see a population change. Based on this information, it can be speculated that Blooming Valley Borough, Rome Township, Sparta Township, and Townville Borough may have an increased vulnerability to extreme temperatures, since 2010, due to the increase in population. Populations in Crawford County, including the socially vulnerable and unserved populations, are at different levels of vulnerability. The socially vulnerable have an increased risk due to the unsheltered or homeless not having proper, and adequate, access to shelter and heating, ventilation, and air conditioning (HVAC) to protect them from extreme temperature events.

Extreme temperatures can have a significant impact on natural areas. Consecutive days of excessive heat or extreme cold can lead to the diminishment of natural habitats such as forests, rivers, and mountains as seen in Crawford County. Excessive heat and extreme cold can cause these areas to lose the nourishment that is needed for these areas to survive and destroy the equilibrium within them. If trends continue there will be more days of excessive heat in the coming years that could impact the equilibrium in these natural areas and change their geographic features. Extreme temperatures and lack of rainfall can lead to drought and the diminishment of rivers and vegetation within the area.

Extreme temperatures can have significant impacts on systems and community lifelines that are essential for the operations of an area. The changing nature of extreme temperature events could account for different levels of impact for every system in an area. For example, excessive cold may disrupt water systems, potentially resulting in frozen or broken pipes due to water freezing in the system because of the lower temperatures. Extreme heat events may increase the demand for potable water for consumption and water for irrigation. This could result in lower reservoir levels and increased concern for water rationing. If extreme temperatures continue for an extended period, or if the extreme temperatures occur while a drought event is ongoing, the vulnerability of an area could be critical. Extreme temperatures could impact the power system by causing an increase for air conditioning in extreme heat events. When power demand is high for an already over-taxed power system, rolling power interruptions or brownouts can occur. This is more typical in the western United States but could occur in Pennsylvania if the conditions are met.

Figure 17 - Average Minimum Temperature Trends for Pennsylvania

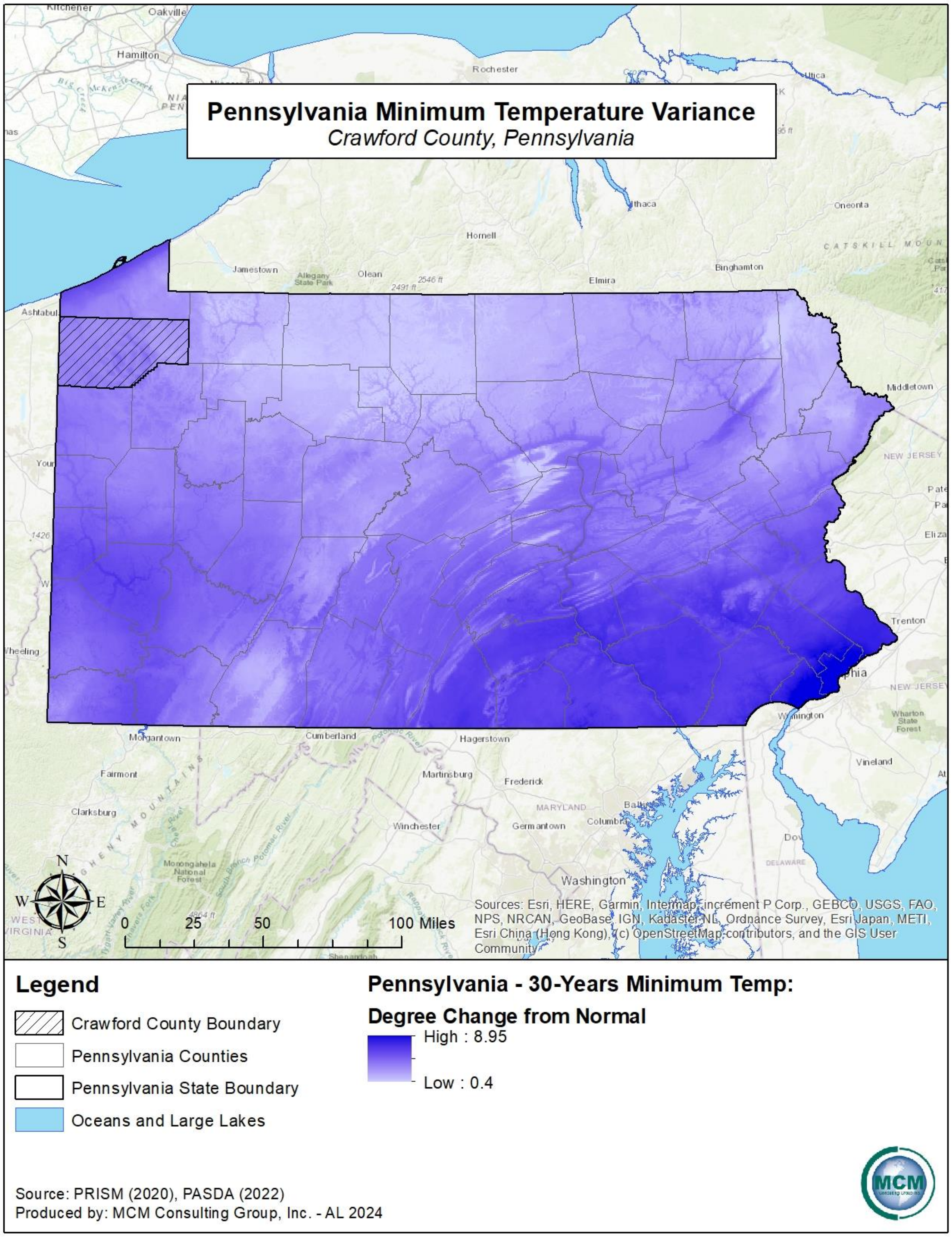
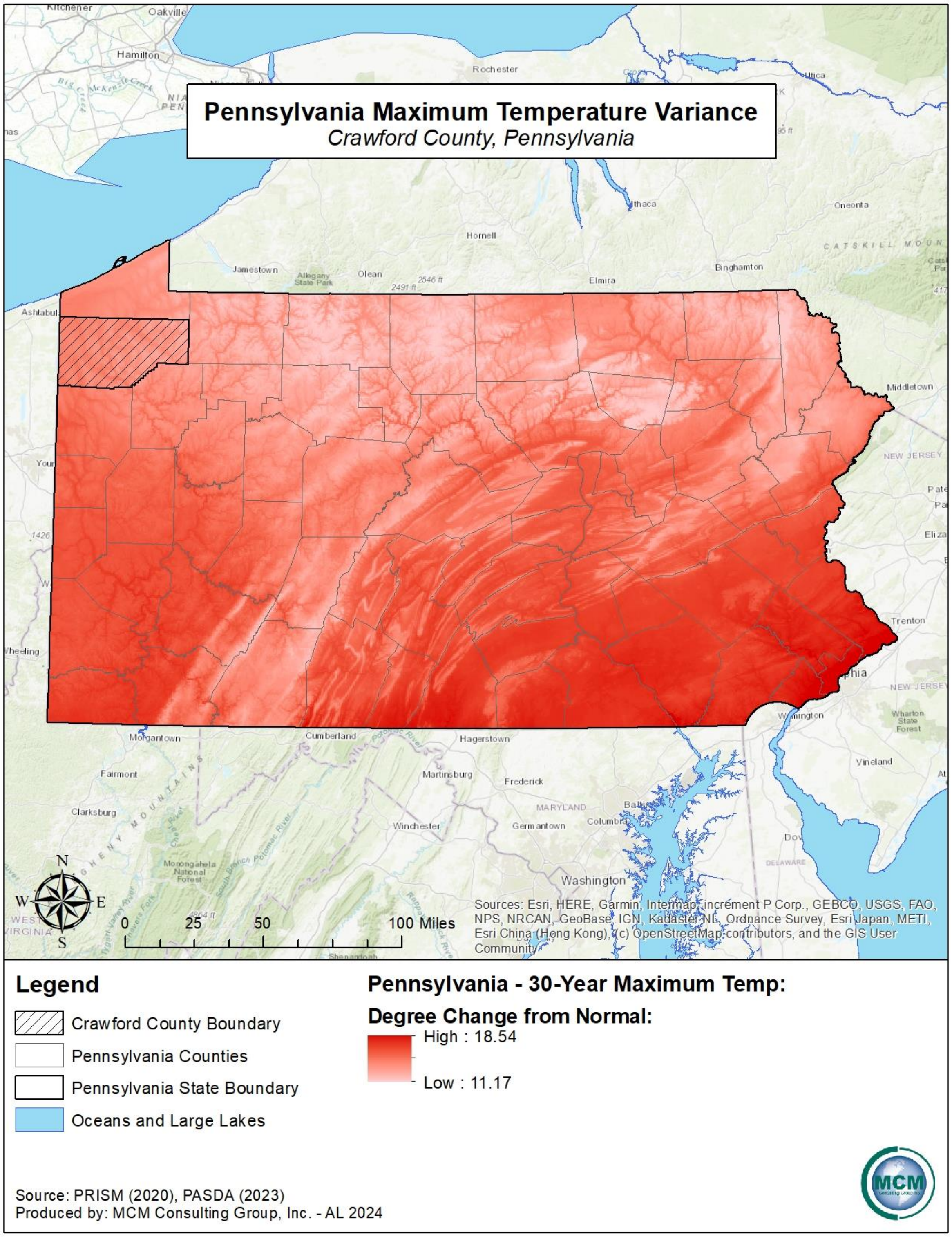


Figure 18 - Average Maximum Temperature Trends for Pennsylvania



4.3.5. Flooding, Flash Flooding, Ice Jam Flooding

4.3.5.1 Location and Extent

Flooding is the temporary condition of partial or complete inundation on normally dry land and it is the most frequent and costly of all hazards in Pennsylvania. Flooding events are generally the result of excessive precipitation. General flooding is typically experienced when precipitation occurs over a given river basin for an extended period. Flash flooding is usually the result of heavy, localized precipitation falling in a short period of time over a given location, often in mountain streams and mountainous regions, and in urban areas where much of the ground is covered in impervious surfaces. Flash floods are relatively common in Crawford County and the severity of those flood events is dependent upon a combination of creek, stream, and river basin topography and physiography, hydrology, precipitation, and weather patterns. Present soil conditions, the degree of vegetative clearing, and the presence of impervious cover must also be considered when determining the severity of a flood or flood event.

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

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 event. Flood recurrence intervals are explained in more detail in section 4.3.3.4. However, in assessing the potential spatial extent of flooding, it is important to know that a floodplain associated with a flood that has a 10% chance of occurring in a given year is smaller than a floodplain associated with a flood that has a 0.2% chance of occurring.

The National Flood Insurance Program (NFIP) publishes digital flood insurance rate maps (DFIRMs). These maps identify the 1% annual chance of flood area. The special flood hazard area (SFHA) and base flood elevations (BFE) are developed from the 1% annual chance flood event as seen in *Figure 19 – Flooding and Floodplain Diagram*. Structure located within the SFHA have a 26% chance of flooding in a thirty-year period. The SFHA serves as the primary regulatory boundary used by FEMA, the Commonwealth of Pennsylvania, and the Crawford County local government. Federal floodplain management regulations and mandatory flood insurance purchase requirements apply to the following high-risk special flood hazard areas in *Table 22 – Flood Hazard High Risk Zones*. Appendix D of this hazard mitigation plan includes a flooding vulnerability map for each municipality in Crawford County with vulnerable structures and community lifeline facilities identified using the most current DFIRM data for Crawford County.

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

Figure 19 - Flooding and Floodplain Diagram

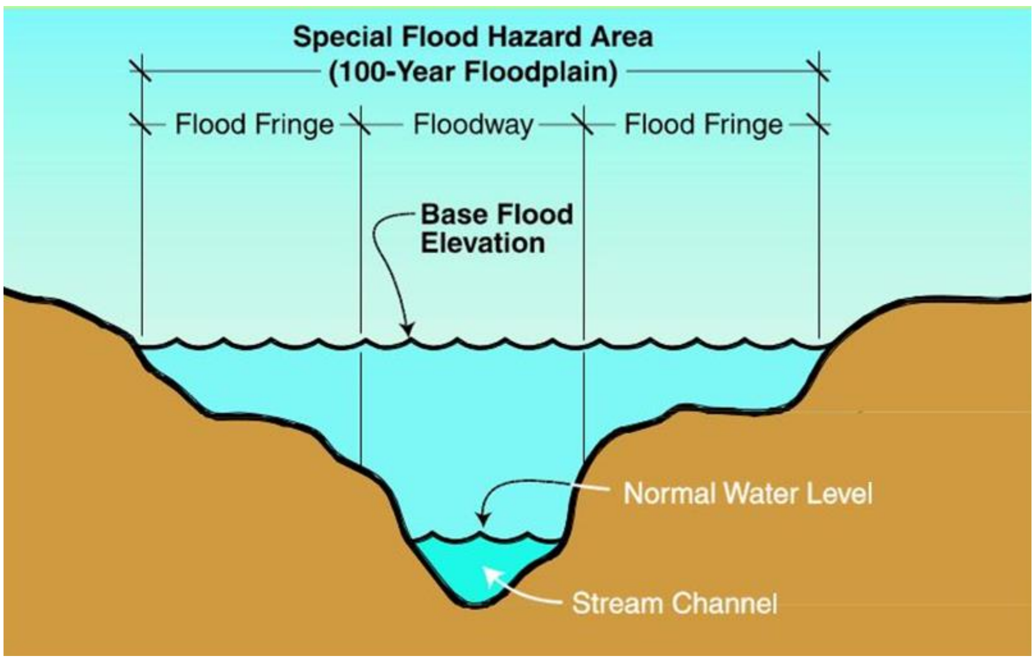


Table 22 - Flood Hazard High Risk Zones

Flood Hazard High Risk Zones	
Zone	**Description**
A	Areas subject to inundation by the 1% annual chance flood event. Because detailed hydraulic analysis has not been performed, no base flood elevations or flood depths are shown.
AE	Areas subject to inundation by the 1% annual chance flood event determined by detailed methods. BFEs are shown within these zones.

Flood Hazard High Risk Zones	
Zone	**Description**
AH	Areas subject to inundation by the 1% annual chance shallow flooding (usually areas of ponding) where average depths are 1 – 3 feet. BFEs derived from detailed hydraulic analysis are shown in this zone.
AO	Areas subject to inundation by the 1% annual chance shallow flooding (usually sheet flow on sloping terrain) where average depths are 1 – 3 feet. Average flood depths derived from detailed hydraulic analysis are shown within this zone.
AR	Areas that result from the decertification of a previously accredited flood protection system that is determined to be in the process of being restored to provide base flood protection.
Source: FEMA, 2017	

4.3.5.2 Range of Magnitude

The Allegheny River basin has caused significant flooding in Crawford County, specifically on the following streams, creeks, and their tributaries:

- Conneaut Creek
- French Creek
    - Cussewago Creek
    - Oil Creek

Several factors determine the severity of floods, including rainfall intensity and duration, topography, ground cover, and the rate of snowmelt. Water runoff is greater in areas with steep slopes and little to no vegetative ground cover. The mountainous terrain of Crawford County can cause more severe floods as runoff reaches receiving water bodies more rapidly over steep terrain. The is of particular concern for areas along steep slopes and on the edges of valleys throughout Crawford County.

Urbanization typically results in the replacement of vegetative ground cover with impermeable surfaces like asphalt and concrete, increasing the volume of surface runoff and stormwater, particularly in areas with poorly planned stormwater drainage systems. A large amount of rainfall over a short time span can cause flash flood events. Flash floods can occur very quickly and with little warning. A flash flood can also be deadly because of the rapid rise in water levels and devastating flow velocities. The more developed areas in the county can be easily susceptible to flash floods because of the significant presence of impervious surfaces, such as streets, sidewalks, parking lots, and driveways. Additionally, small amounts of rain can cause floods in locations where the soil is still frozen, saturated from a previous wet period or if the areas is largely covered in impermeable surfaces such as parking lots, paved roadways, and other developed areas. The county occasionally experiences intense rainfall from tropical storms in later summer and early fall, which can potentially cause flooding as well.

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

Severe flooding also comes with secondary effects that could have long lasting impacts on the population, economy, and infrastructure within Crawford County. Power failures are the most common secondary effect associated with flooding. Coupled with a shortage of critical services and supplies, power failures could cause a public health emergency. Community lifelines, such as sewage and water treatment facilities, can fail, causing sewage overflows and the contamination of groundwater and drinking water. Flooding also has the potential to trigger other hazards, such as landslides, hazardous material spills, and dam failures.

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

Estimation of potential loss is completed through FEMA's HAZUS software, A level two HAZUS scenario was performed for the entirety of Crawford County. The FEMA Global Flood Risk Report and other reports generated by the software at the end of the scenario were utilized to estimate the amount of damage and loss from a flood. The total building loss for a 100-year flood based on a HAZUS level two scenario is displayed in *Table 23 – HAZUS Building Economic Loss Figures*. The total business interruption vales occurring from a proposed 100-year flood based on FEMA HAZUS data is illustrated in *Table 24 – HAZUS Business Interruption Economic Loss Figures*. *Figure 20 – Loss by Occupancy Type* illustrates the breakdown of economic losses by either residential, commercial, industrial, or other use type.

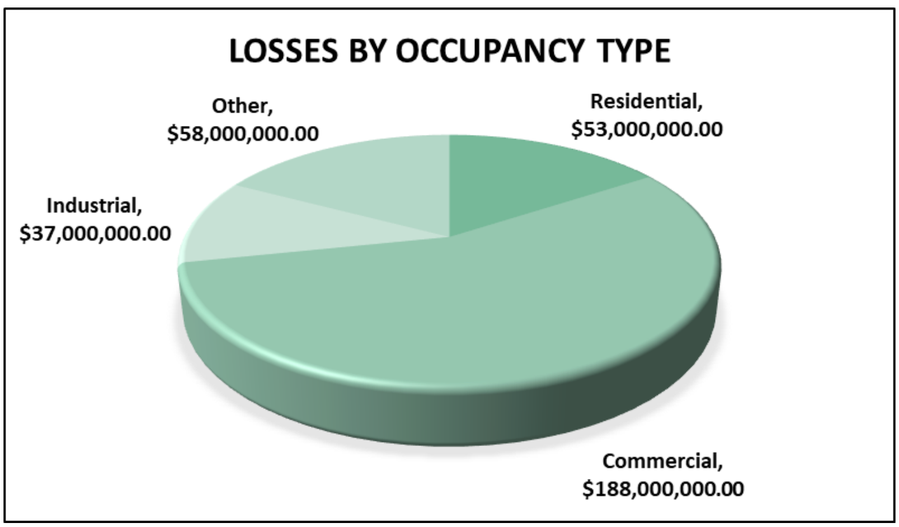
Table 23 - HAZUS Building Loss Figures

HAZUS Building Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Building:	$23,280,000.00	$18,460,000.00	$7,560,000.00	$1,510,000.00	**$50,810,000.00**
Content:	$12,160,000.00	$46,400,000.00	$21,740,000.00	$9,660,000.00	**$89,960,000.00**
Inventory:	$0.00	$1,140,000.00	$3,840,000.00	$30,000.00	**$5,010,000.00**
Subtotal:	**$35,440,000.00**	**$66,000,000.00**	**$33,140,000.00**	**$11,200,000.00**	**$145,780,000.00**
Source: HAZUS, 2023					

Table 24 - HAZUS Business Interruption Economic Loss Figures

HAZUS Business Interruption Economic Loss Figures					
	Residential	**Commercial**	**Industrial**	**Other**	**Total**
Income:	$760,000.00	$49,590,000.00	$1,290,000.00	$3,570,000.00	**$55,210,000.00**
Relocation:	$9,620,000.00	$15,060,000.00	$1,070,000.00	$2,610,000.00	**$28,360,000.00**
Rental Income:	$5,170,000.00	$11,000,000.00	$270,000.00	$700,000.00	**$17,140,000.00**
Wage:	$1,790,000.00	$46,580,000.00	$1,320,000.00	$39,850,000.00	**$89,540,000.00**
Subtotal:	**$17,340,000.00**	**$122,230,000.00**	**$3,950,000.00**	**$46,730,000.00**	**$190,250,000.00**
Source: HAZUS, 2023					

Figure 20 - Loss by Occupancy Type



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

4.3.5.3 Past Occurrence

Crawford County has experienced numerous flooding, flash flooding, and ice jam events in the past. The flooding and flash flooding were caused by a variety of heavy storms, inclement weather, tropical storms, and other issues. A summary of recent flood event history for Crawford County from January 1996 to December 2023 is found in *Table 25 – Past Flood and Flash Flood Events*. Details of each event can be found in NOAA's National Center for Environmental Information (NCEI) database. Additional data was also acquired by examining Crawford County's WebEOC information from 1996 to 2023.

Table 25 - Past Flood and Flash Flood Events

Past Flood and Flash Flood Events			
Event Location	**Event Date**	**Event Type**	**Property Damage Estimate**
City of Meadville	01/18/1996	Flash Flood	$0.00
City of Meadville	02/21/1996	Flash Flood	$0.00
Cussewago Township	04/23/1996	Flash Flood	$0.00
Conneautville Borough	04/23/1996	Flash Flood	$0.00
Crawford County (Entire County)	05/09/1996	Flash Flood	$30,000.00
Saegertown Borough	06/07/1996	Flash Flood	$15,000.00
Crawford County (Entire County)	06/07/1996	Flash Flood	$0.00
Crawford County – Northwest Area	06/18/1996	Flash Flood	$15,000.00
Crawford County – Northwest Area	06/19/1996	Flash Flood	$1,170,000.00
Crawford County (Entire County)	07/19/1996	Flash Flood	$1,500,000.00
Crawford County – Northern Area	08/08/1996	Flash Flood	$0.00
Crawford County (Entire County)	09/17/1996	Flash Flood	$75,000.00
Saegertown Borough	09/28/1996	Flash Flood	$10,000.00
Crawford County (Entire County)	09/28/1996	Flash Flood	$75,000.00
Crawford County (Entire County)	12/11/1996	Flash Flood	$0.00
Crawford County – Northwest Area	02/27/1997	Flash Flood	$75,000.00
Crawford County (Entire County)	06/02/1997	Flash Flood	$50,000.00
Crawford County (Entire County)	06/25/1997	Flash Flood	$50,000.00
City of Meadville	09/10/1997	Flash Flood	$0.00
Crawford County (Entire County)	01/07/1998	Flash Flood	$80,000.00
Crawford County (Entire County)	01/08/1998	Flash Flood	$30,000.00
Crawford County (Entire County)	01/09/1998	Flash Flood	$50,000.00

Past Flood and Flash Flood Events			
Event Location	**Event Date**	**Event Type**	**Property Damage Estimate**
Crawford County (Entire County)	01/09/1998	Flood	$50,000.00
City of Meadville	04/09/1998	Flash Flood	$0.00
Crawford County (Entire County)	01/23/1999	Flash Flood	$50,000.00
Crawford County – Central Area	06/10/1999	Flood	$0.00
City of Meadville	09/29/1999	Flash Flood	$10,000.00
Cambridge Springs Borough	05/31/2000	Flash Flood	$350,000.00
Cambridge Springs Borough	08/02/2000	Flash Flood	$0.00
Cochranton Borough	08/02/2000	Flash Flood	$100,000.00
Crawford County (Entire County)	08/02/2000	Flash Flood	$250,000.00
Conneaut Lake Borough	04/09/2001	Flash Flood	$150,000.00
Crawford County (Entire County)	04/09/2001	Flood	$0.00
Crawford County (Entire County)	04/15/2002		$250,000.00
Crawford County (Entire County)	06/12/2003	Flood	$500,000.00
Crawford County (Entire County)	07/21/2003	Flash Flood	$40,000,000.00
Crawford County (Entire County)	07/22/2003	Flash Flood	$250,000.00
Crawford County (Entire County)	07/23/2003	Flood	$100,000.00
City of Meadville	08/09/2003	Flash Flood	$300,000.00
Crawford County (Entire County)	08/10/2003	Flash Flood	$600,000.00
Crawford County (Entire County)	05/21/2004	Flash Flood	$4,100,000.00
Crawford County (Entire County)	05/22/2004	Flash Flood	$1,800,000.00
Crawford County (Entire County)	05/23/2004	Flash Flood	$500,000.00
Crawford County (Entire County)	07/12/2004	Flash Flood	$350,000.00
Crawford County (Entire County)	07/12/2004	Flood	$50,000.00
Crawford County – Eastern Area	07/18/2004	Flash Flood	$100,000.00
Crawford County (Entire County)	07/31/2004	Flood	$35,000.00
Crawford County (Entire County)	09/08/2004	Flash Flood	$11,500,000.00
Crawford County (Entire County)	09/08/2004	Flood	$250,000.00
Crawford County (Entire County)	09/09/2004	Flood	$2,000,000.00
Crawford County (Entire County)	09/17/2004	Flood	$300,000.00
Crawford County (Entire County)	01/01/2005	Flood	$400,000.00
Summit Township	05/31/2005	Flood	$100,000.00
Crawford County – Western Area	06/10/2005	Flash Flood	$50,000.00
City of Meadville	06/14/2005	Flash Flood	$75,000.00
City of Titusville	06/28/2005	Flash Flood	$50,000.00
Crawford County (Entire County)	07/16/2005	Flash Flood	$50,000.00

Past Flood and Flash Flood Events			
Event Location	**Event Date**	**Event Type**	**Property Damage Estimate**
Crawford County – Southern Area	07/22/2006	Flash Flood	$100,000.00
Crawford County – Southern Area	07/27/2006	Flash Flood	$250,000.00
Crawford County (Entire County)	07/28/2006	Flash Flood	$1,500,000.00
Crawford County – Southwestern Area	07/31/2006	Flash Flood	$750,000.00
Cambridge Springs Borough	07/08/2008	Flash Flood	$25,000.00
Spartansburg Borough	07/08/2008	Flash Flood	$25,000.00
Venango Township	08/10/2009	Flash Flood	$50,000.00
Beaver Township	05/14/2011	Flash Flood	$10,000.00
Cochranton Borough	06/18/2014	Flash Flood	$10,000.00
Oil Creek Township	06/25/2014	Flash Flood	$500,000.00
City of Meadville	01/12/2017	Flood	$30,000.00
West Fallowfield Township	05/28/2017	Flash Flood	$225,000.00
City of Meadville	01/12/2018	Flood	$1,300,000.00
South Shenango Township	06/01/2018	Flash Flood	$100,000.00
Hydetown Borough	07/19/2019	Flash Flood	$1,200,000.00
Cussewago Township	07/11/2021	Flash Flood	$120,000.00
City of Titusville	07/17/2021	Flash Flood	$200,000.00
Greenwood Township	02/17/2022	Flood	$0.00
		Total:	**$74.290,000.00**
Source: NCEI NOAA, 2024 *Property Damage Values are estimated and are not exact figures. Data from NCEI and WebEOC			

The National Flood Insurance Program (NFIP) identifies properties that frequently experience flooding. Repetitive loss properties are structures insured under the NFIP which have had at least two paid flood losses of more than $1,000 over any ten-year period since 1978. The hazard mitigation assistance (HMA) definition of a repetitive loss property is a structure covered by a contract for flood insurance made available under the NFIP that has incurred flood-related damage on two occasions, in which the cost of repair, on average, equaled or exceeded 25% of the market value of the structure at the time of each such flood event; and at the time of the second incidence of flood-related damage, the contract for flood insurance contains increased cost of compliance coverage. *Table 26 – Repetitive Loss Properties* illustrates the communities that have repetitive loss properties, the total building payments, the contents payments, and the number of losses and properties. There are twenty-six repetitive loss properties in Crawford County. *Table 27 – Summary of Type of Repetitive Loss Properties by Municipality* illustrates the breakdown of type of repetitive loss properties in Crawford County.

A property is considered a severe repetitive loss property either when there are at least four losses each exceeding $5,000 or when there are two or more losses where the building payments exceed the property value. *Table 28 – Severe Repetitive Loss Properties* illustrates the communities within Crawford County that have severe repetitive loss properties, the total building payments, the contents payments, and the number of losses and properties. The data used in the table is based on data provided by PEMA.

Most municipalities in Crawford County participate in the NFIP. Information of each participating municipality can be found in *Table 29 – Municipal NFIP Policies & Vulnerability*.

Table 26 - Repetitive Loss Properties

Repetitive Loss Properties						
Community Name	**Community Number**	**Cumulative Building Payment**	**Cumulative Contents Payment**	**Sum of Total Paid**	**Losses**	**Properties**
Cochranton Borough	420348	$13,028.78	$0.00	$13,028.78	2	1
Conneautville Borough	420349	$55,893.48	$52,977.36	$108,870.80	2	1
City of Meadville	420351	$14,490.95	$0.00	$14,490.95	2	1
City of Meadville	420351	$9,134.86	$310.26	$9,445.12	2	1
City of Titusville	420354	$6,788.52	$2,237.56	$9,026.08	2	1
City of Titusville	420354	$8,810.65	$0.00	$8,810.65	2	1
City of Titusville	420354	$15,000.00	$3,561.52	$18,561.52	2	1
City of Titusville	420354	$9,656.78	$0.00	$9,656.78	2	1
City of Titusville	420354	$22,926.68	$2,875.66	$25,802.34	3	1
City of Titusville	420354	$15,262.65	$0.00	$15,262.65	5	1
City of Titusville	420354	$24,235.37	$0.00	$24,235.37	3	1
City of Titusville	420354	$25,207.62	$0.00	$25,207.62	4	1
City of Titusville	420354	$14,298.54	$0.00	$14,298.54	2	1

Repetitive Loss Properties						
Community Name	**Community Number**	**Cumulative Building Payment**	**Cumulative Contents Payment**	**Sum of Total Paid**	**Losses**	**Properties**
City of Titusville	420354	$11,470.34	$0.00	$11,470.34	2	1
City of Titusville	420354	$10,077.96	$0.00	$10,077.96	2	1
City of Titusville	420354	$39,128.76	$4,764.24	$43,893.00	2	1
Oil Creek Township	421568	$15,928.29	$0.00	$15,928.29	3	1
Steuben Township	421571	$14,133.06	$0.00	$14,133.06	2	1
Steuben Township	421571	$31,931.93	$7,115.83	$39,047.76	4	1
Steuben Township	421571	$6,866.46	$0.00	$6,866.46	2	1
Troy Township	421572	$18,060.19	$0.00	$18,060.19	4	1
Venango Township	421574	$4,113.02	$0.00	$4,113.02	2	1
Vernon Township	421575	$9,623.48	$0.00	$9,623.48	2	1
Vernon Township	421575	$9,014.89	$0.00	$9,014.89	3	1
Woodcock Township	421578	$5,352.82	$0.00	$5,352.82	3	1
Summit Township	422400	$8,402.00	$0.00	$8,402.00	2	1
Total:		**$418,838.08**	**$73,842.43**	**$492,680.47**	**66**	**26**
Source: FEMA, 2024						

Table 27 - Summary of Type of Repetitive Loss Properties by Municipality

Summary of Type of Repetitive Loss Properties by Municipality					
Municipality	**Type**				
	Non-Residential	**2-4 Family**	**Single Family**	**Condo**	**Other Residential**
Cochranton Borough	0	0	1	0	0
Conneautville Borough	1	0	0	0	0

Summary of Type of Repetitive Loss Properties by Municipality					
Municipality	Type				
	Non-Residential	2-4 Family	Single Family	Condo	Other Residential
City of Meadville	0	1	1	0	0
Oil Creek Township	0	0	1	0	0
Steuben Township	0	0	3	0	0
Summit Township	0	0	1	0	0
City of Titusville	3	1	10	0	0
Troy Township	0	0	1	0	0
Venango Township	0	0	1	0	0
Vernon Township	0	0	2	0	0
Woodcock Township	0	0	1	0	0
Source: FEMA, 2024					

Table 28 - Severe Repetitive Loss Properties

Severe Repetitive Loss Properties						
Community Name	Community Number	Cumulative Building Payments	Cumulative Contents Payments	Sum of Total Paid	Losses	Properties
City of Titusville	420354	$41,828.00	$432.56	$42,260.56	5	1
City of Titusville	420354	$34,997.95	$0.00	$34,997.95	5	1
	Total:	**$76,826.95**	**$433.56**	**$77,258.51**	**10**	**2**
Source: FEMA, 2024						

Table 29 - Municipal NFIP Policies & Vulnerability

Municipal Participation in the National Flood Insurance Program			
Municipal Name	Community Number	Initial FHBM	Latest Mapping Dates
Athens Township	421562	10/25/1974	08/16/2012
Beaver Township	422385	02/28/1975	08/16/2012
Bloomfield Township	421563	01/31/1975	08/16/2012
Blooming Valley Borough	421559	01/31/1975	08/16/2012
Cambridge Township	421564	09/06/1974	08/16/2012

Municipal Participation in the National Flood Insurance Program			
Municipal Name	**Community Number**	**Initial FHBM**	**Latest Mapping Dates**
Cambridge Springs Borough	420346	08/02/1974	08/16/2012
Centerville Borough	420347	03/28/1975	08/16/2012
Cochranton Borough	420348	08/27/1976	08/16/2012
Conneaut Township	422387	01/10/1975	08/16/2012
Conneaut Lake Borough	422386	01/17/1975	08/16/2012
Conneautville Borough	420349	08/02/1974	08/16/2012
Cussewago Township	422388	01/10/1975	08/16/2012
East Fairfield Township	421565	05/31/1974	08/16/2012
East Fallowfield Township	422389	01/10/1975	08/16/2012
East Mead Township	421566	10/18/1974	08/16/2012
Fairfield Township	421567	05/31/1974	08/16/2012
Greenwood Township	422390	01/17/1975	08/16/2012
Hayfield Township	421227	08/30/1974	08/16/2012
Hydetown Borough	420350	08/02/1974	08/16/2012
Linesville Borough	421560	01/10/1975	08/16/2012
Meadville, City of	420351	10/12/1973	08/16/2012
North Shenango Township	423636	09/05/1980	08/16/2012
Oil Creek Township	421568	10/22/1976	08/16/2012
Pine Township	422392	04/11/1975	08/16/2012
Randolph Township	422393	01/10/1975	08/16/2012
Richmond Township	421569	10/25/1974	08/16/2012
Rockdale Township	422394	01/10/1975	08/16/2012
Rome Township	422395	09/20/1974	08/16/2012
Sadsbury Township	422396	01/24/1975	08/16/2012
Saegertown Borough	420352	06/21/1974	08/16/2012
South Shenango Township	422397	01/03/1975	08/16/2012
Sparta Township	422398	01/17/1975	08/16/2012
Spartansburg Borough	421561	01/03/1975	08/16/2012
Spring Township	421570	05/31/1974	08/16/2012
Springboro Borough	420353	06/21/1974	08/16/2012
Steuben Township	421571	12/13/1974	08/16/2012
Summerhill Township	422399	01/31/1975	08/16/2012
Summit Township	422400	01/10/1975	08/16/2012
Titusville, City of	420354	05/31/1974	08/16/2012
Townville Borough	422401	01/24/1975	08/16/2012

Municipal Participation in the National Flood Insurance Program			
Municipal Name	**Community Number**	**Initial FHBM**	**Latest Mapping Dates**
Troy Township	421572	11/01/1974	08/16/2012
Union Township	421573	08/30/1974	08/16/2012
Venango Borough	420355	08/30/1974	08/16/2012
Venango Township	421574	05/31/1974	08/16/2012
Vernon Township	421575	10/18/1974	08/16/2012
Wayne Township	421576	05/31/1974	08/16/2012
West Fallowfield Township	422651	04/21/1978	08/16/2012
West Mead Township	420356	08/31/1973	08/16/2012
West Shenango Township	422402	01/17/1975	08/16/2012
Woodcock Borough	422403	01/17/1975	08/16/2012
Woodcock Township	421578	11/15/1974	08/16/2012
Source: FEMA, 2024 Note: FHBM: Flood Hazard Boundary Map			

4.3.5.4 Future Occurrence

Flooding is a frequent problem throughout the Commonwealth of Pennsylvania. Crawford County will certainly be impacted by flooding events in the future, as Crawford County experiences some degree of flooding annually. The threat of flooding is compounded in the late winter and early spring months, as melting snow can overflow streams, creeks, and tributaries, increasing the amount of groundwater, clogging stormwater culverts and bridge openings. The NFIP recognizes the 1% annual chance flood, also known as the base flood of a one-hundred-year flood, as the standard for identifying properties subject to federal flood insurance purchase requirements. A 1% annual chance flood is a flood which has a 1% chance of occurring in a given year or is likely once every one-hundred years. The digital flood insurance maps (DFIRMs) are used to identify areas subject to the 1% annual chance of flooding.

A property's vulnerability to a flood is dependent upon its location in the floodplain. Properties along the banks of a waterway are the most vulnerable. The property within the floodplain is broken into sections depending on its distance from the waterway. The ten-year flood zone has a 10% chance of being flooded every year. However, this label does not mean that this area cannot flood more than once every ten years. This label simply designates the probability of a flood of this magnitude every year. Further away from this area is the fifty-year floodplain. This area includes all of the ten-year floodplain plus additional property. The probability of a flood of this magnitude occurring during a one-year period is 2%. A summary of flood probability is shown in *Table 30 – Flood Probability Summary*.

Table 30 - Flood Probability Summary

Flood Probability Summary	
Flood Recurrence Intervals	**Annual Chance of Occurrence**
10-year	10.00%
50-year	2.00%
100-year	1.00%
500-year	0.20%
Source: FEMA, 2009	

The future occurrences of flooding, flash flooding, and ice jam flooding in Crawford County are expected to increase due to the rate of climate change in the Commonwealth of Pennsylvania, and the world. Climate change will include ocean temperature rise, which can result in more intense hurricane and tropical storm seasons in the Atlantic Ocean. This intensity could result in an increase in the number of hurricanes and tropical storms that could impact Pennsylvania and Crawford County. These hurricanes and tropical storms could result in a large volume of precipitation occurring over a short period of time, resulting in a flood or flash flood event. It is important to note that these impacts are the secondary result of other hazards, increased by climate change, that could result in flooding events.

4.3.5.5 Vulnerability Assessment

Riverine and Stream Flooding

Crawford County is vulnerable to stream and river flooding on an annual basis. Flooding puts the entire population at some level of risk, whether through flooding of homes, businesses, places of employment, roadways, sewers, and water infrastructure. Flooding can cause significant power outages and poor road conditions that can lead to heightened transportation accident risk.

County community lifelines are the most vulnerable buildings and services when riverine and stream flooding is considered. Community lifeline facilities are facilities that, if damaged, would present an immediate threat to life, public health, and safety. Facilities that use and store hazardous materials pose a potential threat to the environment during flooding events if flooding causes a leak, inundation, or equipment failure. Appendix D of this hazard mitigation plan includes a flooding vulnerability map for each municipality in Crawford County, with vulnerable structures and community lifeline facilities that are located within the special flood hazard area.

Table 31 – Expected Damage to Essential Facilities (HAZUS) illustrates the estimated damage levels to certain essential facilities based on classifications in the HAZUS General Building Stock. There are no facilities that are estimated to be at least moderately damaged by a 100-year flooding event in the HAZUS Level Two scenario that was completed for Crawford County. Plans for such an event, and the damage that would result to essential facilities, must be put in place to successfully mitigate the potential disruption to community lifeline facilities.

Table 31 - Expected Damage to Essential Facilities (HAZUS)

Expected Damage to Essential Facilities				
Classification	Number of Facilities			
	Total:	At Least Moderate:	At Least Substantial:	Loss of Use:
Emergency Operations Center	1	0	0	0
Fire Stations	31	0	0	0
Hospitals	3	0	0	0
Police Stations	12	0	0	0
Schools	72	0	0	0

Table 32 - County Structures Within Special Flood Hazard Area shows the number of site structure address points within the Special Flood Hazard Area as well as the community lifeline facilities. This information was compiled using the Special Flood Hazard Area and GIS data provided by the Crawford County GIS Department.

Table 32 - County Structures Within Special Flood Hazard Area

County Structures Within Special Flood Hazard Area		
Municipality	Site Structure Address Points Within Flood Area	Community Lifelines within Flood Area
Athens Township	6	0
Beaver Township	6	0
Bloomfield Township	388	0
Blooming Valley Borough	0	0
Cambridge Township	60	0
Cambridge Springs Borough	36	0
Centerville Borough	9	0
Cochranton Borough	100	0
Conneaut Township	2	0
Conneaut Lake Borough	3	0

County Structures Within Special Flood Hazard Area		
Municipality	**Site Structure Address Points Within Flood Area**	**Community Lifelines within Flood Area**
Conneautville Borough	19	0
Cussweago Township	3	0
East Fairfield Township	52	0
East Fallowfield Township	2	0
East Mead Township	4	0
Fairfield Township	157	0
Greenwood Township	5	0
Hayfield Township	44	0
Hydetown Borough	40	0
Linesville Borough	8	0
Meadville, City of	532	2
North Shenango Township	6	0
Oil Creek Township	44	0
Pine Township	7	0
Randolph Township	0	0
Richmond Township	0	0
Rockdale Township	9	0
Rome Township	0	0
Sadsbury Township	144	0
Saegertown Borough	65	1
South Shenango Township	68	0
Sparta Township	3	0
Spartansburg Borough	1	0
Spring Township	7	0
Springboro Borough	11	0
Steuben Township	27	0
Summerhill Township	4	0
Summit Township	165	0
Titusville, City of	321	1
Townville Borough	1	1
Troy Township	27	0
Union Township	7	0
Venango Borough	14	0
Venango Township	48	0
Vernon Township	186	0
Wayne Township	48	0
West Fallowfield Township	2	0

County Structures Within Special Flood Hazard Area		
Municipality	**Site Structure Address Points Within Flood Area**	**Community Lifelines within Flood Area**
West Mead Township	18	0
West Shenango Township	7	0
Woodcock Borough	0	0
Woodcock Township	76	0
Totals:	**2,792**	**5**

Table 33 – Community Lifeline Facilities Additional Information illustrates the additional information including name, the municipality, and the type of facility for each community lifeline facility that falls within the Special Flood Hazard Area for Crawford County. This information was compiled using Crawford County's GIS information with the assistance of the Crawford County GIS Department.

Table 33 - Community Lifeline Facilities Additional Information

Community Lifeline Facilities Additional Information		
Type of Facility:	**Facility Name:**	**Municipality:**
Community Lifelines		
Grocery Store	Dollar Tree	Meadville
Electric Substation	Electric 172965	
Electric Substation	Electric 123525	Titusville
Grocery Store	H&H Market Place	Saegertown
Fire Department	Townville VFD	Townsville

In addition to the items listed above, there are ten building properties that are considered historic and cultural for Crawford County that are registered with the National Register of Historic Place that are in the Special Flood Hazard Area. These properties are the Baldwin-Reynolds House, Bently Hall, the Independent Congregational Church, the Amos Kelly House, the Dr. J. R. Mosier Office, the Roueche House, Ruter Hall, the Edward Saeger House, the Judge Henry Shippen House, and the Titusville City Hall. These locations are at an increased risk of flooding due to annual flood events unless mitigated.

Flash Flooding

Flash flooding is a common occurrence in Crawford County and can occur anywhere in the county. A large portion of flash flooding occurs in populated areas that have increased impervious ground cover. During the risk assessment process, numerous resources were utilized to determine flash flooding locations in Crawford County. Municipalities were asked to identify locations within the municipality that were prone to frequent flash flooding. The National Climatic Data Center was also queried to determine flash flood vulnerable areas. This data reflected in *Table 25 – Past Flood and Flash Flood Events* above.

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

- City of Meadville
- City of Titusville
- Cochranton Borough
- Cambridge Springs Borough

Although the above locations were identified as vulnerable areas in Crawford County, they are not the only locations that are vulnerable to flash flooding. The Crawford County Hazard Mitigation Team will continue to work with municipalities to identify vulnerable flash flooding locations and identify vulnerable populations and community lifelines.

Municipalities with an increased risk to flooding, flash flooding, and ice jam flooding (due to the intersection with the Special Flood Hazard Area):

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Township
- Cambridge Springs Borough
- Centerville Borough
- Cochranton Borough
- Conneaut Township
- Conneaut Lake Borough
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Linesville Borough
- Meadville, City of
- North Shenango Township
- Oil Creek Township
- Pine Township
- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township

- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Townville Borough
- Troy Township
- Union Township
- Venango Borough
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township
- West Shenango Township
- Woodcock Borough
- Woodcock Township

All of the populations of Crawford County, including the unserved and the underserved populations, are at an increased vulnerability to flooding hazards. All municipalities in Crawford County directly interface with the regulatory flood boundaries in county. Unserved and underserved populations have the potential to be more vulnerable to flooding hazards in Crawford County. Homeless, unsheltered, and displaced persons would not have housing or homes to use as a shelter in the event of a flooding hazard. Those populations also may not have easy access to warning systems or alerts for flash flooding hazards. All of the county could be at increased vulnerability, specifically any populations located on Cussewago Creek and/or French Creek.

Systems in Crawford County are at increased vulnerability to flooding hazards. All of the utilities in Crawford County could be adversely impacted by very specific flooding and flash flooding events. Utilities may be damaged or destroyed from a flooding event, or from a cascading hazard from flooding events. Major flooding could cause an issue in the delivery of services, including electricity, to the citizens and residents of Crawford County.

While flooding does not typically adversely affect natural areas, a comprehensive vulnerability assessment was completed for natural areas in Crawford County, including public recreation areas, state parks, state game lands, and any other outdoor or natural area resources.

The following natural areas directly intersected with areas of the Special Flood Hazard Area (SFHA) for Crawford County:

- Cambridge Springs Access – Public Recreation – Cambridge Township
- Canadohta Lake Access – Public Recreation – Bloomfield Township
- Conneaut Creek Fishing Easement – Public Recreation – Spring Township
- Conneaut Lake Access – Public Recreation – Summit Township

- Cussweago Creek Access – Public Recreation – Vernon Township
- Drake Well Museum and Park – City of Titusville
- Nicholls Property – Public Recreation – Spring Township
- Nicholls Property #2 – Public Recreation – Spring Township
- Pymatuning State Park – Conneaut Township, Linesville Borough, North Shenango Township, Pine Township, South Shenango Township, West Shenango Township
- Saegertown Access – Public Recreation – Saegertown Borough, Woodcock Township
- Shaw's Landing – Public Recreation – Fairfield Township, Union Township
- State game land 69 – Randolph Township, Richmond Township, Troy Township
- State game land 85 – Rockdale Township
- State game land 101 – Beaver Township
- State game land 122 – Athens Township, Steuben Township, Troy Township
- State game land 146 – Richmond Township
- State game land 152 – Cussewago Township
- State game land 200 – Richmond Township
- State game land 202 – Bloomfield Township
- State game land 213 – Fairfield Township, Greenwood Township, Sadsbury Township, Union Townshp, Vernon Township
- State game land 214 – East Fallowfield Township, North Shenango Township, Pine Township, Sadsbury Township, West Fallowfield Township
- State game land 269 – Cussewago Township
- State game land 277 – Cambridge Township, Rockdale Township
- Sugar Lake Access – Public Recreation – Wayne Township
- Tamarack Lake – Public Recreation – East Fallowfield Township, East Mead Township, West Mead Township
- Western Game Farm – Rockdale Township

Not all of these locations will be impacted by every flooding event in Crawford County, but at least some of the areas listed above will be impacted due to their close proximity to the Special Flood Hazard Area (SFHA).

Impacts of flooding, flash flooding, and ice jam flooding can also be influenced by population change. As seen in *Table 3 – Population Change in Crawford County*, four municipalities have experienced population growth between the 2010 decennial census and the 2020 decennial census. Based on this information, it can be speculated that these four municipalities have an increased vulnerability to flooding, flash flooding, and ice jam flooding hazards, since 2010. This increased vulnerability is due to more potential development and that development encroaching on high vulnerability areas for Crawford County, including near the Special Flood Hazard Area.

Land use is a factor that has the potential to impact the vulnerability to flooding, flash flooding, and ice jam flooding in Crawford County. Land use, in the form of a built environment, such as residential and commercial expansion, especially in the Special Flood Hazard Area or areas directly adjacent, could increase the severity impact of these hazards. The change of land use from areas of easy infiltration of groundwater to impervious surfaces can increase the severity and the frequency of flash floods, increasingly in areas where flash floods have occurred in the past. An influx of people, commercial enterprises, and infrastructure development also increases the vulnerability of areas to flooding, flash flooding, and ice jam flooding.

4.3.6. Hurricane and Tropical Storm

4.3.6.1 Location and Extent

Crawford County does not have an open-ocean coastline area. However, the impacts from coastal storms such as tropical storms and hurricanes can expand inland. Tropical depressions are cyclones with maximum sustained winds of less than 39 miles per hour (mph). The system becomes a tropical storm when the maximum sustained winds reach between 39 and 74 miles per hour. When wind speeds exceed 74 mph, the system is considered a hurricane. Tropical storms impacting Crawford County develop in tropical or sub-tropical waters found in the Atlantic Ocean, Caribbean Sea, or Gulf of Mexico. Another type of tropical storms is the nor'easter, which is a large cyclone that rotates clockwise and is typically associated with the Atlantic Ocean and the East Coast of the United States between North Carolina and Massachusetts. The name nor'easter comes from the direction that the strongest winds typically blow from the cyclone.

While Crawford County is located about 336.12 miles inland of the East Coast of the United States, tropical storms can track inland and cause heavy rainfall and strong winds. Crawford County is located inland of the East Coast region, designated by FEMA, as being Hurricane-Susceptible (see *Figure 23 – Pennsylvania Wind Zones*). Crawford County falls within wind zone four as shown in *Figure 23 – Pennsylvania Wind Zones*. Zone IV suggests that shelters and critical facilities should be able to withstand winds that range up to 250 MPH. Tropical storms and hurricanes are regional and seasonal events that can impact very large areas that are hundreds to thousands of miles across over the life of the storm. Hurricane and tropical storm seasons are typically from June to November. All communities within Crawford County are equally subject to the impacts of hurricanes and tropical storms that track near the county. Areas in Crawford County which are subject to flooding, wind, and winter storm damage are particularly vulnerable.

4.3.6.2 Range of Magnitude

The impact tropical storms or hurricane events have on an area is typically measured in terms of wind speed. Flood damage results from intense precipitation and wind, typically from coastal storms, which impact L. Expected damage from hurricane force winds is measured using the Saffir-Simpson Scale (*Table 34 - Saffir-Simpson Scale*). The Saffir-Simpson Scale categorizes hurricane intensity linearly based upon maximum sustained winds, barometric pressure, and storm surge potential. Categories three, four, and five are classified as "major" hurricanes, but category one and two storms can contain potential significant storm surge. Category one storms result in very dangerous winds with some damage, while category two storms result in extremely dangerous winds with extensive damage. Category three storms result in devastating damage and category four/five storms result in catastrophic damage. Although major hurricanes comprise only 20% of all tropical cyclones making landfall, they account for over 70% of the damage in the United States. While hurricanes can cause high winds and associated impacts, it is also important to recognize the potential for flooding events during hurricanes, tropical storms, and nor'easters. In Crawford County wind impacts from tropical events include downed trees and utility poles to cause utility interruptions. Mobile homes, because they may not be well-anchored, have a greater potential to be impacted by high winds. Additionally, these storms can produce high volumes of rainfall that cause flash flooding which can be followed by stream and riverine flooding. The risk assessment and associated impact for flooding events is included in Section 4.3.3.5.

Table 34 - Saffir-Simpson Scale

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

4.3.6.3 Past Occurrence

Table 35 – History of Coastal Storms Impacting Crawford County lists all coastal storms that have impacted Crawford County from 1972 to 2023. *Figure 21 – Historic Tropical Storms/Hurricanes in Pennsylvania* identifies some past hurricanes that had an inland path through Pennsylvania. Hurricane Agnes was a severe coastal storm event in June of 1972 that significantly impacted large portions of the commonwealth but did not impact Crawford County directly.

Hurricane Irene and Tropical Storm Lee impacted and caused damage to Crawford County. Although they were separate events, Hurricane Irene and Tropical Storm Lee together caused significant rainfall in Crawford County due to how close the events took place. First, Tropical Storm Lee caused significant flooding in the central and eastern counties in Pennsylvania with wind damage that caused utility outages for 1-2 days. Then, Hurricane Irene caused additional flooding with utility interruptions for 5-8 days. Many flooding events took place in the county during this time.

Hurricane Sandy was another coastal storm event that caused significant damage to Crawford County. Sandy caused significant wind damage and utility interruptions for multiple days in Crawford County. Hurricane Sandy ranks among the most damaging coastal storms to ever impact Crawford County. In Crawford County, more than half of the people, or more than fifty percent of the county's population, were without power for an extended period. Crawford County had assessed 44,439 structures, including mobile and single-family homes/businesses, for property damage. The estimated storm-recovery costs total is between 7,134,043 which includes all labor, housing, materials/equipment, and feeding expanded 24/7 staffing for longer than a week.

Table 35 - History of Coastal Storms Impacting Crawford County

History of Coastal Storms Impacting Crawford County	
Year	**Name**
1955	Hurricane Connie
1959	Hurricane Gracie
1968	Hurricane Candy
1972	Tropical Storm Agnes
1989	Hurricane Hugo
1995	Hurricane Opal
1999	Hurricane Floyd
2003	Tropical Strom Henri
2004	Tropical Strom Isabel
2004	Tropical Depression Frances
2005	Tropical Depression Ivan
2006	Hurricane Katrina
2008	Tropical Depression Ernesto
2011	Hurricane Ike
2011	Tropical Strom Lee

History of Coastal Storms Impacting Crawford County	
Year	**Name**
2012	Hurricane Sandy
2017	Tropical Strom Cindy
Source: NOAA, 2024	

Figure 21 - Historic Tropical Storms/Hurricanes in Pennsylvania

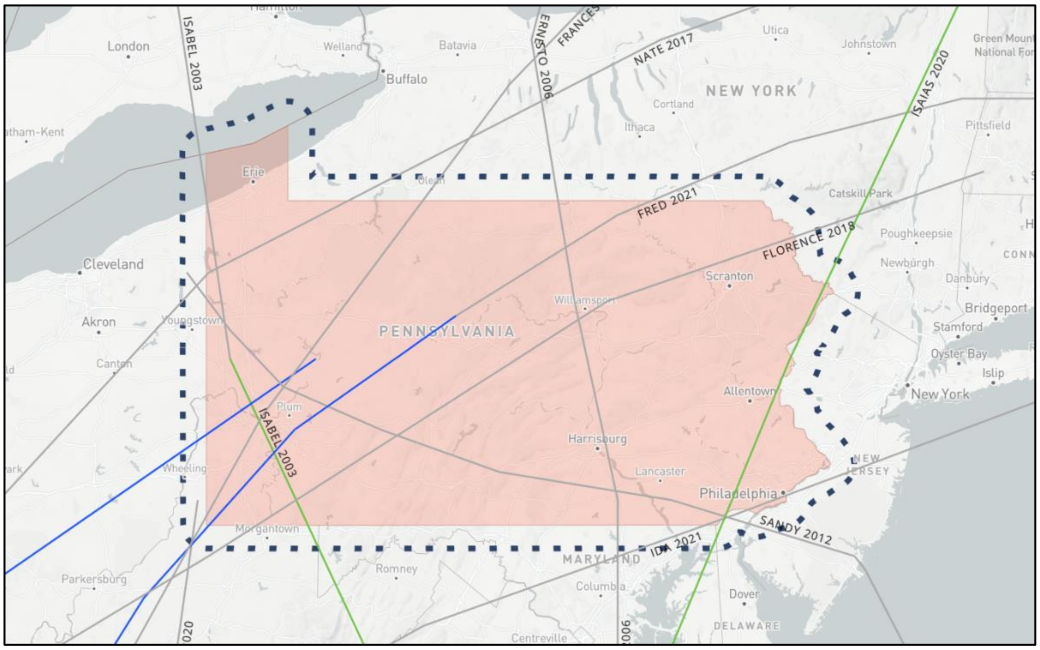
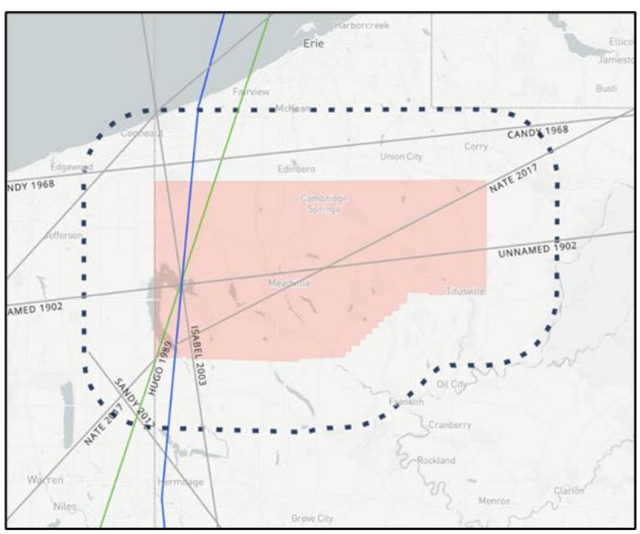


Figure 22 - Historic Tropical Storms/Hurricanes in Crawford County



4.3.6.4 Future Occurrence

Although hurricanes and tropical storms can cause flood events consistent with 100 and 500-year flood levels, the probability of occurrence of hurricanes and tropical storms is measured relative to wind speed. *Table 36 – Annual Probability of Wind Speeds* shows the annual probability of winds that reach the strength of tropical storms and hurricanes in Crawford County and the surrounding areas based on a sample period of forty-six years. According to FEMA, there is a low probability each year that Crawford County will experience winds from coastal storms that could cause minimal to moderate damages (*Table 36 – Annual Probability of Wind Speeds*). The potential future impacts from a tropical storm or hurricane will be approximately 91.59%. The probability of winds exceeding 118 mph is less than one percent annually.

Table 36 - Annual Probability of Wind Speeds

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

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

Climate change is causing atmospheric temperatures to rise, which corresponds to a rise in ocean surface temperatures, resulting in warmer and moister conditions where tropical storms develop. However, the relationship between climate change and hurricanes can be complex due to the many other factors that are associated with hurricane development which include wind shear and air pollution. Warmer oceans store more energy and are capable of fueling stronger storms and it is projected that Atlantic hurricanes will become more intense and produce more precipitation as ocean surface temperatures rise. The storms associated with tropical storms/hurricanes can also linger around for a longer period of time in a given place due to the climate change which enhances destructive impacts in the future. Other possible connections of hurricanes in the near future related to climate change are the length of hurricane season and seeing more hurricanes earlier or later than usual hurricane season. There are expected to be more category four and five hurricanes in the Atlantic and the hurricane season may be elongated, all which impact the future of Crawford County.

4.3.6.5 Vulnerability Assessment

The impacts of climate change are tangible and hazardous realities. Tropical storms tracking nearby Crawford County can not only cause high winds, but also heavy rains to occur. A vulnerability assessment for hurricanes and tropical storms focusses on the impacts of flooding and severe winds. Flooding associated with hurricanes/tropical storms can occur in areas throughout Crawford County which can cause damage to buildings and infrastructure. The assessment for flood-related vulnerability is addressed in Section 4.3.3 and a discussion of wind related vulnerability is addressed in Section 4.3.10. Due to the impact of hurricanes and tropical storms, the vulnerability for Crawford County is moderate. Potential economic losses could include direct building loss and business interruption. Direct building loss is direct damage to any building or structure. Business interruption includes relocation, employee wage loss, expenses, income loss, etc. Crawford County vulnerability level is moderate for direct building loss. The total direct building loss amount for Crawford County equates to $145.80 million dollars. The total business interruption value for Crawford County equates to $190.25 million dollars. Therefore, the vulnerability of direct building loss and business interruption is moderate.

As seen in *Table 3 – Population Change in Crawford County,* forty-six of the fifty-one in Crawford County have experienced a population loss since the 2010 decennial census. Four municipalities have seen a net population increase from the 2010 decennial census to the 2020 decennial census. Based on this information, it can be speculated that these four municipalities may have an increased vulnerability of hurricane and tropical storm conditions, since 2010, due to the increase in population.

Hurricanes and tropical storms may disproportionately affect underserved, unserved, and socially vulnerable populations, amplifying existing hardships. Fragile infrastructure in these areas is more prone to damage, which can hinder evacuation and rescue efforts. Limited access to resources exacerbates challenges during and after the storms, from securing safe shelter to obtaining essential supplies. Vulnerable communities often lack financial resilience, facing prolonged economic setbacks as local businesses may suffer.

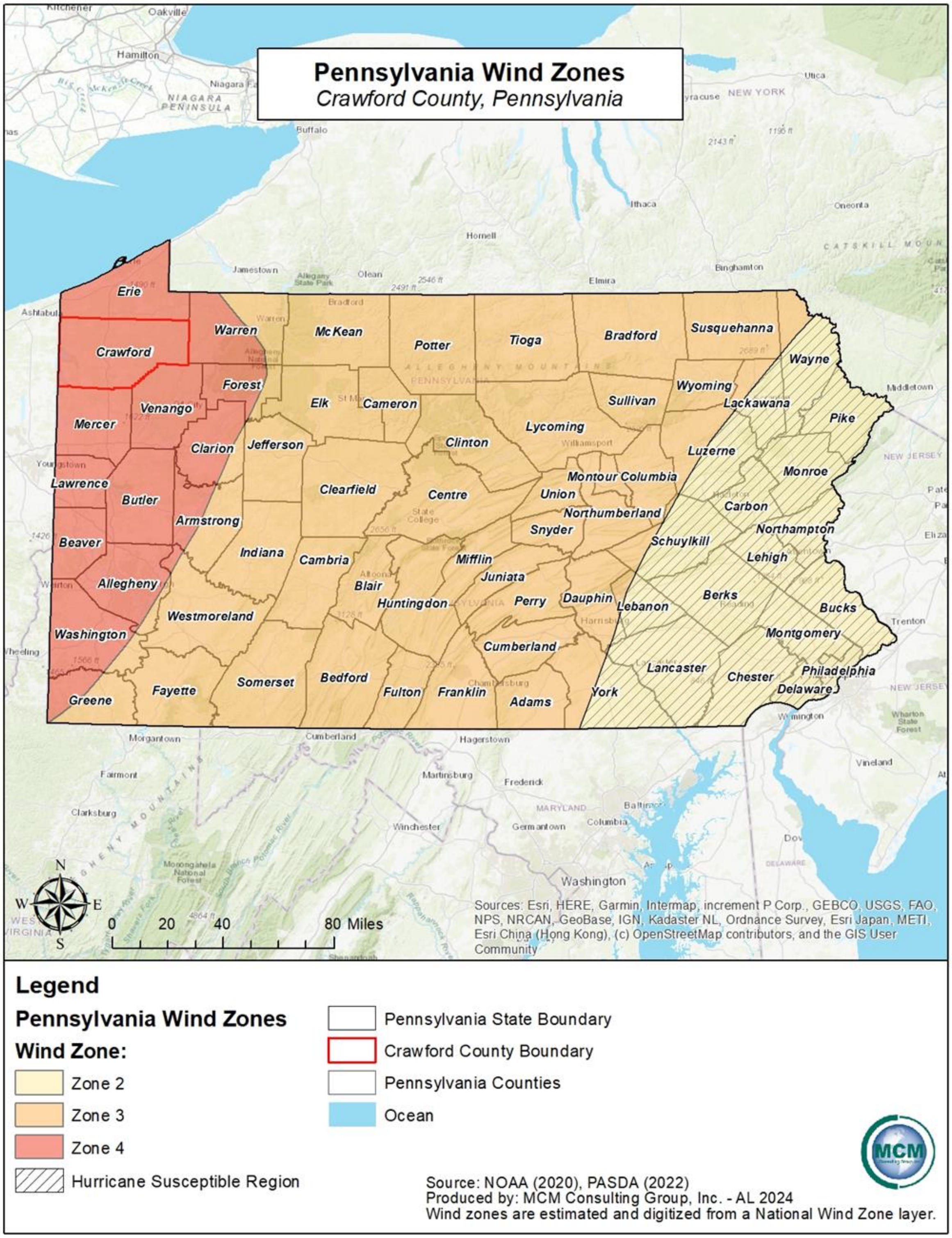
Municipalities with increased risk to hurricane and tropical storm (based on previous GIS tracks):

- Athens Township
- Beaver Township
- Blooming Valley Borough
- Centerville Borough
- Conneaut Township
- Linesville Borough
- Meadville, City of
- North Shenango
- Pine Township
- Rome Township
- South Shenango Township
- Sparta Township
- Steuben Township

Land use is a factor that has the potential to impact hurricane and tropical storm severity. Land use, in the form of a built environment, such as residential expansion, can cause hurricane impact severity to increase. This impact severity increases because as the built environment expands and becomes more complex, the impact the event will have on that area also increases. This is due to an influx of people, infrastructure, and critical infrastructure and community lifelines in harm's way.

Hurricanes and tropical storms exert profound impacts on both natural and cultural areas. Ecologically, these intense weather events can result in habitat destruction, altering landscapes, and threatening biodiversity. Erosion and flooding may harm delicate ecosystems. Culturally, these storms endanger heritage sites, historic structures, and artifacts, eroding tangible, and intangible cultural elements. Sustainable recovery efforts must embrace an integrated approach, recognizing the interconnected vulnerability of natural and cultural landscapes to the formidable forces of hurricanes and tropical storms.

Figure 23 - Pennsylvania Wind Zones



4.3.7. Invasive Species

4.3.7.1 Location and Extent

An invasive species is a species that is not indigenous to a given ecosystem and that, when introduced to a non-native environment, tends to thrive. The spread of an invasive species often alters ecosystems, which can cause environmental and economic harm and pose a threat to human health. Often, an invasive species spreads and reproduces quickly. Invasive species are not limited to organisms that come from a foreign country. Invasive species can come from a different region in the United States. The main instigator of invasive species is human activity. Either intentionally or unintentionally, other species may accompany people when they travel, introducing the stowaway species to a novel ecosystem. In a foreign ecosystem, a transported species may thrive, potentially restructuring the ecosystem and threatening its health. Common pathways for invasive species introduction to Pennsylvania include but are not limited to:

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

The Governor's Invasive Species Council of Pennsylvania (PISC), the lead organization for invasive species threats, recognizes two types of invasive species: Aquatic and Terrestrial.

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

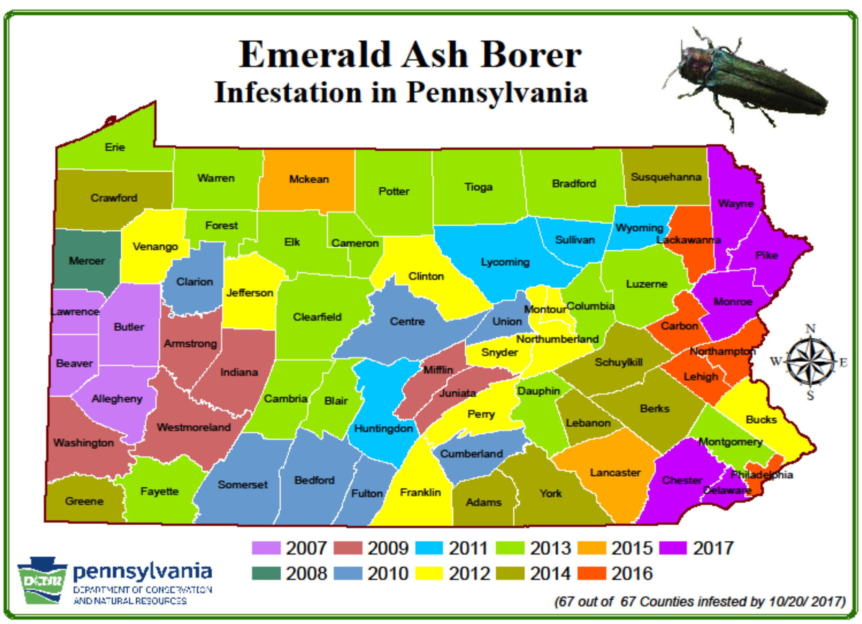
Terrestrial Invasive Species (TIS) are nonnative plants, vertebrates, arthropods, or pathogens that complete their lifecycle on land instead of in an aquatic environment and whose introduction does or is likely to cause economic/environmental damage or harm to human health.

The location and extent of invasive threats is dependent on the preferred habitat of the species, as well as the species' ease of movement and establishment. For example, kudzu vine is an aggressive vascular plant. With wide ecological parameters and ease of spread, the vine is a more widespread invasive species threat. Other species' spread, such as the spotted lantern fly, has been limited by state agency activity. First discovered in Berks County in 2014, the spotted lantern fly was placed under a quarantine by the Pennsylvania Department of Agriculture in thirteen counties. *Table 37 - Prevalent Invasive Species* lists invasive species that have been found in Crawford County.

4.3.7.2 Range of Magnitude

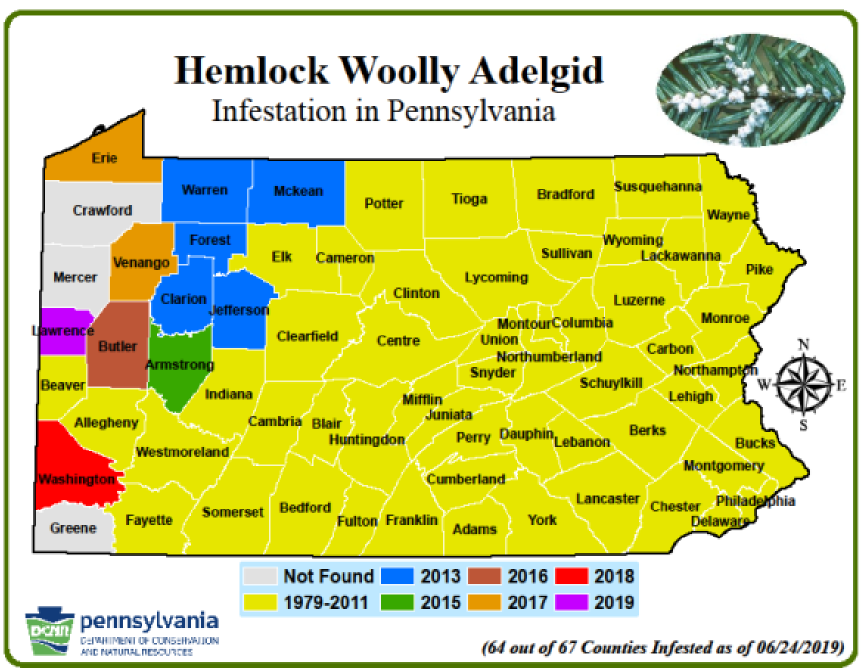
The magnitude of invasive species threats ranges from nuisance to widespread killer. Some invasive species are not considered agricultural pests, and do not harm humans or cause significant ecological problems. For example, Brown Marmorated Stink Bugs are not considered to be an agricultural pest and do not harm humans. Other invasive species can have many negative impacts and cause significant changes in the composition of ecosystems. For example, the Emerald Ash Borer creates a 99% mortality rate in any ash tree it infects. The aggressive nature of many invasive species can cause significant reductions in biodiversity by crowding out native species. This can affect the health of individual host organisms as well as the overall well-being of the affected ecosystem. An example of a worst-case scenario for invasive species in Pennsylvania is the Emerald Ash Borer in Crawford County and the surrounding region (see *Figure 24 - Emerald Ash Borer Infestation in Pennsylvania*).

Figure 24 - Emerald Ash Borer Infestation in Pennsylvania



Another example of an invasive pest is the hemlock woolly adelgid. Hemlock woolly adelgid is a fluid-feeding insect that feeds on hemlock trees throughout eastern North America, including Pennsylvania. The egg sacs of these insects look like the tips of cotton swabs clinging to the undersides of hemlock branches. Hemlock woolly adelgid was introduced from Asia into the Pacific Northwest in 1924. It is likely to have been introduced into the northeastern United States in the 1950s, and it was first discovered in Pennsylvania in 1967. To date, sixty-four counties in Pennsylvania, not including Crawford County, have been infested with this insect. See *Figure 25 - Hemlock Woolly Adelgid Infestation in Pennsylvania*. Currently, Crawford, Mercer, and Greene counties are the three counties in the commonwealth not reporting an infestation. Eastern hemlock (Pennsylvania's state tree) and Carolina hemlocks (found further south in the Smoky Mountain sections of the Appalachians) are more susceptible to hemlock woolly adelgid damage than Asian and western hemlock trees due to feeding tolerance and predators that protect the latter species. Hemlock woolly adelgid sucks fluid from the base of hemlock needles. It may also inject toxins into the tree as it feeds, accelerating needle drop and branch dieback. Although some trees die within four years, trees often persist in a weakened state for many years. Hemlocks that have been affected by hemlock woolly adelgid often have a grayish-green appearance (hemlocks naturally have a shiny, dark green color).

Figure 25 - Hemlock Woolly Adelgid Infestation in Pennsylvania



A final example of an invasive species is the Spotted Lanternfly. The Spotted Lanternfly is a harmful invasive species which feeds on plants, damaging or destroying them. This can negatively impact the areas of Pennsylvania known for outdoor scenery and activities. According to the Penn State Extension, the Spotted Lanternfly is a significant threat to Pennsylvania agriculture, landscapes, and natural ecosystems, including grape, tree-fruit, hardwood, and nursery industries, which collectively are worth nearly $18 billion to the state's economy, outdoor recreation, and biodiversity. The Spotted Lanternfly was not found in Crawford County in 2023. However, the Spotted Lanternfly is undoubtedly continuing to spread. The State Department of Agriculture gives the total number of infected counties as fifty-one, as of 2023. *Figure 26 – Pennsylvania Spotted Lanternfly Infestation* illustrates the counties in Pennsylvania that are considered to be in the quarantine zone for this pest.

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 succumb to an infestation more easily. A worst-case example could be the Hemlock Woolly Adelgid causing reduced biodiversity, increased wildfire potential, and thermal harm to small stream cold water fisheries and habitats.

4.3.7.3 Past Occurrence

Invasive species have been entering Pennsylvania since the arrival of European settlers, but not all occurrences require government action. Crawford County is known for its great number of geographic features. There are various state game lands within the area which include state game land 214. Pymatuning state park, Pormona Park, Roche Park, Shady Brook Park, are other well-known areas in the county that have significant amounts of forest land and lakes which species may invade. Due to the vast area of forests, there are many invasive terrestrial species that have been widespread in Crawford County that are common problems throughout the Commonwealth. Some of the most popular problematic species in Crawford County include:

- Emerald Ash Borer
- Japanese Bettle
- Garlic Mustard

Many of the extreme problematic species have been around for many years. However, the most recent problematic species are the Emerald Ash Borer, Hemlock Wooly Adelgid, and the Spotted Lanternfly. In 2007, both the Emerald Ash Borer and Hemlock Wooly Adelgid were both newly spotted species that caused extreme damage. Even more recently than 2007, the Spotted Lanternfly appeared in Crawford County. In 2014, the spotted lanternfly was found in the commonwealth. *Table 37 - Prevalent Invasive Species* lists problematic non-native species that are established in Crawford County.

Table 37 - Prevalent Invasive Species

Prevalent Invasive Species		
Common Name	**Scientific Name**	**Type**
Alewife	Alosa pseudoharengus	Plant
American Water Lotus	Nelumbo lutea	Plant
Amur Honeysuckle	Lonicera maackii	Plant
Asiatic Clam	Corbicula fluminea	Animal
Bitter Dock	Rumex obtusifolius	Plant
Black Medic	Medicago lupulina	Plant
Black Mustard	Brassica nigra	Plant
Black Swallow-wort	Veronica officinalis	Plant
Blue Cattail	Typha x glauca	Plant
Brittle Naiad	Najas minor	Plant
Buckthorn	Rhamnus cathartica	Plant
Canada Bluegrass	Poa compressa	Plant
Canada Thistle	Cirsium arvense	Plant
Carolina Fanwort	Cabomba caroliniana	Plant
Chinese Silver Grass	Miscanthus sinensis	Plant
Climbing Nightshade	Solanum dulcamara	Plant
Colt's-foot	Tussilago farfara	Plant
Common Carp	Cyprinus carpio	Animal
Common Chickweed	Stellaria media	Plant
Common Crown-vetch	Coronilla varia	Plant
Common Frogbit	Hydrocharis morsus-ranae	Plant
Common Mullein	Verbascum thapsus	Plant
Common Reed	Phragmites australis ssp. australis	Plant
Common Speedwell	Veronica officinalis	Plant
Common St. John's-wort	Hypericum perforatum	Plant
Common Velvetgrass	Holcus lanatus	Plant
Creeping Buttercup	Ranunculus repens	Plant
Creeping Jenny	Lysimachia nummularia	Plant
Curly-leaf Pondweed	Potamogeton crispus	Plant
Cypress Spurge	Euphorbia cyparissias	Plant
Dame's Rocket	Hesperis matronalis	Plant
English Plantain	Plantago lanceolata	Plant
Eurasian Water-milfoil	Myriophyllum spicatum	Plant
European Alder	Alnus glutinosa	Plant
Field Sowthistle	Sonchus arvensis	Plant

Prevalent Invasive Species		
Common Name	**Scientific Name**	**Type**
Garden Bird's-foot-trefoil	Lotus corniculatus	Plant
Garden Loosestrife	Lysimachia vulgaris	Plant
Garden Stonecrop	Hylotelephium telephium	Plant
Garlic Mustard	Alliaria petiolata	Plant
Giant Bentgrass	Agrostis gigantea	Plant
Giant-chickweed	Myosoton aquaticum	Plant
Glossy False Buckthorn	Frangula alnus	Plant
Goldfish	Carassius auratus	Animal
Great Hairy Willowherb	Epilobium hirsutum	Plant
Greater Burdock	Arctium lappa	Plant
Ground-ivy	Glechoma hederacea	Plant
Hemlock Woolly Adelgid	Adelges tsugae	Animal
Honeysuckle	Lonicera spp.	Plant
Hydrilla	Hydrilla verticillata	Plant
Japanese Barberry	Berberis thunbergii	Plant
Japanese Knotweed	Reynoutria japonica var. japonica	Plant
Japanese Mysterysnail	Cipangopaludina japonica	Animal
Japanese Stiltgrass	Microstegium vimineum	Plant
Jumping Worms	Amynthas-Metaphire spp.	Animal
Kentucky Fescue	Lolium arundinaceum	Plant
Lady's Thumb	Persicaria maculosa	Plant
Lesser Burdock	Arctium minus	Plant
Lesser Celandine	Ranunculus ficaria	Plant
Lesser Periwinkle	Vinca minor	Plant
Marshpepper Knotweed	Persicaria hydropiper	Plant
Meadow Fescue	Schedonorus pratensis	Plant
Meadow Goat's-beard	Tragopogon dubius	Plant
Meadow Timothy	Phleum pratense	Plant
Morrow's Honeysuckle	Lonicera morrowii	Plant
Mouse-ear Hawkweed	Hieracium pilosella	Plant
Mugwort	Artemisia vulgaris	Plant
Multiflora Rose	Rosa multiflora	Plant
Narrowleaf Cattail	Typha angustifolia	Plant
Northern Catalpa	Catalpa speciosa	Plant
Orange Daylily	Hemerocallis fulva	Plant
Orange Hawkweed	Hieracium aurantiacum	Plant

Prevalent Invasive Species		
Common Name	**Scientific Name**	**Type**
Orchard Grass	Dactylis glomerata	Plant
Poison-hemlock	Conium maculatum	Animal
Privet	Ligustrum spp.	Plant
Purple Loosestrife	Lythrum salicaria	Plant
Red-eared Slider	Trachemys scripta elegans	Animal
Reed Canary Grass	Phalaris arundinacea	Plant
Roundleaf Bittersweet	Celastrus orbiculatus	Plant
Rusty Crayfish	Faxonius rusticus	Animal
Sea Lamprey	Petromyzon marinus	Animal
Sheep Sorrel	Rumex acetosella	Plant
Spongy Moth	Lymantria dispar	Animal
Spotted Starthistle	Centaurea stoebe ssp. micranthos	Plant
Sweet Vernal Grass	Anthoxanthum odoratum	Plant
Sweetflag, Calamus	Acorus calamus	Plant
Tree-of-Heaven	Ailanthus altissima	Plant
True Forget-me-not	Myosotis scorpioides	Plant
Velvetleaf	Abutilon theophrasti	Plant
White Clover	Trifolium repens	Plant
White River Crayfish	Procambarus acutus	Animal
Wild Basil	Clinopodium vulgare	Plant
Wild Chervil	Anthriscus sylvestris	Plant
Winter Creeper	Euonymus fortunei	Plant
Yellow Arch-angel	Lamiastrum galeobdolon	Plant
Yellow Floatingheart	Nymphoides peltata	Plant
Yellow Iris	Iris pseudacorus	Plant
Zebra Mussel	Dreissena polymorpha	Animal
Scribner's Bluegrass	Poa trivialis	Plant
Watercress	Rorippa nasturtium-aquaticum	Plant
Source: iMapInvasives, 2024; PA DCNR, 2019		

4.3.7.4 Future Occurrence

According to the Pennsylvania Invasive Species Council (PISC), the probability of future occurrence for invasive species threats is growing due to the increasing volume of transported goods, increasing efficiency and speed of transportation, and expanding international trade agreements. Expanded global trade has created opportunities for many organisms to be transported to and establish themselves in new counties and regions. In 2017, Pennsylvania alone imported over $83 billion in goods from abroad, including agricultural, forestry, and fishery goods that commonly carry unknow pests. Climate change is contributing to the introduction of new invasive species. As maximum and minimum seasonal temperatures change, pests can establish themselves in previously inhospitable climates. This also gives introduced species an earlier start and increases the magnitude of their growth, possibly shifting the dominance of ecosystems in the favor of non-native species. In order to combat the increase in future occurrences, the PISC released the Invasive Species Management Plan in April 2010 and updated the plan in 2017. The plan outlines the Commonwealth's goals for managing the spread of nonnative invasive species and creates a framework for responding to threats through research, action, and public outreach and communication. More information can be found here: https://www.agriculture.pa.gov/Plants_Land_Water/PlantIndustry/GISC/Pages/default.aspx.

There are several invasive species that are found near Crawford County but have not yet been detected inside the county (see *Table 38 – Future Vulnerable Species*). Especially in cases like this, control efforts, heightened awareness, and public outreach and education can help prevent an invasive species from becoming established in the future. Once a species is established, it is more difficult to eradicate it from an ecosystem, so prevention is very important. The species listed in *Table 38 – Future Vulnerable Species* are all widespread and highly problematic in nearby counties, but have not yet been reported in Crawford County. The development of appropriate plans will assist the county in reducing the possibility of a future encounter with any of these species. Working toward keeping these species from entering the area would be beneficial to the forests of Crawford County.

Climate change and its relationship with invasive species has a major correlation. According to the U.S Geological Survey, climate change has been creating a new pathway for invasive species to be introduced into the environment. As an example, the rise in temperature allows existing invasive species to expand their geographic area. Also, climate change hinders the tools for eliminating invasive species.

Table 38 - Future Vulnerable Species

Prevalent Invasive Species		
Common Name	**Scientific Name**	**Type**
Alsike Clover	Trifolium hybridum	Plant
Asiatic Dayflower	Commelina communis	Plant
Autumn Olive	Elaeagnus umbellata	Plant
Bamboo	Phyllostachys spp.	Plant
Banded Mysterysnail	Viviparus georgianus	Animal

Prevalent Invasive Species		
Common Name	Scientific Name	Type
Beech Leaf Disease Nematode	Litylenchus crenatae mccannii	Animal
Bell's Honeysuckle	Lonicera x bella	Plant
Bishop's Goutweed	Aegopodium podagraria	Plant
Bloody-red Shrimp	Hemimysis anomala	Animal
Bohemian Knotweed	Reynoutria x bohemica	Plant
Border Privet	Ligustrum obtusifolium	Plant
Bouncing-bet	Saponaria officinalis	Plant
Brown Starthistle	Centaurea jacea	Plant
Bull Thistle	Cirsium vulgare	Plant
Burning Bush	Euonymus alatus	Plant
Butter-and-eggs	Linaria vulgaris	Plant
Cheatgrass	Bromus tectorum	Plant
Chicory	Cichorium intybus	Plant
Colonial Bentgrass	Agrostis capillaris	Plant
Common Star-of-Bethlehem	Ornithogalum umbellatum	Plant
Common Water-hyacinth	Eichhornia crassipes	Plant
Creeping Bentgrass	Agrostis stolonifera	Plant
Cutleaf Blackberry	Rubus laciniatus	Plant
Dockweed Smartweed	Polygonum lapathifolium	Plant
Dog Rose	Rosa canina	Plant
Eastern Helleborine	Epipactis helleborine	Plant
English Ivy	Hedera helix	Plant
European Lily-of-the-valley	Convallaria majalis	Plant
Field Garlic	Allium vineale	Plant
Five-leaf Akebia	Akebia quinata	Plant
Flowering-rush	Butomus umbellatus	Plant
Foxtail Mint	Mentha x villosa	Plant
Freshwater Jellyfish	Craspedacusta sowerbyi	Animal
Goatsrue	Galega officinalis	Plant
Gold-moss	Sedum acre	Plant
Green Crawler	Lumbricus terrestris	Animal
Guelder-rose Viburnum	Viburnum opulus var. opulus	Plant
Hair Fescue	Festuca filiformis	Plant
Hairy Bittercress	Cardamine hirsuta	Plant
Japanese Angelica Tree	Aralia elata	Plant
Japanese Honeysuckle	Lonicera japonica	Plant

Prevalent Invasive Species		
Common Name	**Scientific Name**	**Type**
Japanese Virgin's-bower	Clematis terniflora	Plant
Japanese-spurge	Pachysandra terminalis	Plant
Knapweed	Centaurea spp.	Plant
Knotweed	Reynoutria spp.	Plant
Mile-a-minute vine	Persicaria perfoliata	Plant
Mimosa	Albizia julibrissin	Plant
Mint	Mentha spp.	Plant
Mud Bithynia	Bithynia tentaculata	Plant
Musk Thistle	Carduus nutans	Plant
New Zealand Mudsnail	Potamopyrgus antipodarum	Animal
Northern Catalpa	Catalpa speciosa	Plant
Norway Maple	Acer platanoides	Plant
Oregon Grape	Berberis aquifolium	Plant
Oxeye Daisy	Leucanthemum vulgare	Plant
Peppermint	Mentha x piperita	Plant
Perennial Pea	Lathyrus latifolius	Plant
Pink Lotus	Nelumbo nucifera	Plant
Porcelainberry	Ampelopsis brevipedunculata	Plant
Poverty Brome	Bromus sterilis	Plant
Purple Deadnettle	Lamium purpureum	Plant
Quagga Mussel	Dreissena bugensis	Animal
Queen Anne's Lace	Daucus carota	Plant
Rainbow Smelt	Osmerus mordax	Plant
Red Wiggler	Lumbricus rubellus	Animal
Round Goby	Neogobius melanostomus	Plant
Rudd	Scardinius erythrophthalmus	Animal
Russian-thistle	Salsola kali ssp. tragus	Plant
Scribner's Bluegrass	Poa trivialis	Plant
Scud; Amphipod	Echinogammarus ischnus	Animal
Siberian Elm	Ulmus pumila	Plant
Silver Grass	Miscanthus spp.	Plant
Slider	Trachemys scripta	Animal
Spotted Cat's-ear	Hypochaeris radicata	Plant
Sweet Bedstraw	Galium odoratum	Plant
Sweetclover	Melilotus officinalis	Plant
Tall Buttercup	Ranunculus acris var. acris	Plant

Prevalent Invasive Species		
Common Name	**Scientific Name**	**Type**
Tatarian Honeysuckle	Lonicera tatarica	Plant
Tubenose Goby	Proterorhinus semilunaris	Animal
Water Chestnut	Trapa natans	Plant
Water Lettuce	Pistia stratiotes	Plant
Watercress	Rorippa nasturtium-aquaticum	Plant
Weak-leaf Yucca	Yucca flaccida	Plant
White Moth Mullein	Verbascum blattaria	Plant
White Perch	Morone americana	Animal
White Sweet-clover	Melilotus albus	Plant
White Willow	Salix alba	Plant
Wild Parsnip	Pastinaca sativa	Plant
Wild Teasel	Dipsacus fullonum	Plant
Wineberry	Rubus phoenicolasius	Plant
Yellow-bellied Slider	Trachemys scripta scripta	Animal
Source: iMapInvasives, 2024; PA DCNR, 2019		

4.3.7.5 Vulnerability Assessment

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

Since there are large swatches of public land in Crawford County, there is a risk of future damage from invasive species that are present in the area. With about 194,447 of total land in Crawford County, there is vulnerability to various land sites and waterways. If an invasive species were to invade the popular terrestrial areas or waterways in Crawford County, a negative impact could occur. The invasion from an invasive species could cause damage to the scenic and natural resources needed in the county. Additionally, tourism for the county is vulnerable to the invasive species as well and would be affected if the parks were destroyed. Therefore, a great amount of land and native wildlife within Crawford County are at risk with the presence of invasive species.

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

The Governor's Invasive Species Council of Pennsylvania (PISC) has identified over 100 species threats that are or could potentially become significant in Pennsylvania. Of these threats, county and municipal leaders believe that the most significant are invasive forest pests like the Emerald Ash Borer, Hemlock Woolly Adelgid, the Spotted Lanternfly, and plants like the Tree-of-Heaven which have all been identified in red in *Table 37 - Prevalent Invasive Species.*

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

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

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

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

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

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

It is best to act before a species can become established in the county, so forest management such as park rangers should be aware of invasive species found nearby Crawford County, but not yet present in the county (priority species in *Table 38 – Future Vulnerable Species*). Public outreach and education are important to increase knowledge of these species to improve identification and prevention of invasion. Without action, due to the instances and extent of the current infestations, it is reasonable to project that the county's vulnerability will increase.

All of the socially vulnerable populations in Crawford County are at an increased vulnerability to invasive species. The homeless and the unsheltered populations are at risk due to not having a structure to reside in. Also, the economically vulnerable of Crawford County may not have the capability to fix or hire pest control if their homes are damaged or overrun by invasive species.

As seen in *Table 3 – Population Change in Crawford County*, Blooming Valley Borough, Rome Township, Sparta Township, and Townville Borough have seen a net population increase from the 2010 decennial census to the 2020 decennial census. Based on this information, it can be speculated that these municipalities may have an increased risk to invasive species, since 2010, due to the increase in population and possible construction.

The historic properties in Crawford County are at different levels of vulnerability to invasive species. Most of the historic properties in Crawford County are made of brick and masonry construction and are at a lower risk of vulnerability from invasive species. There are approximately ten buildings that are historic in Crawford County that are of brick and masonry construction they the Baldwin-Reynolds House, Bently Hall, Independent Congregational Church, Amos Kelly House, Dr. J.R. Mosier Office, Roueche House, Ruter Hall, Edward Saeger House, Judge Henry Shippen House, and the Titusville City Hall. Most of the culturally significant covered bridges in Crawford County are made of wood and could be damaged by invasive species making them more vulnerable. Seven historic properties are made of stone and could be damaged by invasive species, but it is low.

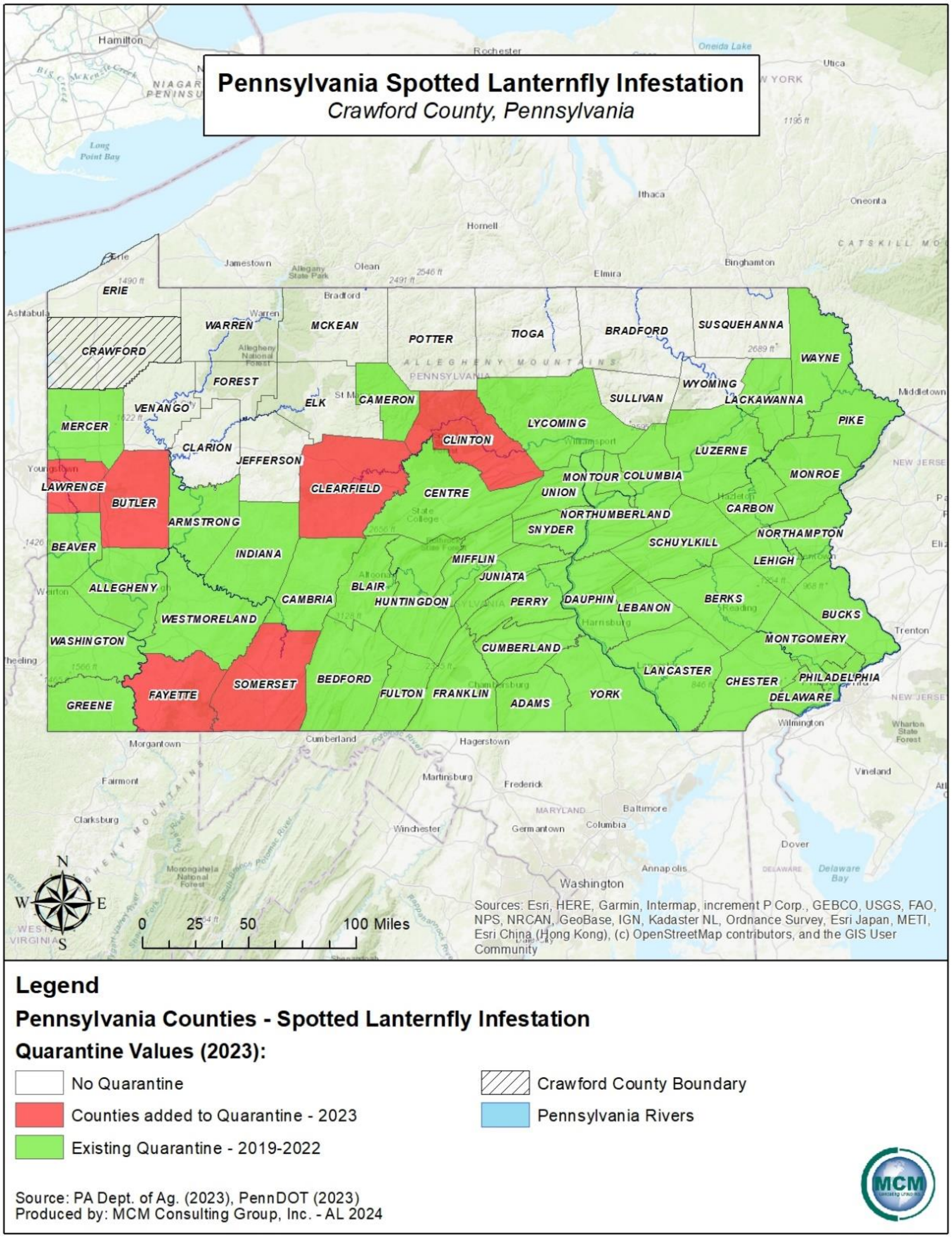
Land use changes in Crawford County could be a factor in the potential impact invasive species have on native species. Land use is a major factor with the severity of invasive species. Land use, in the form of a built environment, such as residential expansion, can cause invasive species impact severity to increase. Impact severity increases because as the built environment expands and becomes more complex, the impact the event will have on that area also increases because there is an influx of people, infrastructure, and critical infrastructure in the hazard area. According to Smithsonian Environmental Research Center, invasive species thrive on major land use disturbances, as an example the logging of a forest or flooding to a wetland can create conditions that invasive species thrive on to move into a specific area.

Invasive species in Crawford County pose a significant threat to infrastructure systems through various mechanisms. Invasive plants like kudzu or Japanese knotweed can damage infrastructure such as roads, bridges, and buildings by infiltrating cracks and causing structural damage. Their aggressive growth can also obstruct drainage systems, leading to flooding and erosion, thus compromising the integrity of roads and bridges.

Invasive animals, such as feral hogs or zebra mussels, can disrupt infrastructure by burrowing into embankments, weakening them and increasing the risk of collapse. Additionally, animals like rodents or insects may gnaw on electrical wiring and utility cables, leading to malfunctions or even fires, posing risks to both infrastructure and public safety.

Furthermore, invasive species can interfere with transportation systems by clogging waterways. For example, invasive aquatic plants can impede navigation channels, necessitating costly scouring operations. Invasive insects like the emerald ash borer can devastate tree populations, including those lining roads or railways, posing hazards from falling trees and impacting transportation routes.

Figure 26 - Pennsylvania Spotted Lanternfly Infestation



4.3.8. Landslide

4.3.8.1 Location and Extent

Rock falls and other slope failures can occur in areas of Crawford County with moderate to steep slopes. Many slope failures are associated with precipitation events – periods of sustained above-average precipitation, specific rainstorms, or snowmelt events. Rockfalls, rockslides, rock topples, block slides, debris flows, mud flows, and mud slides are all forms of landslides. Areas experiencing erosion, decline in vegetation cover and earthquakes are also susceptible to landslides. Human activities that contribute to slope failure include altering the natural slope gradient, increasing soil and water content, and removing vegetation cover. Areas where this type of human activity is common are areas that were excavated along highways and other roadways.

The Pennsylvania Department of Conservation and Natural Resources (PA DCNR) describes landslide susceptibility in Crawford County as generally low. *Figure 27 – Landslide Hazard Areas* shows areas of landslide susceptibility in Crawford County. A majority of Crawford County is located in the Northwestern Glaciated Plateau Section. Northwestern Glaciated plateau physiographic province which is known for the low vulnerability based on physiographic region to all forms of landslide. Steep slopes are evenly spread throughout the county and there are locations that can be prone to landslides in almost every municipality.

4.3.8.2 Range of Magnitude

Landslides cause damage to transportation routes, utilities, and buildings. They can also create travel delays and other side effects for transportation of people and material. Fortunately, death and injuries due to landslides are relatively rare in Pennsylvania. Almost all of the known deaths due to landslides have occurred when rocks fall or other slide along highways involve vehicles. Storm-induced debris flows are the only other type of landslide likely to cause injuries. As residential and recreational development increase on and near steep mountain slopes, the hazard from these rapid events will also increase. Most Pennsylvania landslides are moderate to slow moving and damage objects and buildings, rather than people.

The Pennsylvania Department of Transportation (PennDOT) and large municipalities incur substantial costs due to landslide damage and to additional construction costs for new roads in known landslide-prone areas. A 1991 estimate showed an average of $10 million per year is spent on landslide repair contracts across the Commonwealth of Pennsylvania and a similar amount is spent on mitigation costs for grading projects (DCNR, 2009). A number of highway sites in Pennsylvania need temporary or permanent repair at an estimated cost of between $300,000.00 and $2 million each. Similar landslide events that effect traffic and roadways throughout the commonwealth occur intermittently throughout the year. A 7,500-pound rockslide closed down parts of Pennsylvania State Route 11 in Montour County, Pennsylvania in November of 2020 for a number of weeks. Events of similar magnitude can and have occurred in and around Crawford County.

The 2023 Pennsylvania Hazard Mitigation Plan lists Crawford County as having a low incidence of landslides and low susceptibility. Crawford County landowners and real estate developers must know the magnitude of susceptibility within the county prior to the start of development.

4.3.8.3 Past Occurrence

No comprehensive list of landslide incidents in Crawford County is available, and there is no formal reporting system in place. PennDOT and municipal departments are responsible for slides that inhibit the flow of traffic or damage roads and bridges, but they generally only repair the road and the adjacent right-of-way areas.

4.3.8.4 Future Occurrence

Historically, significant landslide events are likely to not occur in Crawford County. Mismanaged development in steeply sloped areas could increase the frequency of occurrence. Road cuts are the most common development that puts an area at an increased probability of a slide. The Pennsylvania Department of Environmental Protection (PA DEP) has an Erosion and Sediment (E & S) program that sets requirements intended to mitigate erosion associated with development projects of a certain scale. The guidelines offered in this program are similar to landslides prevention practices.

Climate change has the potential to increase the frequency of landslides in Crawford County. Climate change could result in more intense rainfall from more frequent hurricanes and tropical storms. This increase in rainfall could cause an increase in soil runoff, therefore weakening slopes that are steep and considered to be a hazard. More frequent landslides could occur from this weakening of the slopes because soil movement will likely increase with a higher volume of precipitation.

4.3.8.5 Vulnerability Assessment

Landslides are often precipitated by other natural hazards such as earthquakes or floods. A significant landslide can cause millions of dollars in damages. Continued enforcement of floodplain management and proper road and building construction can mitigate the vulnerability to landslides. Floodplain management is important where mining has occurred within proximity to watercourses and associated flat-lying areas. Surface water may permeate into areas that still have open fractures and the build-up of surface water in those fractures could lead to unexpected flood events and landslide events.

A comprehensive database of land highly prone to erosion and landslides is difficult to produce. The potential for erosion and landslides should be considered when planning construction projects in Crawford County. There are several general factors that can be indicators of landslide prone areas including:

- Locations on or close to steep hills.
- Areas of steep road cuts or excavations.
- Steep areas where surface run-off is channeled.
- Fan shaped areas of sediment and rock accumulations.
- Evidence of past sliding such as tilted utility line, tilted trees, cracks in the ground and irregularly, surfaced ground.

All the municipalities in Crawford County are vulnerable to landslides. *Table 39 – Structure Vulnerability Data* illustrates the number of site structure address points per municipality and the number of structures in high slope areas. Landslide events are most likely to occur in steeply sloped areas and in places where landforms have been altered for purposes of highway construction or other development. This is especially true if development is located at the base or crest of cliffs or near large highway cut-outs. These areas should be considered vulnerable to landslides, particularly if mitigation measures have not been implemented.

Table 39 - Structure Vulnerability Data

Structure Vulnerability Data		
Municipality	**Number of Addressable Structures Per Municipality**	**Number of Structures in Slope Area**
Union Township	1	0
Totals:	**1**	**0**

There are no historic or cultural properties in Crawford County that are registered with the National Register of Historic Places and is within a slope area of greater than 23°.

Municipalities with an increased risk to landslide (due to slope areas over 23°):

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Township
- Cambridge Springs Borough
- Centerville Borough
- Cochranton Borough

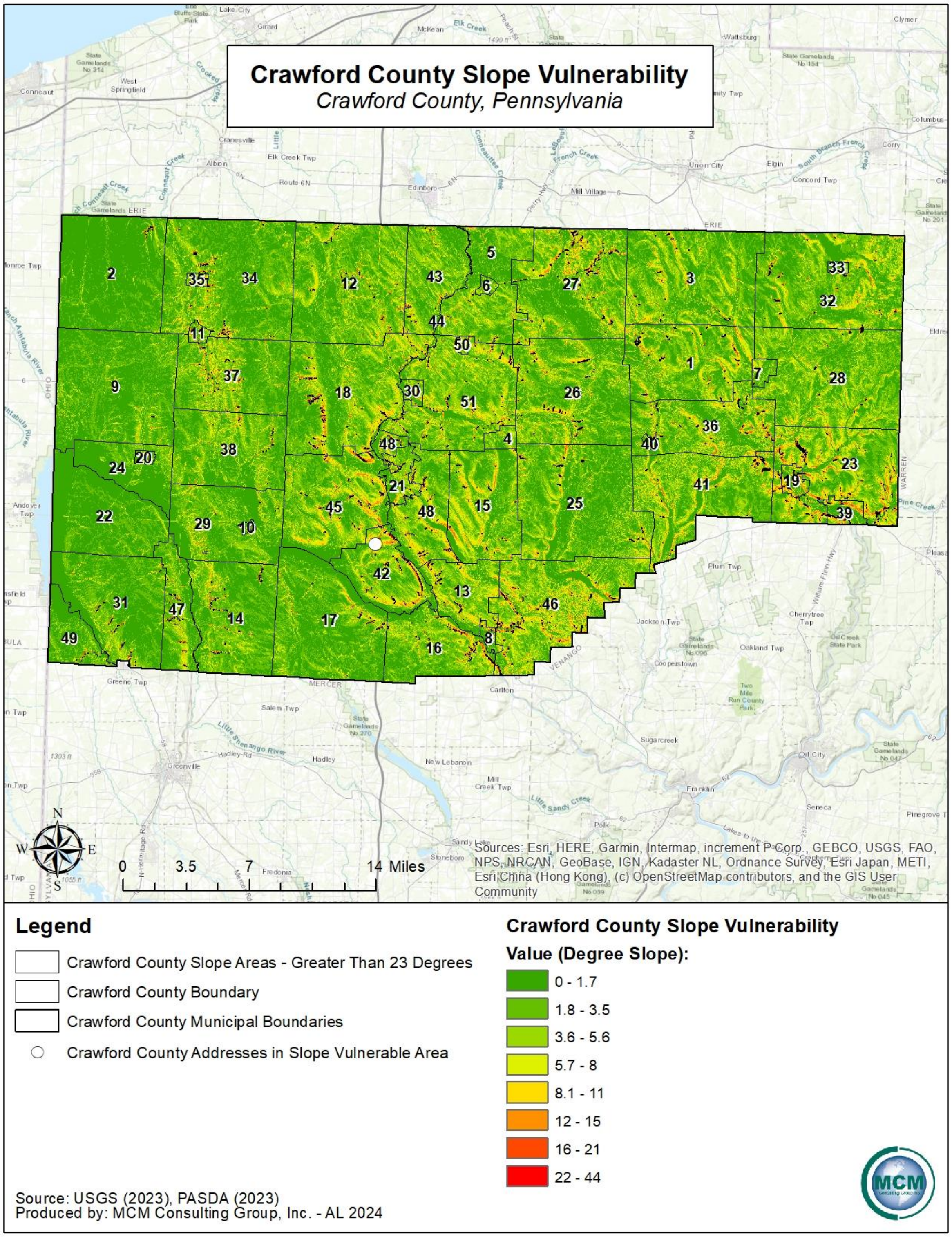
- Conneaut Township
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Meadville, City of
- Oil Creek Township
- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Townville Borough
- Troy Township
- Union Township
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township
- West Shenango Township
- Woodcock Township

The socially vulnerable populations and communities in Crawford County, including the homeless and unsheltered populations, are at an increased vulnerability to landslides. Those socially vulnerable populations can be found in the higher population density areas of the county. As seen *in Table 3 – Population Change in Crawford County*, Rome Township, Sparta Township, Blooming Valley Borough, and Townville Borough have seen a net population increase from the 2010 decennial census to the 2020 decennial census. Based on this information, it can be speculated that these municipalities may have an increased/equivalent risk to landslides, since 2010, due to the increase in population and construction.

When a landslide occurs, the resulting ground instability can lead to telephone pole collapse, disruption of fiber or copper cables systems, and in severe cases, cellular tower failure. The disruption to these networks, if the landslide event is significant, can also result in a loss of communication capabilities, hindering response coordination, and leaving communities impacted by the landslide vulnerable to other natural or human-caused hazards. Landslide events can also cause above ground localized transportation issues if an event were to occur along a transportation route through Crawford County. This can cause a delay in daily transportation and may require alternate transportation routes to be established for an extended period of time.

Natural areas and resources in Crawford County could be adversely impacted from landslides. Landslides typically occur in areas of steep slope, or areas of slope instability. Specific natural areas or parks that have the potential for landslides due to steep slopes include enter areas. Landslides occur in natural areas on a regular basis and are often only reported substantially after occurrence. Natural resources that are utilized by the residents and businesses of Crawford County could be damaged by landslides. This could include any farming, land cultivation, lumbering, or development of natural products.

Figure 27 - Landslide Hazard Areas



4.3.9. Lightning Strike

4.3.9.1 Location and Extent

Lightning is a massive electrostatic discharge between electrically charged regions within clouds, or between a cloud and the Earth's surface. The charged regions within the atmosphere temporarily equalize themselves through a lightning flash, commonly referred to as a strike if it hits an object on the ground.

There are three primary types:

- A lightning strike from a clod to itself (intra-cloud or IC)
- A lightning strike from one cloud to another cloud (cloud to cloud or CC)
- A lightning strike between the cloud and the ground (cloud to ground or CG)

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

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

4.3.9.2 Range of Magnitude

Severe thunderstorms have lightning risks and can cause significant damage and be life threatening, though only a small percentage of thunderstorms become severe. Northeastern Pennsylvania sits in a moderate risk area susceptible to lightning strikes, western Pennsylvania sits clearly in a region of the country susceptible to lightning strikes but high-risk areas for lighting strikes are the southeast or the central portions of the United States. This information can be seen in *Figure 28 – United States Lightning Risk Rating*. The 2023 Commonwealth of Pennsylvania All Hazards Mitigation Plan states that Pennsylvania ranks ninth among the fifty states in the country's number of lightning deaths between 1959 and 2022. Lightning flashes occur in Crawford County during the summer months. Lightning can cause severe injury and, in some cases, can be fatal. Most fatal strikes are not direct strikes to people but the result of ground current. Most individuals survive ground current strikes. Other impacts of ground current include death and injuries to livestock, forest and brush fires, and damages to buildings, communication systems, power lines, and utility systems across the country. *Figure 29 – U.S. Lightning Strike Fatalities 2018 to 2022* shows the number of lightning fatalities from direct strikes for the United States. Pennsylvania registered five fatalities for that five-year time period.

4.3.9.3 Past Occurrence

Thunderstorms and lightning occur many times each year in Pennsylvania. According to NOAA, lightning has been responsible for six deaths in Pennsylvania between the years 2019-2023. Pennsylvania ranked 38th in the United States in lightning strike deaths in terms of population density in the 2023 Pennsylvania State Hazard Mitigation Plan. As of the writing of this plan update, there have been no fatalities from lighting in Pennsylvania in 2024.

4.3.9.4 Future Occurrence

Lightning strikes and thunderstorms are expected during and around the spring and summer months. These events have occurred in Crawford County in the past and will continue to occur in the future, although multiple casualties or deaths are highly unlikely. Climate change will result in a greater frequency of storms and an increase in the strength of thunderstorms. The rising temperature will result in warmer air with more moisture which will increase the likelihood of thunderstorms. This increase in thunderstorms is likely to result in more occurrences of lightning strikes.

4.3.9.5 Vulnerability Assessment

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

The potential for lightning strikes and thunderstorms exists in all municipalities in Crawford County. Events being held outdoors during the summer months are particularly vulnerable to lightning strikes. Due to the recreational and rural characteristics, including waterways, there is the potential in Crawford County for death and injuries to occur from lightning strikes. Natural areas are at an increased vulnerability to damage from lightning, including damage from strikes and cascading impacts like wildfires and brush fires. All of the natural areas and resources in Crawford County are at an increased vulnerability, but not all natural areas would be impacted by any one single event.

Land use changes and population may also affect the likelihood of lightning strikes. While this is of high debate, some research suggests that land use changes in the form of urbanization may increase the frequency of lightning strikes. Research suggests that urbanization increases local climate and therefore increases the amount of lightning strikes in that area. These urban areas typically have a higher population density compared to more rural areas, therefore increasing the built environment and heightening the areas vulnerability to lightning strikes.

As seen in *Table 3 – Population Change in Crawford County*, forty six of the fifty-one municipalities in Crawford County have experienced a population loss since the 2020 decennial census. Four municipalities have seen a net population increase from the 2020 decennial census to the 2020 decennial census, while one has had no change. Based on this information, it can be speculated that enter Blooming Valley Borough, Rome Township, Sparta Township, and Townville Borough may have an increased vulnerability to lightning strikes, since 2020, due to the increase in population and the corresponding built environment. Populations in Crawford County, including the socially vulnerable underserved, and unserved populations, may be disproportionately impacted. Inadequate infrastructure and unsafe housing leave these communities more susceptible to lightning strikes. The historic and cultural resources in Crawford County could be at an increased risk of damage from lightning strikes if proper mitigation techniques and procedures are not implemented or in place.

Figure 28 - United States Lightning Risk Rating

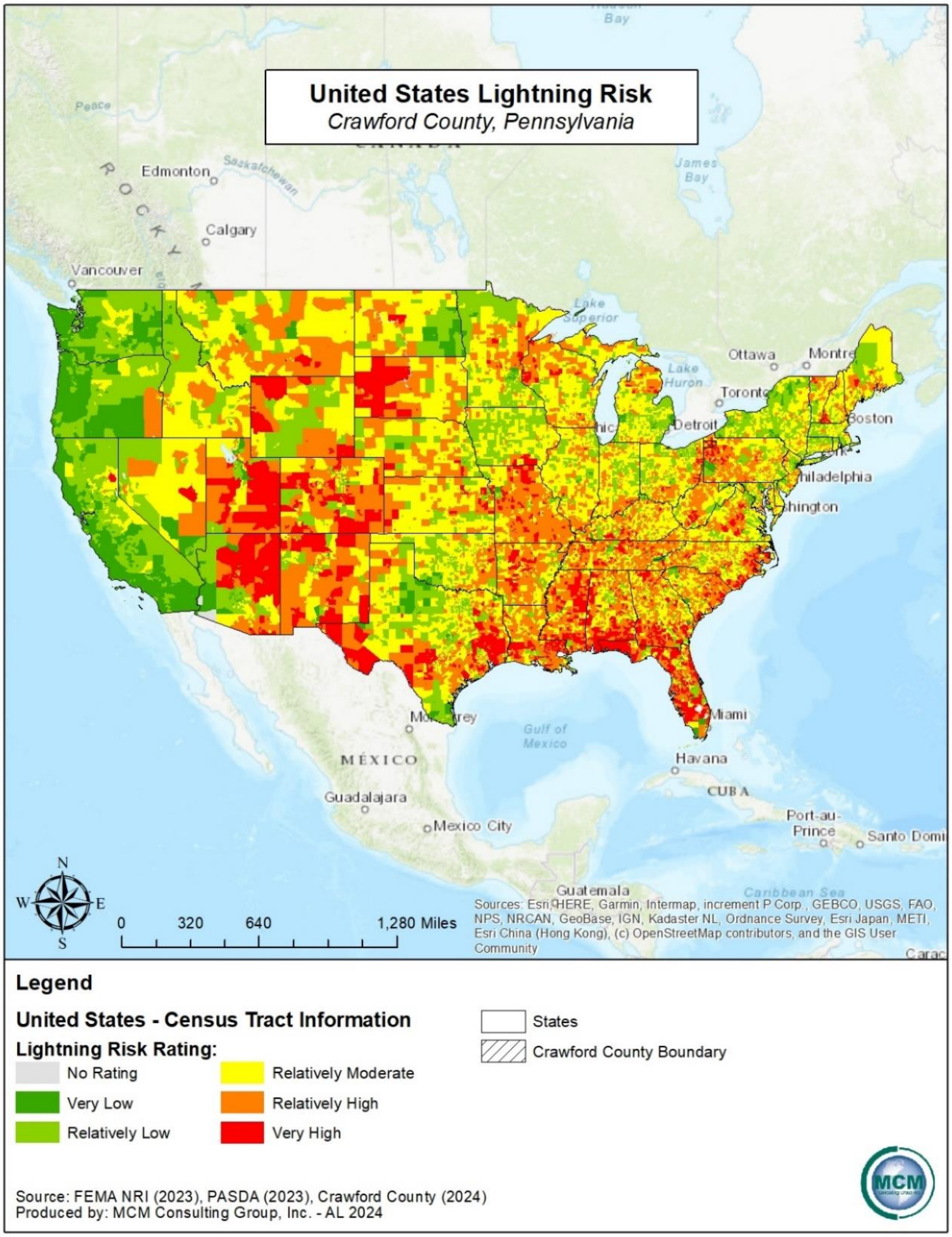
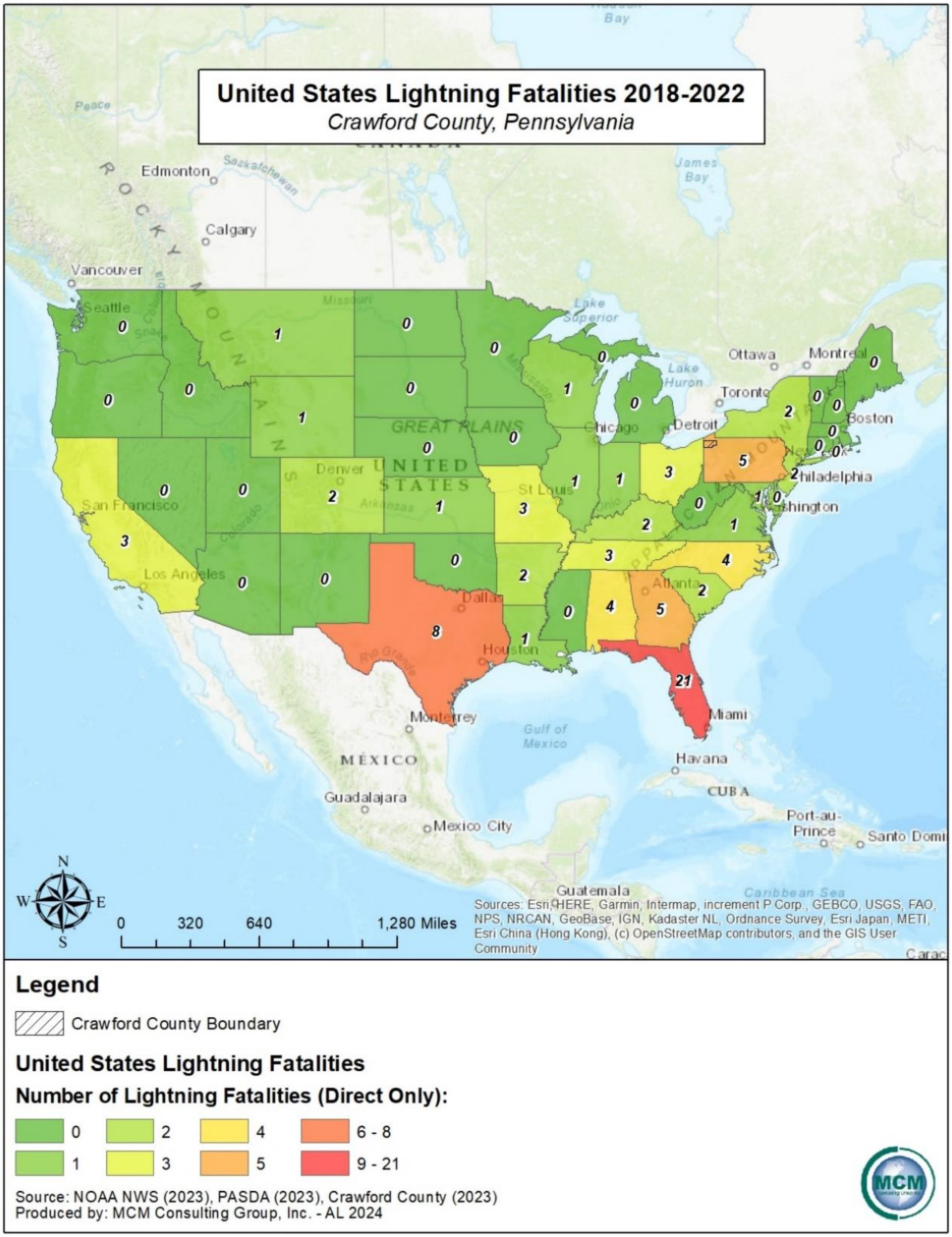


Figure 29 - U.S. Lightning Strike Fatalities 2018 to 2022



4.3.10. Pandemic, Epidemic, and Infectious Disease

4.3.10.1 Location and Extent

Epidemic

An epidemic occurs when an infectious disease spreads more quickly than expected by medical and healthcare authorities. It is characterized by widespread growth or extent that spreads quickly and incurs a greater rate of novel or endemic cases than baseline estimates would initially project. When an epidemic occurs, it typically impacts a larger area than a localized outbreak. Epidemics often include multiple countries, although not always spreading to different continents. In short, epidemics are regional.

Pandemic

A pandemic is a disease outbreak that spreads across countries or continents, which affects the population of a vast area. When a pandemic occurs, the event usually affects more people and takes more lives than an epidemic. Pandemics are described as an extensive epidemic. Generally, pandemic diseases cause sudden illness in all age groups on a global scale. Pandemics are continuous events in third-world countries but do not frequently affect the United States. A pandemic is measured and defined by the spreading of a disease rather than the fatalities with which it is associated. The characteristics of a pandemic outbreak include large and rapid scale spread, overload of healthcare systems, inadequate medical supplies, disruption of economy/society, and medical supply shortages. While a pandemic may be characterized as a type of epidemic, an epidemic is not a type of pandemic. Additionally, pandemics travel more efficiently than epidemics. In the event that a pandemic occurs in the eastern United States, the entirety of Crawford County would likely be impacted.

Endemic

An endemic is described as a disease that is present in a community at all times but occurs in a relatively low frequency and is not spreading at a rapid rate. An endemic can be a previous pandemic such as influenza, or coronavirus (COVID-19), or a more regionalized virus such as Ebola virus in Africa. An endemic can become a pandemic if the disease mutates into a more virulent strain.

Infectious Disease

Infectious diseases are illnesses caused by pathogenic organisms such bacteria, viruses, fungi, or parasites. Organisms become harmful and cause disease under certain conditions. The sources of infectious disease may originate from contaminated food or waterways, infected animals/livestock, or infection from biological vectors such as mosquitoes, etc. Infectious diseases include influenza, rabies, Middle East Respiratory Syndrome (MERS), West Nile virus, Lyme Disease, Zika virus, and Ebola virus.

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

4.3.10.2 Range of Magnitude

Public health emergencies typically occur on a regional basis. The magnitude of pandemic or infectious disease threat in the Commonwealth will range significantly depending on the aggressiveness of the virus in question, factors within the community that are impacted (medical care access, population density, etc.), and the ease of transmission. For example, the West Nile virus produces clinically asymptomatic cases less than 80% of the time. Therefore, approximately 20% of the cases result in mild infection, also known as West Nile fever. However, there is a small percentage of cases that could result in severe neurological disease and even death.

Pandemic influenza has a higher transmission rate from person-to-person compared to the West Nile virus. Advances in medical technologies have greatly reduced the number of deaths caused by influenza over time. In the early 1900s, flu pandemics historically caused tens of millions of deaths, while the 2009 Novel H1N1, known as swine flu, caused fewer than 20,000 deaths world-wide. Many people infected with swine flu in 2009 recovered without needing medical treatment. Without recent medical inventions and technologies, modern influenza would be associated with higher morbidity rates. About 70% of those who were hospitalized during the 2009 H1N1 flu virus in the United States belonged to a high-risk group. However, with the COVID-19 pandemic, the transmission rates were much higher than any previous outbreaks related to other members of the coronavirus family such as SARS-CoV and MERS-CoV.

In the past 100 years, humanity did not face a microbial pandemic similar in scale to the COVID-19 pandemic. The worldwide transmission rate of COVID-19 from human to human rapidly advanced in 2020 and 2021. Of the six global outbreaks of viral infections, three were caused by coronaviruses (SARS, MERS, and COVID-19).

While there are limited secondary hazards related to public health emergencies, an outbreak can cause a variety of cascading hazards. Civil disorder due to supply shortages is the most common cascading hazard to result from pandemic, epidemic, or infectious disease. Additional potential effects could include: a shortage of medical supplies and personnel, hoarding of household paper and cleaning supplies, school and business disruption, government closings, government restrictions on travel, low attendance at places of employment, slowed productivity, and widespread economic instability.

The World Health Organization (WHO) developed an alert system to help inform the world about the seriousness of a pandemic. The alert system has six phases, with Phase 1 being the lowest risk and Phase 6 being the greatest risk of pandemic. The phases were developed in 1999, but then revised in 2005 and 2009 to provide a global framework and aid countries in pandemic preparedness and response planning. These phases of alert systems were used during the COVID-19 pandemic. These phases are listed below in *Table 40 - Pandemic Influenza Phases*.

Table 40 - Pandemic Influenza Phases

Pandemic Influenza Phases	
Phase	**Characteristics**
Phase 1	No animal influenza virus circulating among animals has been reported to cause infection in humans.
Phase 2	An animal influenza virus circulating in domesticated or wild animals is known to have caused infection in humans and is therefore considered a specific potential pandemic threat.
Phase 3	An animal or human-animal influenza reassortant virus has caused sporadic cases or small clusters of disease in people but has not resulted in human-to-human transmission sufficient to sustain community-level outbreaks.
Phase 4	Human-to-human transmission (H2H) of an animal or human-animal influenza virus able to sustain community-level outbreaks has been verified.
Phase 5	The same identified virus has caused sustained community level outbreaks in two or more countries in one WHO region.
Phase 6	The pandemic phase is characterized by community level outbreaks in at least one other country in a different WHO region in addition to the criteria defined in Phase 5. Designation of this phase will indicate that a global pandemic is under way.
Post-Peak Period	Levels of pandemic influenza in most countries with adequate surveillance have dropped below peak levels.

Pandemic Influenza Phases	
Phase	**Characteristics**
Possible New Wave	Level of pandemic influenza activity in most countries with adequate surveillance rising again.
Post-Pandemic Period	Levels of influenza activity have returned to the levels seen for seasonal influenza in most countries with adequate surveillance.
Source: WHO, 2009	

4.3.10.3 Past Occurrence

Pandemic & Epidemic

Several pandemic influenza outbreaks have occurred over the past 100 years that not only affected Crawford County but the United States as a whole. *Table 41 - Past Pandemic Events in the United States* illustrates the various past pandemic events that have occurred since the late 1800's. Prior to COVID-19, the worst recorded pandemic was the Spanish Flu, due to the amount of infection spread that was present in the world. The two most recent pandemics that have occurred in Crawford County and the United States are the swine flu/Novel H1N1 and COVID-19 pandemics, with COVID-19 being the most current and having the highest transmission rates.

Spanish Flu

An estimated 1/3 of the world's population was infected and had clinically apparent illnesses during the 1918 - 1919 influenza pandemic. Pennsylvania experienced severe effects from the Spanish Flu. It claimed 500,000 lives in the United States, which included individuals in Crawford County. There is a lack of data which provides exact numbers of deaths that occurred in Crawford County from the Spanish Flu, however there were a total of 60,000 deaths in Pennsylvania. Deaths occurring in Crawford County are included in this number. There were approximately 47,000 reported cases and 12,000 deaths in Philadelphia in just over four weeks. In the first six months, there were about half a million cases and 16,000 deaths of the Spanish Flu in Philadelphia. The factors of high population density including crowded and unhygienic conditions contributed to higher numbers of cases and death rates across Pennsylvania.

Swine Flu/Avian Flu/H1N1

Each year, different strains of influenza are labeled as potential pandemic threats. Strains of influenza, or the flu, are highly contagious as they commonly attack the respiratory tract in humans. Influenza pandemic planning began in response to the H5N1 (avian) flu outbreak in Asia, Africa, Europe, the Pacific, and the Near East in the late 1990s and early 2000s. Avian flu did not reach pandemic proportions in the United States, but the country began planning for flu outbreaks.

Crawford County was impacted by the H1N1 virus during 2009. The Pennsylvania Department of Health (PA DOH) set up clinics throughout the county to administer vaccines to at-risk populations. A total 10,940 cases and seventy-eight deaths occurred in Pennsylvania from this pandemic but there is insufficient data to determine the exact number of cases and deaths from swine flu in Crawford County.

COVID-19

Crawford County was directly impacted by the COVID-19 pandemic. As of June 2023, Pennsylvania had an estimated 3,527,854 million total cases and 50,398 deaths related to the COVID-19 pandemic. The first cases in Pennsylvania were reported on March 6, 2020, in Delaware and Wayne counties. The first confirmed case of COVID-19 in Crawford County was in March 2020. Beginning in December of 2020, there was a large-scale vaccination effort to combat COVID-19. Municipalities in Crawford County indicated a decrease in the pandemic and infectious disease section of the risk factor assessment municipal comparison.

Table 41 - Past Pandemic Events in the United States

Past Pandemic Events in the United States	
Year(s)	**Common Name**
1889	Russian Flu
1918	Spanish Flu/H1N1
1957	Asian Flu/H2N2
1968	Hong Kong Flu/H3N2
2009	Swine flu/Novel H1NI
2020	COVID-19
Sources: WHO & CDC, 2020	

Infectious Disease

Not only has Crawford County experienced pandemic events, but the county has also experienced infectious disease events. The two major infectious disease events experienced across Crawford County and Pennsylvania as a whole are the West Nile Virus and Lyme Disease. Due to the climatic traits of Pennsylvania these infectious diseases thrive in Crawford County. Both diseases are transmitted by the biological vector of an insect which is found throughout the county.

West Nile Virus

West Nile virus reached the United States in 1999 and a year later was detected in Pennsylvania when mosquito pools, dead birds, and/or horses in nineteen counties tested positive for the virus. By 2003, all counties in the Commonwealth had confirmed cases. A comprehensive network has been developed in Pennsylvania that includes trapping mosquitoes, collecting dead birds, and monitoring horses, people and, in past years, sentinel chickens. Although West Nile Virus positive cases are few in Crawford County, 2023 had the most positive cases in Crawford County since 2018. Over the past five years, no human has tested positive for West Nile Virus in Crawford County. *Table 42 - West Nile Virus Control Program in Crawford County since 2018* outlines the West Nile Virus within Crawford County from 2018 to 2023.

Table 42 - West Nile Virus Control Program in Crawford County since 2018

West Nile Virus Control Program in Crawford County Since 2018				
Year	**Total Positives**	**Human Positives**	**Mosquito Positives**	**Bird Positives**
2023	7	0	6	1
2022	1	0	1	0
2021	0	0	0	0
2020	0	0	0	0
2019	1	0	1	0
2018	3	0	2	1
Source: PA Department of Environmental Protection, 2023				

Lyme Disease

Lyme Disease has been present in the United States and Crawford County for many years. More wooded areas have higher cases due to ticks being the main biological vector. Lyme disease is found in all sixty-seven counties within Pennsylvania. Crawford County has an overall approximately 540 confirmed cases of Lyme disease from 2000 until 2020, although actual totals may be significantly higher due to under reporting. Crawford County as a whole has a moderately high positive total for Lyme Disease in the county, especially over the past several years. It is possible that numbers have risen dramatically due to lack of testing in previous years. Crawford County experienced the highest number of positive cases in 2018 and 2019. Lyme disease case counts have been consistently rising over the past several years. It should be noted that information represented for each county may vary due to reporting practices. Hence these figures represent a rough estimate of the Lyme disease burden in Crawford County. *Table 43 - Lyme Disease Data for Crawford County* outlines the total positive cases of Lyme Disease within Crawford County from 2000 to 2020. Data after 2020 was not available for this report.

Table 43 - Lyme Disease Data for Crawford County

Lyme Disease Data for Crawford County	
Year	**Total Positives**
2000	0
2001	0
2002	0
2003	4
2004	4
2005	4
2006	1
2007	4
2008	4
2009	1
2010	3
2011	4
2012	13
2013	4
2014	16
2015	21
2016	61
2017	85
2018	126
2019	139
2020	46
Source: PA Tick Check, 2023	

Zika Virus

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

4.3.10.4 Future Occurrence

Pandemic & Epidemic

The probability of a widespread public health emergency effecting Crawford County is approximately once every ten years. Minor outbreaks of less serious communicable disease, such as influenza, will occur much more frequently. The occurrence of pandemic influenza outbreaks is unpredictable, and complete avoidance of the events is unlikely. Therefore, future occurrences of pandemics and infectious disease events are very likely. Pandemics may also emerge from other diseases, especially invasive pathogens for which Crawford County and Pennsylvania as a whole lack natural immunity.

Influenza

It is estimated that 5% to 25% of Pennsylvanians get the flu each year, and 120 to 2,000 individuals die from complications of influenza. The CDC recommends that everyone six months and older get a flu vaccine every season to prevent future cases from rising. People who are at a high risk of serious flu illness should take flu antiviral drugs as soon as they get sick.

Infectious Disease

Infectious diseases such as West Nile Virus and Lyme Disease have been present in Crawford County for many years and are expected to perpetuate. The best way to prevent infectious disease outbreaks, including West Nile Virus and Lyme Disease, is to actively address the causes of the diseases. West Nile Virus occurrence can be reduced by removing mosquito breeding locations in stagnant water sources and Lyme Disease occurrence can be reduced by utilizing insect repellant, removing ticks promptly, applying pesticides, and reducing tick habitats. Occurrence of Zika Virus can also be reduced by removing mosquito breeding areas and areas of stagnant water. Both West Nile Virus and Lyme Disease are expected to continue occurring in Crawford County in the future.

Climate change can result in a wider range of pandemic, epidemics, and infectious diseases that can impact larger areas of the globe. As climate change continues to occur, more populations have the potential to come into contact with vectors for diseases. The migration of animals could also increase vulnerability to this hazard for populations in Crawford County. Climate change is discussed below in Section 4.3.7.5.

4.3.10.5 Vulnerability Assessment

Crawford County is considered to be a moderate vulnerability county in regard to the pandemic events. It is extremely difficult to predict the occurrence and the magnitude of a pandemic or epidemic event. The COVID-19 pandemic disproportionately affected populations over the age of sixty-five, especially those in nursing homes. It has had disparate effect on socially vulnerable populations, including unsheltered and homeless individuals.

Elderly individuals, children and immune deficient individuals are the most vulnerable to disease. Nursing facilities, personal care facilities, daycares, schools, and hospitals are considered more vulnerable since there are often groups of these socially vulnerable individuals present at these community lifelines. Congregate living facilities, including correctional institutions and dormitories would also be at an increased risk due to the difficulties in adhering to the social distancing required to help stop the spread of a pandemic. During the COVID-19 pandemic, nursing homes and personal care homes in Pennsylvania reported high numbers of cases and deaths, and several county jails and state correctional institutions reported wide community spread.

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

The number of hospitals within the county, and availability of beds within the hospitals, determine the amount of care vulnerable and sick patients will receive. It is important for hospitals to review and exercise emergency response plans and continuity of operations plans (COOP) to ensure that there is an effective public health response.

All critical infrastructure facilities and community lifeline facilities are vulnerable to pandemic, epidemic, and infectious disease, due to the people working and operating those facilities being at an increased vulnerability based on location and dispersion of disease vectors. This includes all of the critical infrastructure in the county and the community lifelines, a total of sixty-six locations. This includes but is not limited to two hospitals, three EMS stations, nine medical clinics, eight police stations, and twenty-nine fire stations. These locations are spaced evenly throughout the county but are clustered primarily in the boroughs of the county.

A pandemic can vastly impact historic resources by disrupting routine maintenance, leading to physical deterioration of structures and artifacts. The closure of cultural institutions, including museums and archives, hinders public access and educational activities. Economic downturns may reduce funding for preservation efforts, while a decline in tourism threatens the financial sustainability of historic sites. Community engagement may suffer if events and traditional practices are disrupted, affecting the transmission of cultural knowledge.

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

PODs are coordinated with county emergency managers by the PA DOH with the six regional healthcare districts (see *Figure 30 - Pennsylvania Department of Health Districts*). Crawford County is in the Northwest region. At the time of the writing of this plan, PODs were involved with mass vaccinations against COVID-19 and most PODs have been shut down due to lack of high-demand for vaccinations.

Municipalities with an increased risk to pandemic, epidemic, and infectious disease:

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Township
- Cambridge Springs Borough
- Centerville Borough
- Cochranton Borough
- Conneaut Township
- Conneaut Lake Borough
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Linesville Borough
- Meadville, City of
- North Shenango Township
- Oil Creek Township
- Pine Township
- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Spartansburg Borough
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Townville Borough
- Troy Township
- Union Township
- Venango Borough
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township

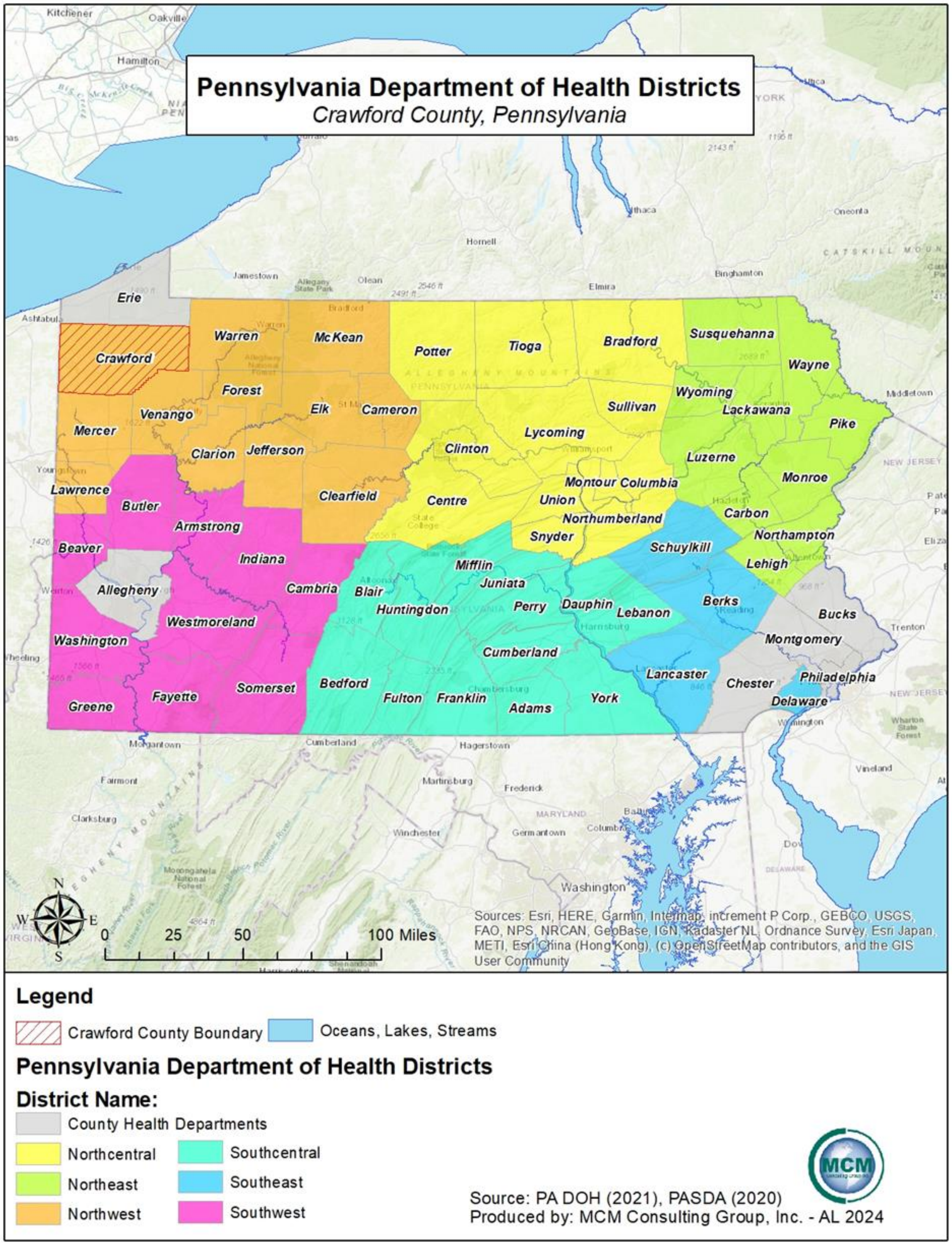
- West Shenango Township
- Woodcock Borough
- Woodcock Township

Land use and land development could directly impact the vulnerability of Crawford County to pandemic, epidemic, and infectious disease. Development of forested and rural areas could result in populations coming into direct contact with vectors for infectious disease including, most prominently, Lyme Disease and West Nile Virus. When rural and natural habitats for wildfire are developed, those vectors that live along and with wildlife have the potential to encounter that individuals developing properties, and the populations that will occupy or live in those areas. An increase in development could also lead to an increase in the number of individuals living in Crawford County, increasing the county's vulnerability to pandemic events, like COVID-19.

Climate change can significantly impact the dynamics of pandemics, epidemics, and infectious diseases. Rising temperatures and altered precipitation patterns can expand the geographic range of disease vectors, such as mosquitoes carrying diseases like malaria and dengue fever. Changes in climate can also affect the behavior and distribution of animal hosts, potentially facilitating the transmission of zoonotic diseases to humans. Extreme weather events, intensified by climate change, can also disrupt healthcare systems and infrastructure, hindering the response to outbreaks. Additionally, shifts in temperature and humidity can influence the survival and spread of pathogens, potentially leading to the emergence of new infectious diseases. Overall, climate change exacerbates the complexity and challenges of managing and preventing pandemics and epidemics, making it crucial to address both environmental and public health concerns in a coordinated manner to mitigate the impact on global health.

Population changes can directly impact the vulnerability of Crawford County to pandemic events, like COVID-19. With increased populations there is a greater risk of the spread of communicable diseases, especially in areas where the population density is high. There are four Municipalities in Crawford County that have seen an increase in population between 2010 and 2020. This information is shown in *Table 3 – Population Change in Crawford County. Crawford* County should monitor population growth in the boroughs and cities of the county. The socially vulnerable populations in Crawford County are at a higher vulnerability of pandemic, epidemic, and infectious diseases than lesser vulnerable populations. This is due to lack of health care services for homeless, unsheltered, and transient populations in Crawford County and the difficulty in receiving treatment for health issues stemming from pandemics, epidemics, and infectious diseases. The national social vulnerability index for Crawford County from CDC/ATSDR (Center for Disease Control and Prevention/Agency for Toxic Substances and Disease Registry) is 0.5019, which represents a medium to high level of vulnerability.

Figure 30 - Pennsylvania Department of Health Districts



4.3.11. Radon Exposure

4.3.11.1 Location and Extent

Airborne radon gas is radioactive and is a step in the radioactive decay of uranium to radium. Radon is a noble gas, cannot be seen and has no odor. Like other noble gasses, radon gas is very stable, so it does not easily combine with other chemicals. Two isotopes of radon are commonly found: 222Rn and 220Rn. The 220Rn isotope has a very short half-life, so it often only exists for fifty-five seconds, not long enough to pose a hazard to humans. The 222Rn isotope has a half-life of 3.8 days which is long enough to pose a threat to humans. Still, due to the relatively short half-life of 222Rn, it only exists in relative proximity to its radioactive parent, usually within tens of feet away. Radon is a carcinogen and when inhaled, it can lead to the development of lung cancer.

Radioactivity, caused by airborne radon, has been recognized for many years as an important component in the natural background radioactivity exposure of humans, but it was not until the 1980s that the wide geographic distribution of elevated values in houses and the possibility of extremely high radon values in houses were recognized. Radon was discovered as a significant source of natural radiation for humans in 1984 in the Reading Prong geologic province in Eastern Pennsylvania, when routine monitoring of employees leaving the not yet active Limerick nuclear power plant showed readings that a construction worker working on the plant frequently exceeded expected radiation levels despite the fact that the plant was not active. The Environmental Protection Agency (EPA) guidelines state that mitigation actions should be taken if levels exceed 4pCi/L in a home, and most uranium miners have a maximum exposure of 67 pCi/L. Subsequent testing of the Limerick power plant worker's home showed high radon levels of 2,500 pCi/L (pico Curies per Liter), triggering the Reading Prong to become the focus of the first large-scale radon scare.

Radon gas is considered ubiquitous and can be found in indoor and outdoor environments. There is no known safe level of exposure to radon. For most people in Pennsylvania, the greatest risk of radon exposure is from within their home in rooms that are below, directly in contact with, or immediately above the ground. Sources of radon include radon in the air from soil and rock beneath homes, radon dissolved in water from private wells and exsolved during water use (rare in Pennsylvania), and radon emanating from uranium-rich building materials such as concrete blocks or gypsum wallboard (also rare in Pennsylvania). Key factors in radon concentration in homes are the rates of air flow into and out of the house, the location of air inflow, and the radon content of air in the surrounding soil. Because of the flow dynamics of air inside of most houses, even a small rate of soil radon gas inflow can lead to elevated radon concentrations.

There are several factors that contribute to higher radon levels in soil gas:

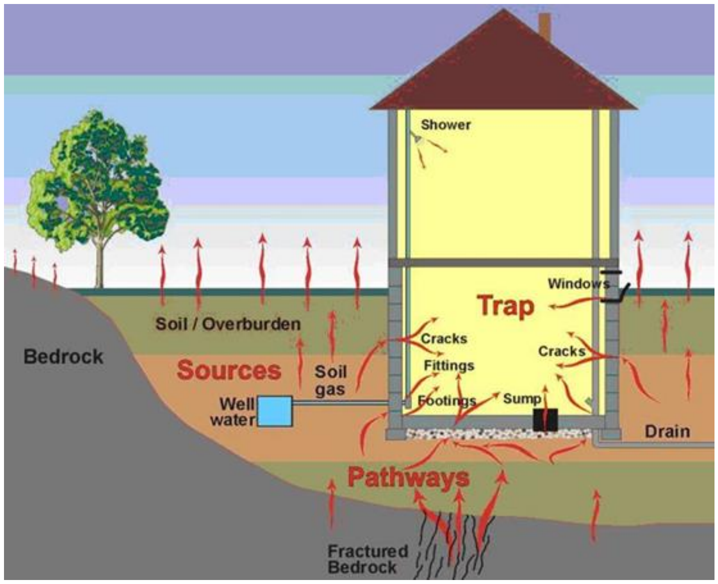
- Proximity to elevated uranium rich deposits (>50ppm). Areas within a few hundred feet of such deposits are most at risk. Such deposits are rare in Pennsylvania.
- Some more common rocks have higher than average uranium content (5 to 50 ppm), and proximity to such rocks also increases the risk of radon exposure. These rock types include black shales as well as granitic and felsic alkali igneous rocks. This is the most common source of high radon levels in Pennsylvania. The Reading Prong elevated radon levels come from Precambrian granitic gneisses.
- Other soil and bedrock properties that facilitate radon mobility. The amount of pore space in the soil and its permeability – more porous soils will allow radon to travel more easily. Limestone-dolomite soils can also be predisposed to collect radon from radium resultant from weathering of iron oxide or clay surfaces. In some cases (like State College in Centre County, PA) even with underlying bedrock having normal uranium concentrations (.5 to 5 ppm), the vast majority of locations built on limestone-dolomite soils exceed radon concentrations of 4pCi/L, and many exceeded 20 pCi/L.

The following three sources of radon in houses are now recognized (see *Figure 31 - Sketch of Radon Entry Points into a House* below):

- Radon in soil air that flows into the house
- Radon dissolved in water from private wells and exsolved during water usage; this is rarely a problem in Pennsylvania
- Radon emanating from uranium-rich building materials (e.g., concrete blocks or gypsum wallboard); this is not known to be a problem in Pennsylvania

High radon levels were initially thought to be exacerbated in houses that are tightly sealed, but it is now recognized that rates of airflow 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 (where radon concentration is 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.

Figure 31 - Sketch of Radon Entry Points into a House



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

The second factor listed above is most likely the cause of high radon levels in Crawford County. The data show that most reported zip codes in the county have high basement radon level test results. The areas and test results are shown in more detail in the past occurrence section.

4.3.11.2 Range of Magnitude

According to the EPA, about 21,000 lung cancer deaths each year in the U.S. are related to radon. It is the second leading cause of lung cancer after smoking and the number one cause of lung cancer among nonsmokers. Radon causes lung cancer by continuing to radioactive decay after being inhaled, and turning into a daughter product (218Po, 214Pb, 214Bi) which may become attached to lung tissue and induce lung cancer due to the continued radioactive decay.

The EPA reports that the national average radon concentration of indoor air of homes is about 1.3 pCi/L, and they recommend that homes be fixed if the radon level is 4pCi/L or more. There is however no safe level of radon exposure, so the EPA also recommends considering fixing a home if the radon level is between 2 pCi/L and 4 pCi/L.

Table 44 - Radon Risk for Smokers and Nonsmokers shows the relationship between various radon levels, probability of lung cancer, comparable risks from other hazards, and action thresholds. As seen in *Table 44 - Radon Risk for Smokers and Nonsmokers* below, a smoker exposed to radon has a much higher risk of lung cancer.

Table 44 - Radon Risk for Smokers and Nonsmokers

Radon Risk for Smokers and Nonsmokers			
Radon Level (pCi/L)	**If 1,000 People Were Exposed to this level over a lifetime…***	**Risk of cancer from radon exposure compares to...*****	**Action Threshold**
SMOKERS			
20	About 260 people could get lung cancer	250 times the risk of drowning	Fix Structure
10	About 150 people could get lung cancer	200 times the risk of dying in a home fire	
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 2pCi/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

Radon Risk for Smokers and Nonsmokers			
Radon Level (pCi/L)	**If 1,000 People Were Exposed to this level over a lifetime…***	**Risk of cancer from radon exposure compares to...*****	**Action Threshold**
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.

4.3.11.3 Past Occurrence

In 1984, the Pennsylvania Radon Bureau responded to the newly detected high radon levels with a massive radon monitoring, educational, and remediation effort. In the start of November 1986, over 18,000 homes had been screened for radon and approximately 59% were found to have radon daughter levels in excess of the 0.020 Working Level (WL) guideline. Radon daughter levels ranged up to 13 WL or 2600 pCi/L or radon gas.

The Pennsylvania Department of Environmental Protection (PA DEP) provides information for homeowners about how to test for radon in their homes, and when they receive a test result over 4 pCi/L, the PA DEP Bureau of Radiation Protection works to help homeowners repair the home and mitigate the hazard. The DEP 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. The PA DEP records all the tests they receive and categorize them in a searchable database by zip code. There are currently 2,174 zip codes in Pennsylvania, but the zip code radon test data only covers for 986 zip codes. The missing zip codes that report in the database as "N/A" for insufficient data either had fewer than thirty test results or no test results at all.

Figure 45 – Radon Test Results in Crawford County shows a total of eleven zip codes in Crawford County where tests were reported to the PA DEP to report their findings; those with no available data were not included in the table. The highest average radon level was reported from the 16354-zip code, which is in the far eastern corner of the county, with an average reading of 9.8 pCi/L within location of the basement. Most reporting zip codes in Crawford County have average basement Radon levels significantly above the suggested EPA action level of 4 pCi/L. The average basement reading for reporting zip codes in the county is 5.6 pCi/L, and the average first floor reading is 3.3 pCi/L.

Table 45 - Radon Test Results in Crawford County

Zip Code	Postal Community	Location	Max Result pCi/L	Average Result pCi/L
16403	Cambridge Springs	Basement	**55.8**	**4.1**
		First Floor	**12.1**	**1.6**
16404	Centerville	Basement	**208.0**	**9.6**
		First Floor	**N/A**	**N/A**
16314	Cochranton	Basement	**91.0**	**8.3**
		First Floor	**N/A**	**N/A**
16316	Conneaut Lakeshore	Basement	**76.6**	**5.1**
		First Floor	**59.9**	**4.6**
16406	Conneautville	Basement	**16.3**	**3.6**
		First Floor	**N/A**	**N/A**
16327	Guys Mills	Basement	**27.5**	**4.5**
		First Floor	**N/A**	**N/A**
16424	Linesville	Basement	**22.6**	**2.8**
		First Floor	**N/A**	**N/A**
16335	Meadville	Basement	**115.7**	**3.9**
		First Floor	**20.5**	**1.7**
16433	Saegertown	Basement	**35.5**	**4.4**
		First Floor	**12.0**	**2.9**
16354	Titusville	Basement	**190.6**	**9.8**
		First Floor	**89.6**	**5.5**

Zip Code	Postal Community	Location	Max Result pCi/L	Average Result pCi/L
16440	Venango	Basement	**24.9**	**5.1**
		First Floor	**N/A**	**N/A**

4.3.11.4 Future Occurrence

Radon exposure is likely given the geologic and geomorphic conditions in Crawford County. The EPA and USGS have mapped radon potential in the US to help target resources and assist local governments in determining if radon-resistant features are applicable for new construction. The designations are broken down in three zones and are assigned by county, as shown in *Figure 32 – Pennsylvania Radon Levels*. Each zone reflects the average short-term measurement of radon that can be expected in a building without radon controls. Crawford County is located within Zone II with counties of moderate potential for radon which indicates an intermediate likelihood of occurrence in the future.

1. Zone 1 has the highest potential and readings can be expected to exceed the 4 pCi/L recommended limit.
2. Zone 2 has a moderate potential for radon with levels expected to be between 2 and 4 pCi/L and
3. Zone 3 has a low potential with levels expected to be less than 2 pCi/L.

Due to the moderate likelihood of future occurrence, the level of radon daughters should be monitored. Radon daughters are the concentration of decay products of radon in the uranium chain. Fortunately, the presence of radon daughters can be monitored through the means as radon gas. *Table 46 - Suggested Actions and Time Frame for Exposure to Radon Daughters* provides suggested actions and time frames for varying levels of exposure to radon daughters.

Table 46 - Suggested Actions and Time Frame for Exposure to Radon Daughters

Suggested Actions and Timeframe for Exposure to Radon Daughters		
Exposure Level*	Suggested Action**	Timeframe For Plan
more than 5.0 WL***	Residents should either promptly relocate or undertake temporary remedial action to lower levels as far below 5.0 WL as possible. Smoking in high areas discouraged.	Within 2-3 days

Suggested Actions and Timeframe for Exposure to Radon Daughters		
Exposure Level*	Suggested Action**	Timeframe For Plan
1.0 to 5.0 WL	Residents should undertake temporary remedial action to lower levels as far below 1.0 WL as possible. Smoking in high areas discouraged.	Within 1 week
0.5 to 1.0 WL	Residents should undertake temporary remedial action to lower levels as far below 0.5 WL as possible.	Within 2 weeks
0.1 to 0.5 WL	Residents should undertake temporary remedial action to lower levels as far below 0.1 WL as possible. Higher exposure levels require action to be taken in a shorter	3 weeks to 3 months
0.02 to 0.1 WL	Residents should undertake temporary and/or permanent remedial action to lower levels below 0.02 WL. Higher exposure levels require action to be taken in a shorter	4 to 15 months

Climate change will have minor impacts on radon exposure in Crawford County, if any. Climate change will have an increased impact on the vulnerability of individuals to radon if those individuals live in an area where permafrost is a feature of the climate. With rising global temperatures, permafrost can melt, resulting in increased soil and bedrock erosion. This can result in higher rates of radon exposure. This is of primary concern to those areas located in the northern latitudes and will not have a significant impact on the bedrock or soils of Crawford County. It is possible that climate change could impact soil and bedrock erosion rates in Crawford County, but these impacts would be minor or unknown, at this time.

4.3.11.5 Vulnerability Assessment

Proper testing for radon levels should be conducted across Crawford County, especially in the areas of higher incidence levels, and for those individuals and households that face the contributing risks. This testing will determine the level of vulnerability that residents face in their homes, as well as in their businesses and schools.

Crawford County is in the EPA Radon Hazard Zone II, meaning there is a moderate risk of radon exposure. Smokers can be up to ten times more vulnerable to lung cancer from high levels of radon depending on the level of radon they are exposed to. Additionally, older homes that have crawl spaces or unfinished basements are more vulnerable to having high radon levels. Average basement radon levels for homes who reported their results to the PA DEP are often found to be above the EPA action level of 4 piC/L. *Figure 33 – Radon Levels by Zip Code* shows the best available data from the EPA about the percentage of homes with radon levels at or above the EPA action level. The EPA estimates that an average radon mitigation system costs approximately $1,200.00. The PA DEP Bureau of Radiation Protection provide short- and long-term tests to determine radon levels, as well as information on how to mitigate high levels of radon in a building. The 2023 PA HMP estimates that there are 49,842 vulnerable buildings in Crawford County that are in areas with high radon test results, and the cost to mitigate the most impacted of those buildings (an estimated 20% of them or 9,968 buildings) would be $4,883,192.

The historic properties in Crawford County are at varying levels of risk to radon levels. There are no historic properties that are at an increased risk of radon exposure. None of the historic buildings are in an area that has had at least an average of 12 pCi/L based on tests reported to the state of Pennsylvania. There is one historic property listed with the National Register of Historic Places that is located in an area that has had at least an average of between 4.51 pCi/L and 5.5 pCi/L of measured radon levels. That property is Titusville City Hall.

The cultural resources in Crawford County could be adversely impacted by radon exposure. The areas that underlay in Crawford County have previous average radon levels between 2.8 pCi/L and 9.6 pCi/L. If these locations have not been properly mitigated, the visitors to these locations could be at risk of radon exposure, even for a short time. The cultural resources in Crawford County are in areas of low to moderate radon vulnerability. The direct hazard to radon exposure at these locations is not related to the buildings, but to the individuals who live, work, visit, and maintain these structures.

The vulnerability of natural areas to radon exposure is negligible. Since radon exposure typically is a natural hazard to humans when in enclosed spaces, and over a large portion of time, natural areas are at a lower risk. Most individuals are doing activities when outdoors and are usually not stationary for hours and days. The local parks, state game lands, state forests, and state parks are at low risk and low vulnerability.

Municipalities with an increased risk of radon exposure (with areas with a basement pCi/L over 12):

- No municipalities

Municipalities without an increased risk of radon exposure (with areas with a basement pCi/L under 12):

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Township
- Cambridge Springs Borough
- Centerville Borough
- Cochranton Borough
- Conneaut Township
- Conneaut Lake Borough
- Conneautville Borough
- Cussewago Township

- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Linesville Borough
- Meadville, City of
- North Shenango Township
- Oil Creek Township
- Pine Township
- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Townville Borough
- Troy Township
- Union Township
- Venango Borough
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township
- West Shenango Township
- Woodcock Borough
- Woodcock Township

Socially vulnerable populations in Crawford County are at an increased vulnerability to radon exposure than other groups within the county. Approximately 13.1% of the population of Crawford County is in poverty, and those individuals may be located in areas of high radon vulnerability. Those individuals may also be unable to purchase or install radon remediation kits and systems due to economic factors. Information from the Pennsylvania Department of Environmental Protection states that installing a radon reduction system can cost between $500.00 to $2,000.00 with the average costing $1,000.00. (PA DEP, 2023) Radon exposure may also impact the health of those considered socially vulnerable. With unequal access to or opportunity to get health care, potential health effects related to radon exposure can go unreported and unaddressed in socially vulnerable populations.

Population changes, especially any increase in population, in Crawford County pose an increased risk to vulnerability of radon exposure to individuals in each municipality. Between the 2010 and the 2020 US Census, four municipalities in Crawford County experienced population growth. These increases can be seen in *Table 3 – Population Change in Crawford County*. Another risk to radon exposure due to population changes could occur from people moving into structures with basements that have sat empty for extended periods of time or converting camps into homesteads. Education about the dangers of radon exposure should occur at the municipal level when existing homes are purchased. New construction can be built with radon prevention systems in place. Radon prevention systems can cost between $500.00 to $2,000.00 per building.

Land use could result in more rapid radon exposure if the areas being used for different land uses are over areas of high radon levels. If new land use results in exposure of the bedrock to weathering, increased radon exposure and leakage will occur. This could include the development of new or commercial properties in an area. New development may be built and constructed with radon reduction systems already in place, reducing the vulnerability for each new location with these systems. New development may have clean aggregate in construction, piping below the foundation slab, sealing of openings in foundations, or electric boxes in the attic for radon reduction system fans (PA DEP, 2023).

Radon can impact Crawford County infrastructure systems by accelerating corrosion in metal components of buildings such as steel reinforcements in concrete, leading to weakening of structural elements over time. This corrosion can compromise the stability of bridges, tunnels, and other critical infrastructure. Additionally, radon-induced degradation of building materials like concrete can cause cracks, spalling, and overall degradation of structural integrity. Radon can infiltrate underground utility tunnels that can corrode pipes, conduits and electrical wiring which can lead to the potential of leaks and electric failures. Radon has the ability to compromise both structural and operational functions of infrastructure systems.

Figure 32 - Pennsylvania Radon Levels

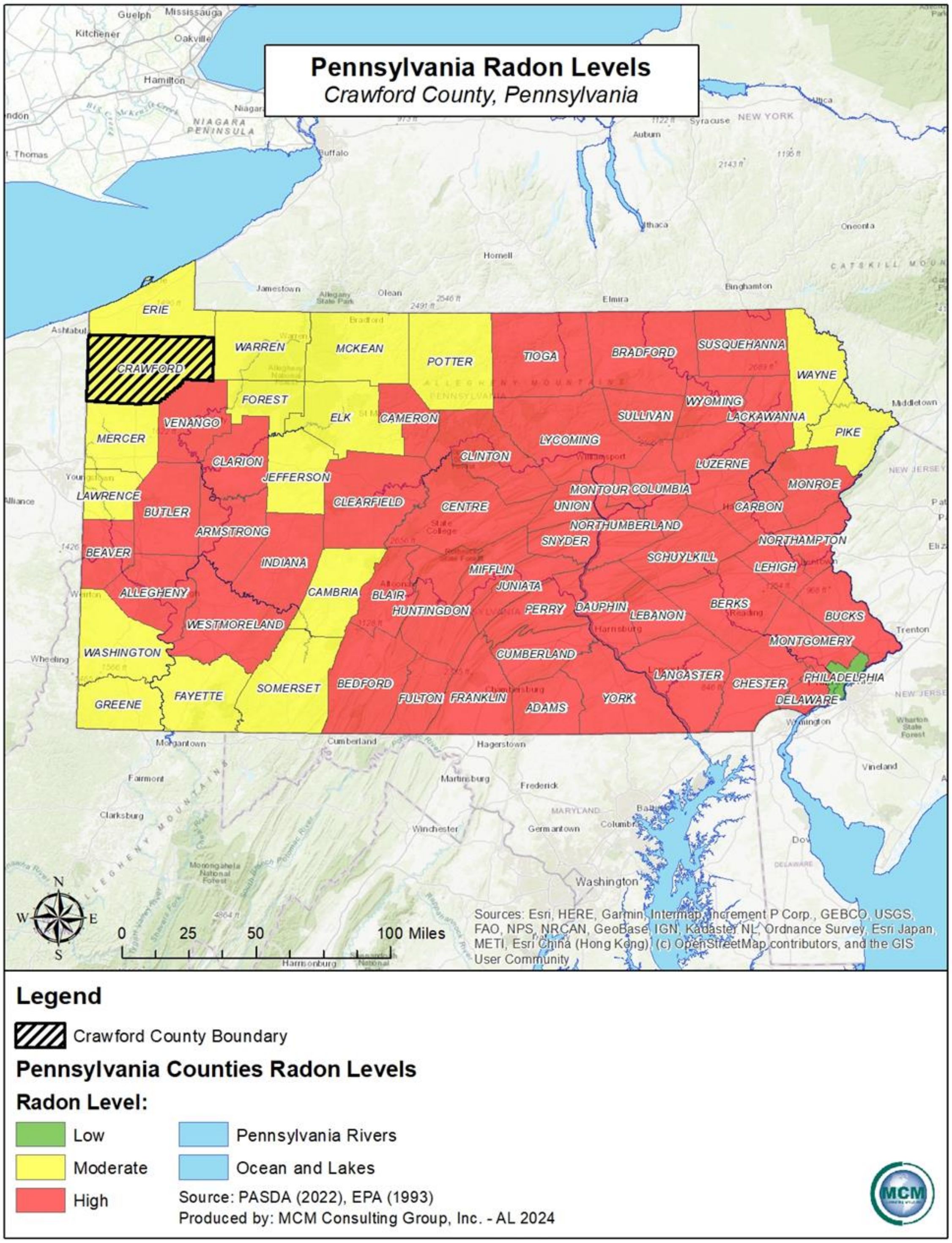
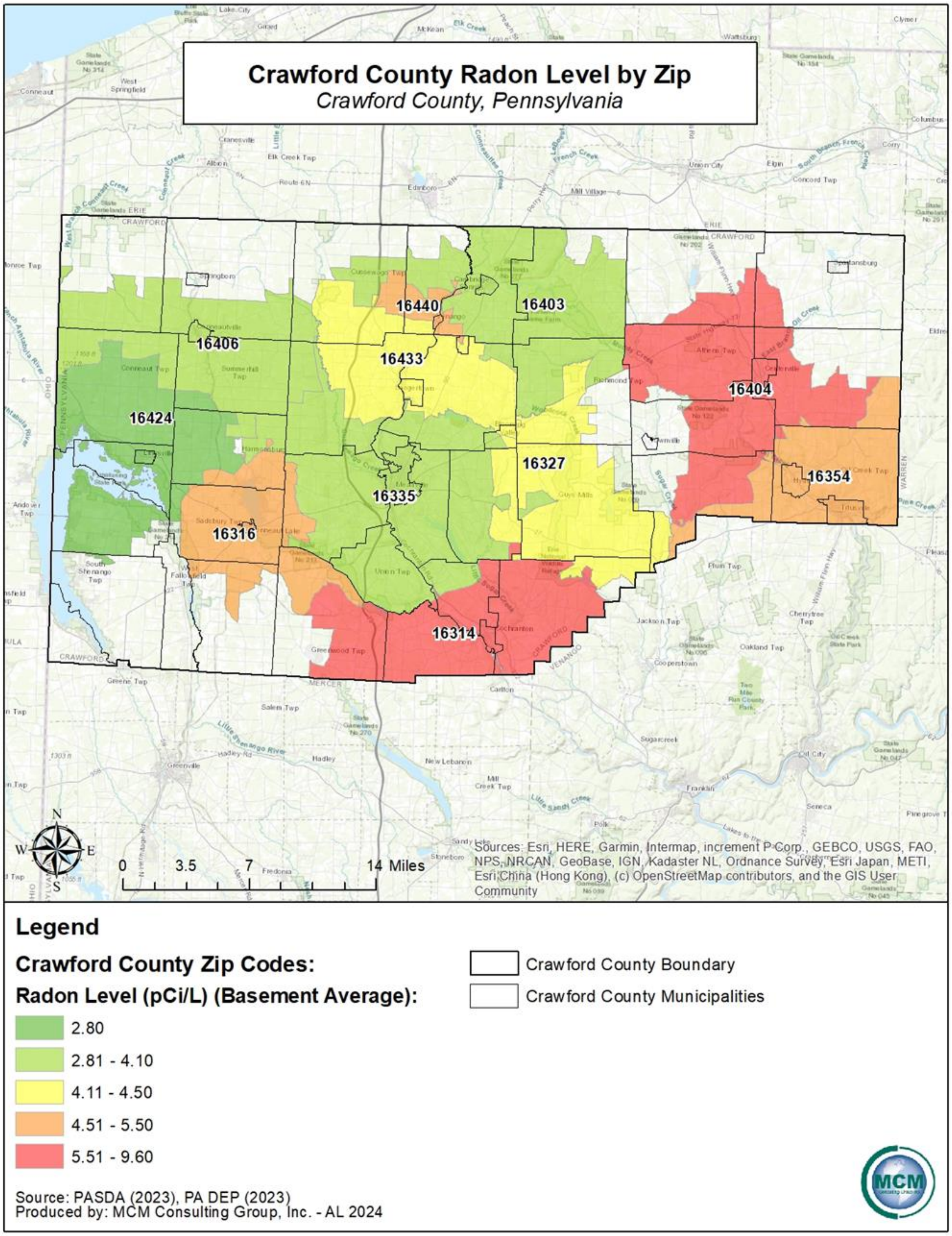


Figure 33 - Radon Levels by Zip Code



4.3.12. Subsidence and Sinkhole

4.3.12.1 Location and Extent

Subsidence is the sinking movement of the earth's surface; the result of this movement is commonly referred to as a sinkhole. There are two common causes of subsidence in Pennsylvania: 1) dissolution of carbonate rock such as limestone or dolomite and 2) mining activity. In the first case, water passing through naturally occurring fractures and bedding planes dissolves bedrock leaving voids below the surface. Eventually, overburden on top of those voids collapses, leaving surface depressions resulting in what is known as karst topography. Characteristic structures associated with karst topography include sinkholes, linear depressions, and cases. Often, sub-surface solution of limestone will not result in the immediate formation of karst features. Collapse sometimes occur only after a large amount of activity, or when a heavy burden is placed on overlying material. The bedrock geology is found mostly in the south-central and eastern portions of the Commonwealth of Pennsylvania, and Crawford County is not located in a karst vulnerable area. Subsidence in Crawford County is primarily due to karst topography and also as a result of mining activity. This plan will focus on both carbonate rock / karst topography and mining activity. Crawford County has a history of subsidence due to carbonate rock and mining activity.

Mining activity is concentrated in the southwestern region of the state. The majority of sub-surface (i.e., underground) extraction of materials such as oil, gas, coal, metal ores (i.e., copper, iron, and zinc), clay, shale, limestone, or water can result in slow-moving or abrupt shifts in the ground surface and these areas have a higher potential to be impacted by sinkholes and subsidence. Sinkholes often develop where the cover above a mine is thin. Sinkhole development normally occurs where the interval to the ground surface is less than three to five times the thickness of the extracted seam and the maximum interval is up to ten times the thickness of the extracted seam. In western Pennsylvania, most sinkholes develop where the soil and rock above a mine are less than fifty feet thick.

Human activity can also result in subsidence or sinkhole events. Leaking water pipes or structures that convey storm-water runoff may result in areas of subsidence as the water dissolves substantial amounts of rock over time. Poorly managed stormwater can be an exacerbating factor is subsidence events. In some cases, construction, land grading, or earthmoving activities that cause changes in stormwater flow can trigger sinkhole events.

4.3.12.2 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 the proximity to development ultimately determine the magnitude of damage incurred. Events could result in minor elevation changes or deep, gaping holes in the surface. Subsidence and sinkhole 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. Isolated incidents of subsidence throughout the coal regions over the past years have affected houses, garages, and trees that have been swallowed up by subsidence holes. Lengths of local streets and highways, and countless building foundations have been damaged.

If long-term subsident or sinkhole formation is not recognized and mitigation measures are not implemented, fractures or complete collapse of building foundations and roadways may result. The worst-case scenario of a mine subsidence event for Crawford County would be similar to an event in Allegheny County in 2013, when sixty-nine homes in Hyde Park sustained mine subsidence damage. The Pennsylvania Department of Environmental Protection responded to the subsidence by filling the mine voids at a cost of $3.7 million. If mitigation measures are not taken, the cost to fill in and stabilize sinkholes can be significant although sinkholes are limited in range of magnitude.

Voids in the earth's subsurface are created where coal was previously mined and removed. The condition removes a significant portion of the support of the overlying rock strata that usually causes the rock strata to fall or subside into the voids that may damage dwellings or other surface structures above the affected areas. Mining locations across the county should be carefully noted and avoided as sites for new construction unless the proper measures are taken to ensure the mine's soundness.

The Crawford County local planning team assigned a risk factor assessment score of 1.6 to subsidence and sinkhole formation. This places the hazard at a low risk factor. *Figure 34 – Sinkhole Susceptibility in Pennsylvania* illustrates the portions of the Commonwealth of Pennsylvania where sinkholes and subsidence are common. The hazard for subsidence and sinkholes in these regions is very high. Crawford County has a large portion of mining areas and is therefore one of these regions.

4.3.12.3 Past Occurrence

There is no comprehensive list of mine subsidence in Crawford County. The Pennsylvania Department of Conservation and Natural Resources (PA DCNR) provides an online sinkhole inventory database, which lists a total of 3,619 identified sinkholes in Pennsylvania as of 2023. Of these sinkholes zero fall within Crawford County. The fact that no sinkholes were identified does not necessarily mean there are no sinkholes in Crawford County. Additionally, the Pennsylvania Department of Environmental Protection indicates that some small incidences of sinkholes occur several times per week and cause limited damage and that many of these are related to failing infrastructure like water main breaks or collapsed pipes.

4.3.12.4 Future Occurrence

There is currently no reliable information regarding the probability of future occurrence of subsidence or sinkholes in Pennsylvania. One way of estimating the probability of future occurrences would be to project the historical trends into the future, but there is no comprehensive documentation of previous events in Crawford County. The PA DEP has noted that mine subsidence events are constant though they vary in intensity and damage. Based on geological conditions and mining activities in Crawford County , the annual occurrence of subsidence and sinkholes near karst topography and where mining occurs is considered likely. Although precise locations of future occurrences is difficult to predict due to site-specific conditions that contribute to sinkhole development, there are several signs that can signal potential development.

The signs include:

- Slumping or falling fence posts, trees, or foundations.
- Sudden formation of small ponds.
- Wilting vegetation.
- Discolored well water.
- Structural cracks in walls and/or floors.

Based on geological conditions and mining activity, subsidence events are not likely to occur in Crawford County. If land development and mining were to occur in an area that is unstable or unsafe, a subsidence event or sinkhole is likely to form. *Figure 36 – Unsuitable Areas for Mining in Pennsylvania* illustrates the areas of Pennsylvania where mining could potentially cause a subsidence event or a sinkhole. A significant number of these areas that are unsuitable for mining are located in and around Crawford County.

Climate change may increase the frequency of subsidence in Crawford County. Climate change could result in more intense rainfall from more frequent hurricanes and tropical storms, and it could result in hot, dry areas becoming increasingly dry. The increase in precipitation could result in ground swelling, due to soils that contain clay minerals absorbing the rainfall. This swelling is seen as an increase in vertical land motion, while shrinking is the decrease in vertical land motion. Shrinking occurs when there are high temperatures that cause the land to dry out, resulting in more movement of the soil, which can be seen as a gradual settling or sudden sinking of Earth’s surface. The combination of shrinking and swelling could increase with climate change and ultimately increase the frequency of subsidence and sinkholes in Crawford County.

4.3.12.5 Vulnerability Assessment

Areas of the county where commercial mining operations take place are the most vulnerable to subsidence and sinkhole hazards. Natural subsidence and sinkholes have never been reported in Crawford County. A mined area may be differentially prone to subsidence based on its geology and depth of mineral seam, but reliable information about the different locations of varying depths of seams are not available. Geologists agree that all areas that are mined are prone to subsidence; therefore, coal mined areas are shown as vulnerable to mine subsidence. Moist of the mining that has occurred in Crawford County was superficial mining of natural resources. The mine sites were abandoned after extraction can potentially become areas susceptible to subsidence events. These areas can be seen in *Figure 35 – Abandoned Mined Sites in Crawford County*. Subsidence cannot be ruled out as a potential hazard for Crawford County. There are no state or county critical infrastructure facilities at risk in the county due to sinkholes.

There are no critical facilities or community lifelines that are within areas of vulnerability to subsidence and sinkhole events in Crawford County. There are no fire departments, police departments, or EMS agencies in those vulnerable areas. There are no historic buildings with 500 feet of abandoned mine inventory locations.

Municipalities with the highest risk of subsidence or sinkholes (abandoned mine areas and areas unsuitable for mining):

- No municipalities

Municipalities with an increased risk of subsidence or sinkholes (abandoned mine areas):

- East Fallowfield Township
- East Mead Township

Municipalities without an increased risk of subsidence or sinkholes (no abandoned mine areas):

- Athens Township
- Beaver Township
- Bloomfield Township
- Blooming Valley Borough
- Cambridge Township
- Cambridge Springs Borough
- Centerville Borough
- Cochranton Borough
- Conneaut Township
- Conneaut Lake Borough
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Hydetown Borough
- Linesville Borough

- Meadville, City of
- North Shenango Township
- Oil Creek Township
- Pine Township
- Randolph Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Spartansburg Borough
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Townville Borough
- Troy Township
- Union Township
- Venango Township
- Vernon Township
- Wayne Township
- West Fallowfield Township
- West Mead Township
- West Shenango Township
- Woodcock Borough
- Woodcock Township

Underserved, unserved, and socially vulnerable populations face heightened impacts from subsidence and sinkholes. Limited resources often result in substandard infrastructure, exacerbating susceptibility to ground collapse. Housing in these areas is prone to structural damage, posing threats to lives and livelihoods. Displacement becomes a critical concern as sinkholes disrupt communities, challenging access to safe shelter. Vulnerable populations may lack the financial means for adequate recovery, perpetuating economic hardships.

Population change can increase the impacts of subsidence or sinkholes in Crawford County. Crawford County has four municipalities that had a population increase between the 2010 and the 2020 US Census. This population change can also be seen in *Table 3 – Population Change in Crawford County*. Based on this information, it can be speculated that these municipalities may have an increased/equivalent risk to subsidence and sinkholes since 2010, due to the increase in population and construction.

Current land use in Crawford County can affect the vulnerability of the county to subsidence and sinkholes. Impervious surfaces allow pollutants from aerial and terrestrial sources to accumulate. During stormwater runoff, these pollutants will run into stormwater drains and directly to local waterbodies. When impervious surfaces increase, so does the quantity, speed, temperature, and pollutant load of the storm water runoff.

Subsidence and sinkholes present dual threats to both natural and cultural areas. Ecologically, these alter landscapes, compromising soil stability and disrupting ecosystems. Sinkholes can swallow habitats, impacting land use for the county. Culturally, the collapse of terrain endangers heritage sites, structures, and artifacts, erasing historical landscapes. Subsidence may threaten traditional agricultural practices linked to specific terrains.

Subsidence and sinkhole events can also pose a threat to systems within Crawford County. Some systems that may be affected by subsidence and sinkhole events are natural gas, water, and the numerous other materials and chemicals transported through underground water systems in Crawford County. During significant subsidence and sinkhole events, underground pipelines may crack, causing the transported material to leak into the ground and contaminating water sources in the county. Even in more contained scenarios, a small leak can have profound impact if the transported material is toxic or hazardous in nature, leading to degradation of the natural resources in the impacted communities. Subsidence and sinkhole events can also cause above ground localized transportation issues if an event were to occur along a transportation route through Crawford County. This can cause a delay in daily transportation and may require alternate transportation routes to be established for an extended period of time.

Figure 34 - Sinkhole Susceptibility in Pennsylvania

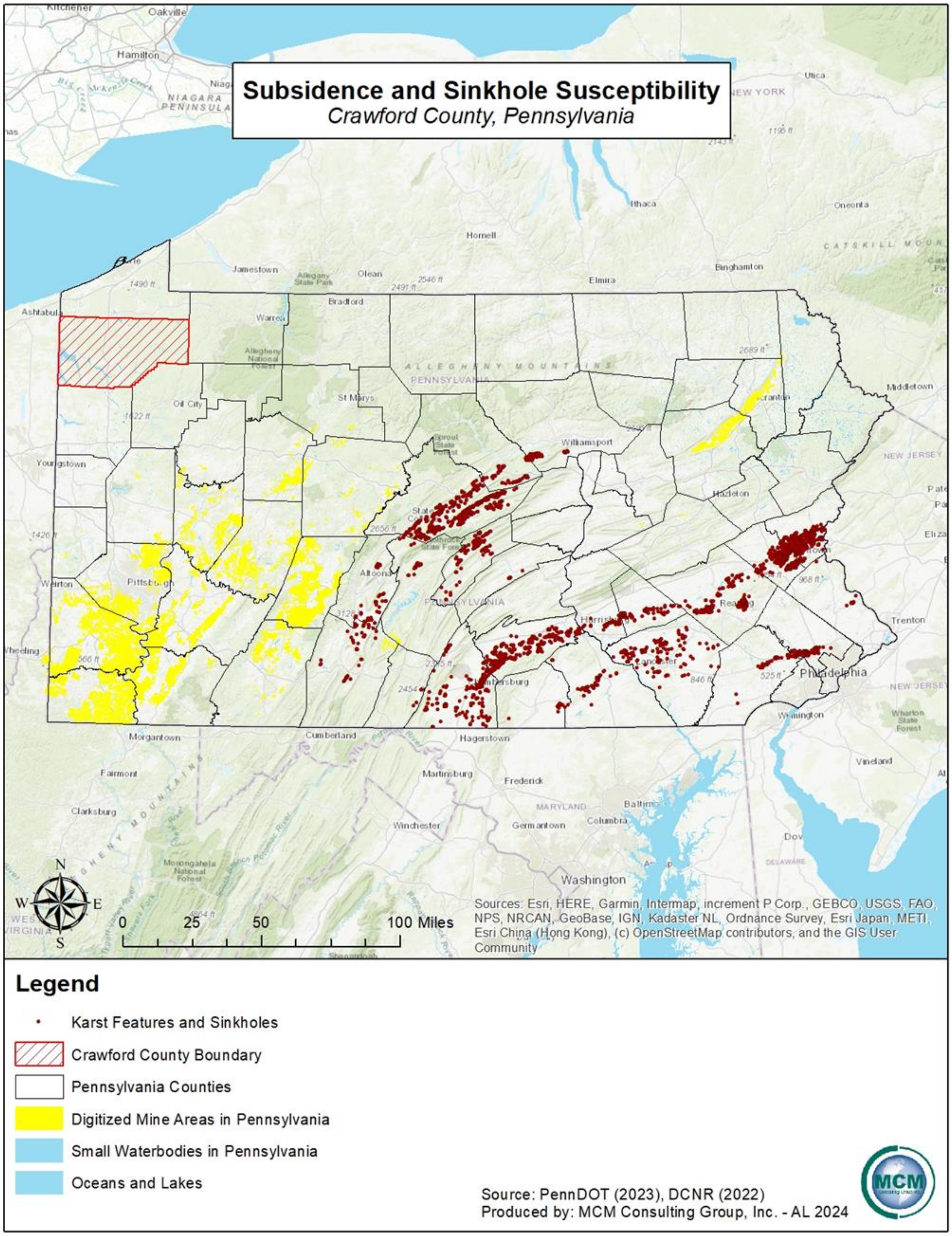


Figure 35 - Abandoned Mined Sites in Crawford County

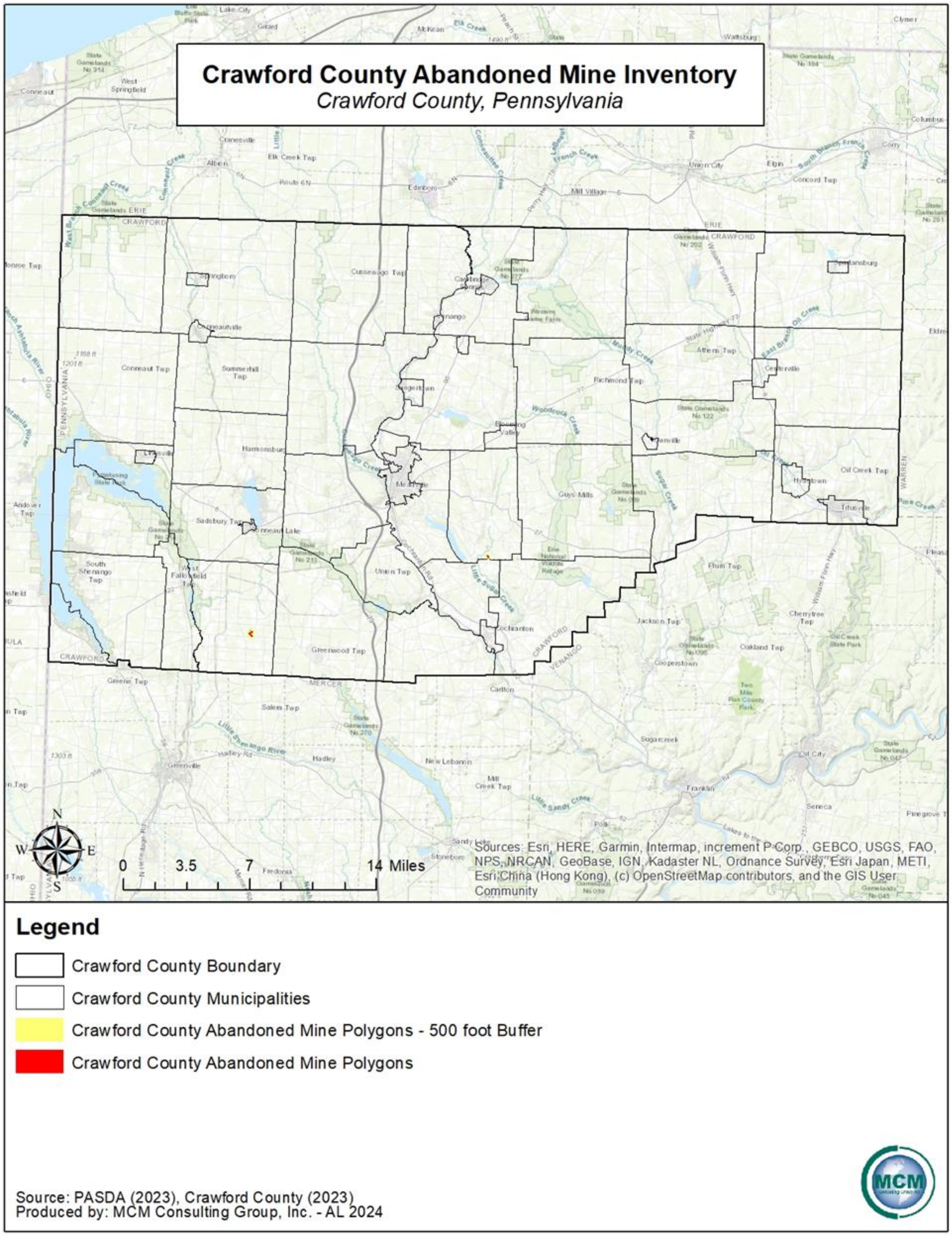
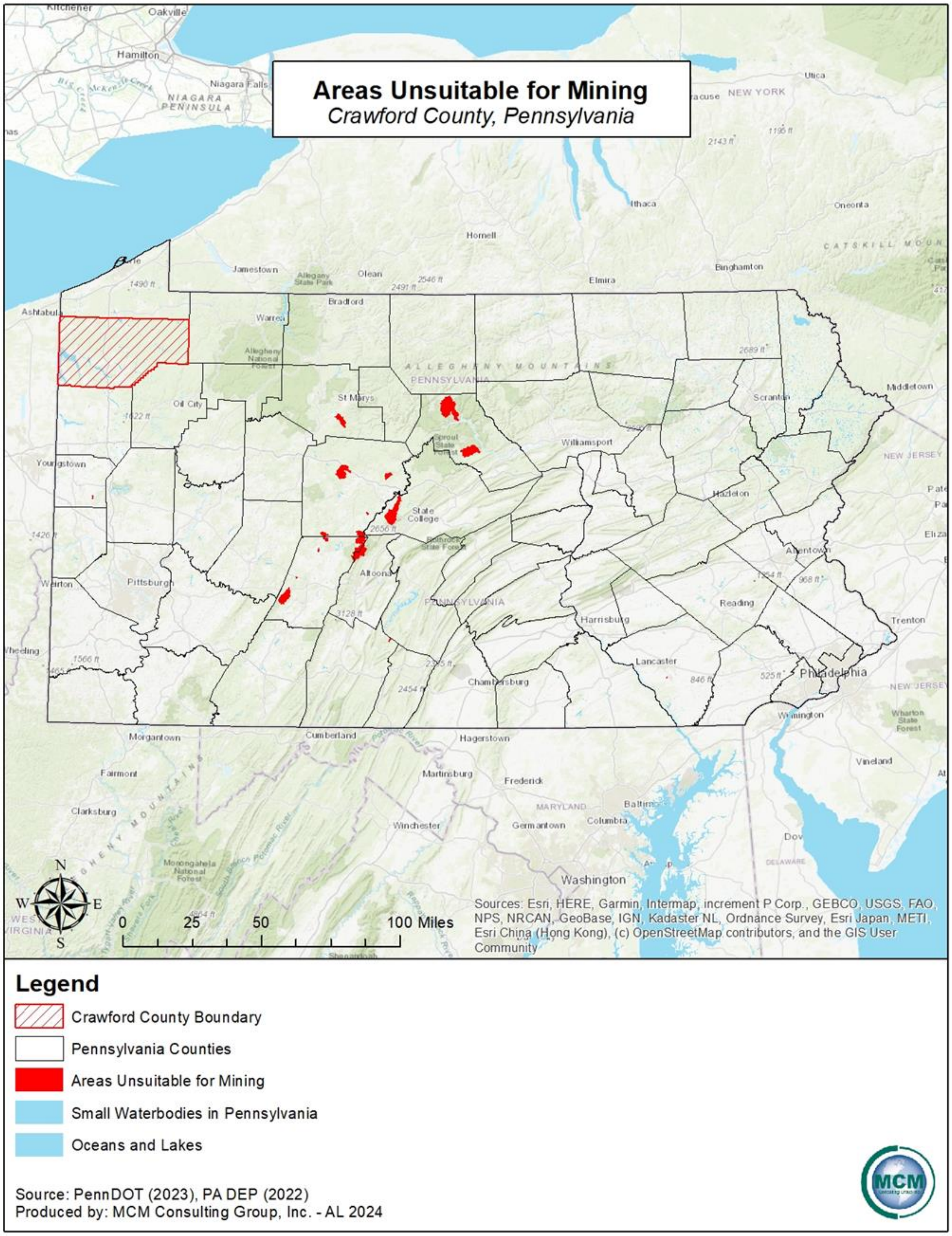


Figure 36 - Unsuitable Areas for Mining in Pennsylvania



4.3.13. Tornado and Windstorm

4.3.13.1 Location and Extent

Tornadoes and windstorms can occur throughout Crawford County and are usually localized in their location and extent. Severe thunderstorms may result in conditions favorable for the formation of windstorms, including tornadoes. Tornadoes are nature's most violent storms and can cause fatalities and devastation to neighborhoods and municipalities within the county and region. Tornadoes can occur at any time during the day or night but are most frequent during the later afternoon and early evening, which are typically the warmest hours of the day. Tornadoes are most likely to occur in the spring and summer.

Tornadoes

There are two main types of tornadoes: supercell and non-supercell. Supercell tornadoes are the most common and often the most dangerous type of tornado. A rotating updraft is key to the development of a supercell and, eventually, a tornado. Once the updraft is rotating and being fed by warm air, a tornado is formed. The other type of tornado is categorized as non-supercell, which is not as common as a supercell tornado. One type of non-supercell tornado is the "Quasi-Linear Convective Systems" (QLCS). The QLCS tornadoes typically arise during the late night or early morning hours and are typically weaker and more short-lived than supercell tornadoes. However, QLCS are more difficult to detect effectively. Another type of non-supercell tornado is a landspout. These tornadoes are narrow, rope-like funnels that form when a thundercloud grows without a rotating updraft, which causes the spinning motion common with tornadoes to appear near the ground.

Windstorms

Windstorms are experienced on a region-wide scale. The most frequent cause of windstorms in Pennsylvania are thunderstorms, although they may also be caused by hurricanes and winter storms. Windstorms are defined as sustained wind speeds of 40 mph or greater, lasting for at least one hour, or winds of 58 mph or greater lasting for any duration. There are a wide variety of windstorm events that can take place in Crawford County.

4.3.13.2 Range and Magnitude

Tornadoes

Each year tornadoes account for $1.1 billion in damages and cause over eighty deaths nationally. Thus far, 2011 was the second worst year on record for deadly tornadoes behind 1936. The number of tornado reports has increased since 1950. While the extent of tornado damage is usually localized, the vortex of extreme wind associated with a tornado can result in some of the most destructive forces on Earth. The damage caused by a tornado is a result of the high-wind velocity and windblown debris, also accompanied by lightning or large hail. The most violent tornadoes have rotating winds of 250 mph or more and are capable of causing extreme destruction and turning normally harmless objects into deadly projectiles.

Tornado movement is characterized in two ways: direction/speed of spinning winds and the forward movement of the tornado, also known as the storm track. The rotational wind speeds can range from 65 to more than 200 miles per hour (mph). The speed of forward motion can range from 0 mph to 50 mph. Forward motion of a tornado path can be a few to several hundred miles in length. Widths of tornadoes vary from less than 100 feet in diameter to more than a mile wide in regard to the largest tornadoes on record. The National Centers for Environmental Information (NCEI) reports that, “the maximum winds in tornadoes are often confined to extremely small areas and vary tremendously over short distance,” which explains why one house in a tornado’s path may be completely demolished while a neighboring house could remain untouched. Some tornadoes never touch the ground and remain short lived, while others may touch the ground or “jump” along its path.

The destruction from tornadoes can range from minor to severe depending on the intensity, size, and duration of the storm. Typically, tornadoes cause the greatest damage to structures of light-weight construction, such as mobile homes. The Enhanced Fujita Scale, also known as the “EF-Scale”, measures tornado strength and associated damages. The EF-Scale is an update to the earlier Fujita Scale, also known as the “F-Scale”, that was published in 1971. These scales classify U.S. tornadoes into six intensity categories based upon the estimated maximum winds occurring within the wind vortex. This scale can be seen in *Table 47 – Enhanced Fujita Scale*. The EF-Scale became effective on February 1, 2007. Since its implementation by the National Weather Service in 2007, the EF-Scale has become the definitive metric for estimating wind speeds within tornadoes based upon damage to buildings and structures. Previously recorded tornadoes are reported with the older F-Scale values, but *Table 47 – Enhanced Fujita Scale* shows F-Scale categories with corresponding EF-Scale wind speeds.

Figure 37 – Pennsylvania Wind Zones identifies wind speeds that could occur across the state, which may be used as the basis for design and evaluation of the structural integrity of shelters and critical facilities. The majority of Pennsylvania falls within Zone III, meaning that the design of shelters and critical facilities should be able to withstand a three-second gust of up to 200 mph, regardless of whether the gust is a result of a tornado, hurricane, tropical storm, or windstorm incident. The western portion of the state falls within Zone IV, which indicates shelters can withstand up to 250 mph winds, while the eastern side falls within Zone II where shelters should be designed to withstand up to 160 mph.

Since Crawford County falls within Zone IV, shelters and critical facilities should be designed to withstand up to 250 mph winds, regardless of whether the gust is the result of a tornado, coastal storm, or windstorm event. While it is difficult to pinpoint the exact locations at the greatest risk of a tornado, the southeast, southwest, and northwest sectors of the commonwealth are more prone to tornadoes.

Tornadoes/windstorms of all types have caused the following problems in Crawford County:

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

Table 47 - Enhanced Fujita Scale

Enhanced Fujita Scale			
EF-Scale Number	**Wind Speed (MPH)**	**F-Scale Number**	**Description of Potential Damage**
EF0	65–85	F0-F1	**Minor damage**: Peels surface off some roofs; some damage to gutters or siding; branches broken off trees; shallow-rooted trees pushed over. Confirmed tornadoes with no reported damage (i.e., those that remain in open fields) are always rated EF0.
EF1	86-110	F1	**Moderate damage**: Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors; windows and other glass broken.
EF2	111–135	F1-F2	**Considerable damage**: Roofs torn off well-constructed houses; foundations of frame homes shifted; mobile homes completely destroyed; large trees snapped or uprooted; light-object missiles generated; cars lifted off ground.

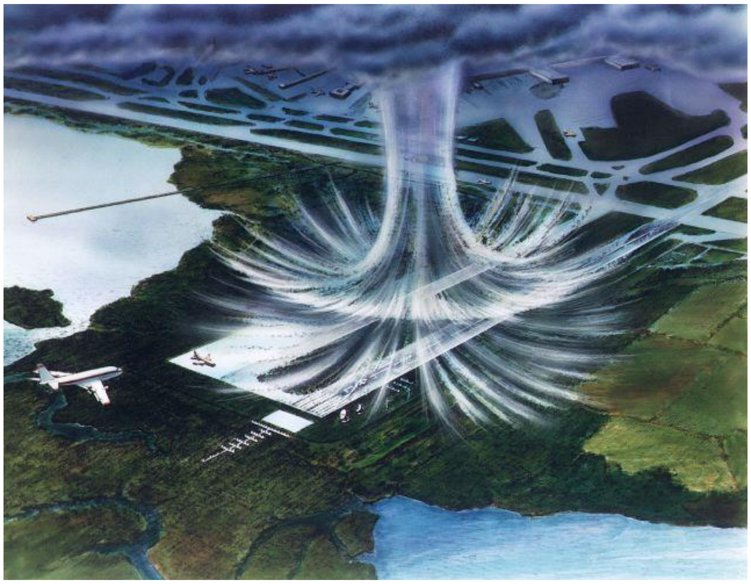
Enhanced Fujita Scale			
EF-Scale Number	**Wind Speed (MPH)**	**F-Scale Number**	**Description of Potential Damage**
EF3	136–165	F2-F3	**Severe damage**: Entire stories of well-constructed houses destroyed; severe damage to large buildings such as shopping malls; trains overturned; trees debarked; heavy cars lifted off the ground and thrown; structures with weak foundations blown away some distance.
EF4	166–200	F3	**Devastating damage**: Well-constructed houses and whole frame houses completely leveled; cars thrown, and small projectiles generated.
EF5	>200	F3-F6	**Extreme damage**: Strong frame houses leveled off foundations and swept away; automobile-sized projectiles fly through the air in excess of 100 m (300 ft.); steel reinforced concrete structure badly damaged; high-rise buildings have significant structural deformation.
Source: NWS, 2007			

Most of the tornadoes that have struck Crawford County have occurred countywide. In 1985, a total of twenty-three confirmed tornadoes touched down across Eastern Ohio, Southwestern New York, and Central/Western Pennsylvania. This outbreak remains the worst in recorded history for this area. Of these twenty-three tornadoes, eight were of violent intensity (F4 or F5) with estimated wind speeds over 200 mph. Crawford County was impacted by the 1985 outbreak.

Windstorms

Windstorms can be broken down into multiple categories. Straight-line winds are the most common wind event and are different from tornadic winds. It is a ground level, non-rotational, wind that comes out of a thunderstorm. Downdrafts are columns of air that rapidly sinks toward the ground and are classified as either a microburst or microburst. A macroburst is the outward burst of strong winds that are near or at the surface with horizontal dimensions greater than 2 ½ miles. Macrobursts winds may begin over a smaller area and then spread out to a wider area, sometimes producing damage similar to a tornado. On the other hand, microbursts are smaller outward bursts of strong winds near or at the surface. Microbursts are less than 2 ½ miles in horizontal dimension and are typically short-lived winds that last a maximum of ten minutes, with windspeeds reaching up to 100 mph. Microburst events can be wet or dry events. Wet microbursts are typically associated with heavy precipitation at the surface. Dry microbursts do not have precipitation associated with them and are commonly found in the western portion of the United States.

A gust front is characterized by wind shift, temperature drop, and gusty winds out ahead of a thunderstorm. Derecho is a long-lived windstorm that is associated with a band of rapidly moving showers or thunderstorms. A typical derecho contains various downbursts and microbursts. If the wind damage is more than 240 miles and includes wind gusts of at least 58 mph, the event would then be classified as a derecho.



4.3.13.3 Past Occurrence

Crawford County has experienced thirty-nine tornado events since 1950, forty high wind incidents, ten strong wind incidents, and 442 thunderstorm wind incidents as seen in *Table 48 – Crawford County Tornado History* and *Table 49 – Crawford County High and Strong Wind History*. Numerous sources provide information in regard to past occurrences and losses associated with tornadoes/windstorms in Crawford County and the commonwealth as a whole. Due to the number of sources available with information, specific number of events and losses could vary slightly between sources. Tornado data was only present until 2021, while windstorm data was only available until 2023, even though more recent events could have possibly occurred. Historically, the county has experienced both severe windstorms and tornadoes.

The most recent tornado impacted Mt. Hope on July 29th, 2021. A brief EF0 tornado began along Fowler Road and tracked southeast and ended near Sugar Lake Road in Wayne Township.

The tornado was estimated to reach a maximum windspeed of 85 mph and caused a notable amount of damage. Some of the damage caused by this tornado included roofs blown off of barns, a semi-truck blown off PA-173, structures destroyed, trees uprooted, and corn fields flattened.

Table 48 - Crawford County Tornado History

Crawford County Tornado History					
Location	**Date**	**Magnitude (F/EF Scale)**	**Deaths**	**Injuries**	**Property Damage**
Crawford County	07/24/1950	F0	0	0	$2,500.00
Crawford County	01/17/1952	F2	0	0	$250,000.00
Crawford County	07/01/1955	F2	0	0	$25,000.00
Crawford County	07/24/1968	F1	0	0	$250,000.00
Crawford County	05/02/1972	F3	0	3	$25,000.00
Crawford County	04/02/1979	F1	0	0	$25,000.00
Crawford County	06/15/1980	F0	0	0	$2,500.00
Crawford County	07/21/1980	F1	0	1	$250,000,000.00
Crawford County	07/28/1981	F2	0	4	$250,000.00
Crawford County	09/01/1981	F1	0	0	$25,000.00
Crawford County	05/02/1983	F0	0	0	$25,000.00
Crawford County	05/31/1985	F2	1	0	$0.00
Crawford County	05/31/1985	F3	2	0	$0.00
Crawford County	05/31/1985	F4	8	75	$25,000,000.00
Crawford County	05/31/1985	F2	0	0	$0.00
Crawford County	05/31/1985	F3	0	0	$2,500,000.00
Crawford County	06/22/1985	F2	0	0	$250,000.00
Crawford County	06/22/1985	F1	0	0	$25,000.00
Crawford County	06/22/1985	F1	0	0	$25,000.00
Crawford County	09/30/1986	F2	0	1	$2,500,000.00
Titusville	09/02/1993	F0	0	0	$5,000.00
Blooming Valley	06/11/1994	F1	0	1	$500,000.00
Saegertown	05/24/1995	n/a	0	0	$50,000.00
Linesville	07/20/1998	F1	0	0	$75,000.00
Custards	06/01/2001	F0	0	0	$100,000.00
Linesville	06/05/2002	F1	0	0	$50,000.00
Crossingville	07/27/2002	F0	0	0	$50,000.00
Cochranton	11/10/2002	F1	0	0	$325,000.00
Guys Mills	05/20/2004	F0	0	0	$50,000.00
Custards	05/25/2004	F2	0	0	$3,500,000.00
Meadville	05/01/2007	EF1	0	0	$500,000.00

Crawford County Tornado History					
Location	**Date**	**Magnitude (F/EF Scale)**	**Deaths**	**Injuries**	**Property Damage**
Conneautville	06/02/2010	EF0	0	0	$125,000.00
Rometown	06/06/2010	EF0	0	0	$30,000.00
Beaver Center	05/26/2011	EF1	0	0	$150,000.00
Conneautville	10/02/2018	EF2	0	1	$750,000.00
Woodcock	10/02/2018	EF1	0	0	$25,000.00
Townville	10/02/2018	EF1	0	0	$25,000.00
Springboro	04/14/2019	EF0	0	0	$50,000.00
Mt. Hope	07/29/2021	EF0	0	0	$0.00
		Totals:	**11**	**86**	**$287,540,000.00**
Source: NOAA NCEI, 2023					

Table 49 - Crawford County High and Strong Wind History

Crawford County High and Strong Wind History					
Location	**Date**	**Type**	**Magnitude (knots)**	**Injuries**	**Property Damage**
Crawford County	01/18/1996	High Wind	52	0	$3,000.00
Crawford County	01/27/1996	High Wind	50	0	$2,000.00
Crawford County	02/11/1996	High Wind	50	0	$2,000.00
Crawford County	03/25/1996	High Wind	50	0	$0.00
Crawford County	10/30/1996	High Wind	50	0	$500.00
Crawford County	02/27/1997	High Wind	n/a	0	$2,000.00
Crawford County	04/06/1997	High Wind	n/a	0	$2,000.00
Crawford County	05/01/1997	High Wind	n/a	0	$2,000.00
Crawford County	12/12/2000	High Wind	n/a	0	$200,000.00
Crawford County	02/09/2001	High Wind	n/a	0	$15,000.00
Crawford County	02/25/2001	High Wind	n/a	0	$15,000.00
Crawford County	10/16/2001	High Wind	n/a	0	$10,000.00
Crawford County	10/25/2001	High Wind	n/a	0	$25,000.00
Crawford County	02/01/2002	High Wind	n/a	0	$35,000.00
Crawford County	03/09/2002	High Wind	52	0	$150,000.00
Crawford County	10/04/2002	High Wind	0	0	$25,000.00
Crawford County	02/04/2003	Strong Wind	40	0	$50,000.00
Crawford County	03/08/2003	Strong Wind	46	0	$75,000.00
Crawford County	05/11/2003	Strong Wind	36	0	$25,000.00
Crawford County	10/14/2003	Strong Wind	35	0	$30,000.00
Crawford County	11/12/2003	High Wind	50	0	$150,000.00
Crawford County	03/05/2004	High Wind	50	0	$75,000.00

Crawford County High and Strong Wind History					
Location	**Date**	**Type**	**Magnitude (knots)**	**Injuries**	**Property Damage**
Crawford County	09/09/2004	Strong Wind	35	0	$25,000.00
Crawford County	12/07/2004	High Wind	50	0	$15,000.00
Crawford County	11/06/2005	High Wind	50	0	$25,000.00
Crawford County	02/17/2006	High Wind	50	0	$50,000.00
Crawford County	03/10/2006	Strong Wind	43	0	$15,000.00
Crawford County	10/28/2006	High Wind	60	0	$100,000.00
Crawford County	12/01/2006	High Wind	50	0	$10,000.00
Crawford County	12/23/2007	High Wind	50	0	$10,000.00
Crawford County	01/09/2008	High Wind	50	0	$20,000.00
Crawford County	01/30/2008	High Wind	50	0	$0.00
Crawford County	05/11/2008	Strong Wind	35	0	$20,000.00
Crawford County	09/14/2008	High Wind	52	0	$1,500,000.00
Crawford County	02/12/2009	High Wind	52	0	$250,000.00
Crawford County	10/07/2009	Strong Wind	39	0	$35,000.00
Crawford County	12/09/2009	High Wind	52	0	$200,000.00
Crawford County	05/08/2010	High Wind	50	0	$75,000.00
Crawford County	04/28/2011	High Wind	50	0	$25,000.00
Crawford County	02/24/2012	High Wind	50	0	$100,000.00
Crawford County	03/03/2012	High Wind	50	0	$2,000.00
Crawford County	10/30/2012	High Wind	50	0	$50,000.00
Crawford County	10/31/2013	Strong Wind	43	0	$10,000.00
Crawford County	11/24/2014	High Wind	52	0	$100,000.00
Crawford County	01/10/2017	High Wind	50	0	$75,000.00
Crawford County	01/01/2019	Strong Wind	44	0	$15,000.00
Crawford County	02/24/2019	High Wind	54	0	$100,000.00
Crawford County	01/12/2020	High Wind	50	0	$0.00
Crawford County	11/15/2020	High Wind	56	0	$0.00
Crawford County	03/26/2021	High Wind	50	0	$0.00
Source: NOAA NCEI, 2023					

4.3.13.4 Future Occurrence

In the United States, tornado activity has increased in variability, with a general decrease in the number of days a year on which activity occurs, but an increase in the number of tornadoes on those days. This indicates an increase in tornado outbreaks. The future probability of a disastrous tornado occurring in Crawford County is ranked as possible, but not highly likely. While the chance of being hit by a tornado in Crawford County is small, the damage that results when the tornado arrives can be devastating. An EF-5 tornado, with a 0.019% annual probability of occurring, can carry wind velocities of 200 mph, resulting in a force of more than 100 pounds per square foot of surface area. This is a "wind load" that exceeds the design limits of most buildings in Pennsylvania. As jurisdictions within the county grow, and as residential and commercial construction continues, the number of people and properties will be greatly affected by tornadoes and windstorms as they increase accordingly.

Based on historic patterns, tornadoes are unlikely to remain on the ground for long distances, especially in areas of the country with hilly terrain, such as the majority of Pennsylvania. However, the high historical number of windstorms with winds at or over 50 knots indicates that the annual chance of a windstorm in the county is uniquely high. The annual tornado season has begun to lengthen, with the season starting earlier than it has historically and ending later. Pennsylvania had, for example, a record number of tornadoes in April and May of 2019 compared to any other April and May on record. Climate change is causing temperatures and air moisture to increase, increasing the frequency and intensity of tornadoes and windstorms. There remains some uncertainty regarding the recurrence of tornadoes. Therefore, the number of future tornadoes and windstorm events could potentially increase due to known and unknown factors.

Based on historical incidents, there are three zones in Pennsylvania that can either experience less than one, one to four, or five to ten of EF-2 or above tornadoes per 3,700 square miles. Communities in Crawford County, as shown in *Figure 38 – Tornado Activity in Crawford County* below, are expected to have one to four tornadoes annually as a future occurrence. The approximation of one to four tornadoes annually assists with determining the rate of future tornado occurrences within Crawford County. Future tornadoes will be similar to those that affected the county in past events.

Windstorm events occur on a more frequent basis compared to tornadoes. Crawford County, specifically, experiences windstorm events more commonly than tornadoes, which causes power failure, loss of communication networks, and residents requiring temporary shelters and provision of supplies. Therefore, unlike tornadoes, this hazardous event has a highly likely probability for future events to occur within the county.

Climate change and its relationship with tornado outbreaks is hard to identify. Some recent studies suggest that as average temperatures begin to rise, so will the intense storms that often lead to the creation of tornadoes. Warm, moist air is the most important aspect for developing strong tornadoes. Climate change can exacerbate this, and it could potentially lead to an increase in frequency and the severity of the events. Although not yet proven, this is one of the most prevalent theories on how climate change can impact tornado frequency and intensity.

4.3.13.5 Vulnerability Assessment

The frequency of windstorms and minor tornadoes is expected to remain relatively constant, vulnerability increases in more densely developed areas. Factors that impact the amount of damage caused by a tornado include the strength of the tornado, the time of day, and the area of impact. Usually, such distinct funnel clouds are localized phenomena impacting a small area. However, the high winds of tornadoes make them one of the most destructive natural hazards. There can be many cascading impacts of tornadoes and windstorms including, but not limited to, transportation accidents, hazardous material spills, flooding, and power outages. A proper warning system is vital for the public to be informed of what to do and where to go during such events.

Additional dangers that accompany tornado-associated thunderstorms, and which increase the vulnerability of Crawford County, include:

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

The economy of Crawford County is highly vulnerable to tornadoes. While there may be severe impact on financial and commercial systems of the economy, these storms, and the damage they cause, can disrupt business long-term. The local economy is vulnerable due to the possibility of being crippled by tornadoes and windstorms and their cascading effects when buildings and supporting infrastructure are destroyed in a storm. Power outages can create work stoppages, while transportation accidents and road closures can limit transportation of goods and services. Additionally, flooding cannot be discounted as it can destroy physical structures, merchandise, and equipment essential for business operation.

Crawford County’s environment is also vulnerable to tornado events. However, since tornado events are typically localized, environmental impacts are rarely widespread. The impact of windstorms on the environment typically takes place over a large area. In either case, where these events occur, severe damage to plant species is likely. This includes uprooting or total destruction of trees and an increased threat of wildfire in areas where dead trees are not removed. Most notably, hazardous material spills can pollute ground water systems and vegetation. In the case of hazardous material spills, the local environment can be negatively impact and can cause extensive cleanup and mitigation efforts. Crawford County is considered a rural county that has a notable amount of tourism that occurs in the surrounding hills, mountains, and state parks. Not only is the environment vulnerable to tornadoes and windstorms, but hikers, tourists, and hunters are also vulnerable when out in the environment. Consequently, in the event of a tornado or severe storm, these tourists have limited emergency notification measures which result in high vulnerability. A storm has the ability, potentially, to destroy structures, damage private and public property, and injure citizens and tourists to the area. People with disabilities, the elderly, functional needs, and non-English speaking residents are more vulnerable to tornadoes, windstorms, and their cascading effects. Without assistance to evacuate and/or seek shelter, and with potential difficulty understanding information, these at-risk populations may be unable to prepare themselves, or their homes and other possessions, to safely endure the storm.

Tornado, windstorm, and cascading events may affect a small portion, or the entirety, of the county. Therefore, it is important to identify specific critical facilities and assets that are most vulnerable to this hazard. Critical facilities are highly vulnerable to windstorms and tornado events. While many severe storms can cause exterior damage to structures, tornadoes can destroy structures, along with their surrounding infrastructure, immediately halting their function. Tornadoes are often accompanied by severe storms which can be threatening to critical facilities within the county. Many secondary effects from these disasters can jeopardize the operation of these critical facilities as well. Critical facilities are particularly vulnerable to power outages which can leave facilities functionless, potentially crippling infrastructure supporting the population of the county. Due to Pennsylvania Uniform Construction Code Act 45, trailers and mobile homes built before 2004, because of their lightweight construction and often unanchored design, are more vulnerable to high winds/tornadoes and will generally sustain more damage than will mobile homes built after 2004. Based on information in the American Community Survey, from the United State Census Bureau 2022, there were approximately 3,186 occupied mobile homes in Crawford County that could be at increased vulnerability to tornados.

As seen in *Table 3 – Population Change in Crawford County*, four of the fifty-one municipalities in Crawford County have seen a net population increase from the 2010 decennial census to the 2020 decennial census. These municipalities are Blooming Valley Borough, Rome Township, Sparta Township, and Townville Borough. Based on this information, it can be speculated that these four municipalities may have an increased/equivalent vulnerability to tornadoes and windstorm hazards, since 2010, due to the increase in population and construction.

Tornadoes and windstorm events may disproportionately affect underserved, unserved, and socially vulnerable populations, amplifying existing hardships. Fragile infrastructure in these areas is more prone to damage, which can hinder evacuation and rescue efforts. Limited access to resources exacerbates challenges during and after the storms, from securing safe shelter to obtaining essential supplies. Vulnerable communities often lack financial resilience, facing prolonged economic setbacks as local businesses may suffer.

Land use, in the form of a built environment, such as residential expansion, can cause tornado impact severity to increase. Impact severity increases when built environment expansion provides an influx of people, infrastructure, and critical infrastructure in harm's way. Since the population in Crawford County had an overall decrease between 2010 and 2020, it can be speculated that the built environment did not increase significantly.

There is only one property listed with the National Register of Historic Places that is at an increased risk of tornadoes in Crawford County. This property is the bridge in East Fallowfield Township. This analysis was run off of the previous tornado paths in the county and 500 feet vulnerability zones. These locations are where tornadoes have previously developed and may develop again.

Tornadoes and windstorms exert profound impacts on both natural and cultural areas. Ecologically, these intense weather events can result in habitat destruction, altering landscapes, and threatening biodiversity. Culturally, these storms endanger heritage sites, historic structures, and artifacts, eroding tangible, and intangible cultural elements. Sustainable recovery efforts must embrace an integrated approach, recognizing the interconnected vulnerability of natural, historical, and cultural landscapes to the formidable forces of tornadoes and windstorms.

All of the critical infrastructure and community lifeline facilities are vulnerable to tornado events. Some of the critical infrastructure can be considered at a higher risk due to the life safety missions that they serve. Facilities that are within 500 feet of previous tornado tracks can be considered at high risk of tornados.

Critical infrastructure and community lifelines at high risk (within 500 ft of previous tracks):

- Fellows Club (Conneautville) VFD
- Ray's Market – Grocery Store
- Rolling Fields Elder Care (Summerhill)
- Springboro VFD

Municipalities with an increased risk of tornadoes (previously impacted):

- Athens Township
- Beaver Township
- Blooming Valley Borough
- Centerville Borough
- Cochranton Borough
- Conneaut Township

- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Hayfield Township
- Linesville Borough
- Pine Township
- Richmond Township
- Rockdale Township
- Rome Township
- Sadsbury Township
- Sparta Township
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Titusville, City of
- Union Township
- West Fallowfield Township
- West Mead Township
- Woodcock Township

Municipalities without an increased risk of tornadoes (not previously impacted):

- Bloomfield Township
- Cambridge Township
- Cambridge Springs Borough
- Conneaut Lake Borough
- Hydetown Borough
- Meadville, City of
- North Shenango Township
- Oil Creek Township
- Randolph Township
- Saegertown Borough
- South Shenango Township
- Spartansburg Borough
- Townville Borough
- Troy Township
- Venango Borough
- Venango Township
- Vernon Township
- Wayne Township
- West Shenango Township
- Woodcock Borough

Figure 37 - Pennsylvania Wind Zones

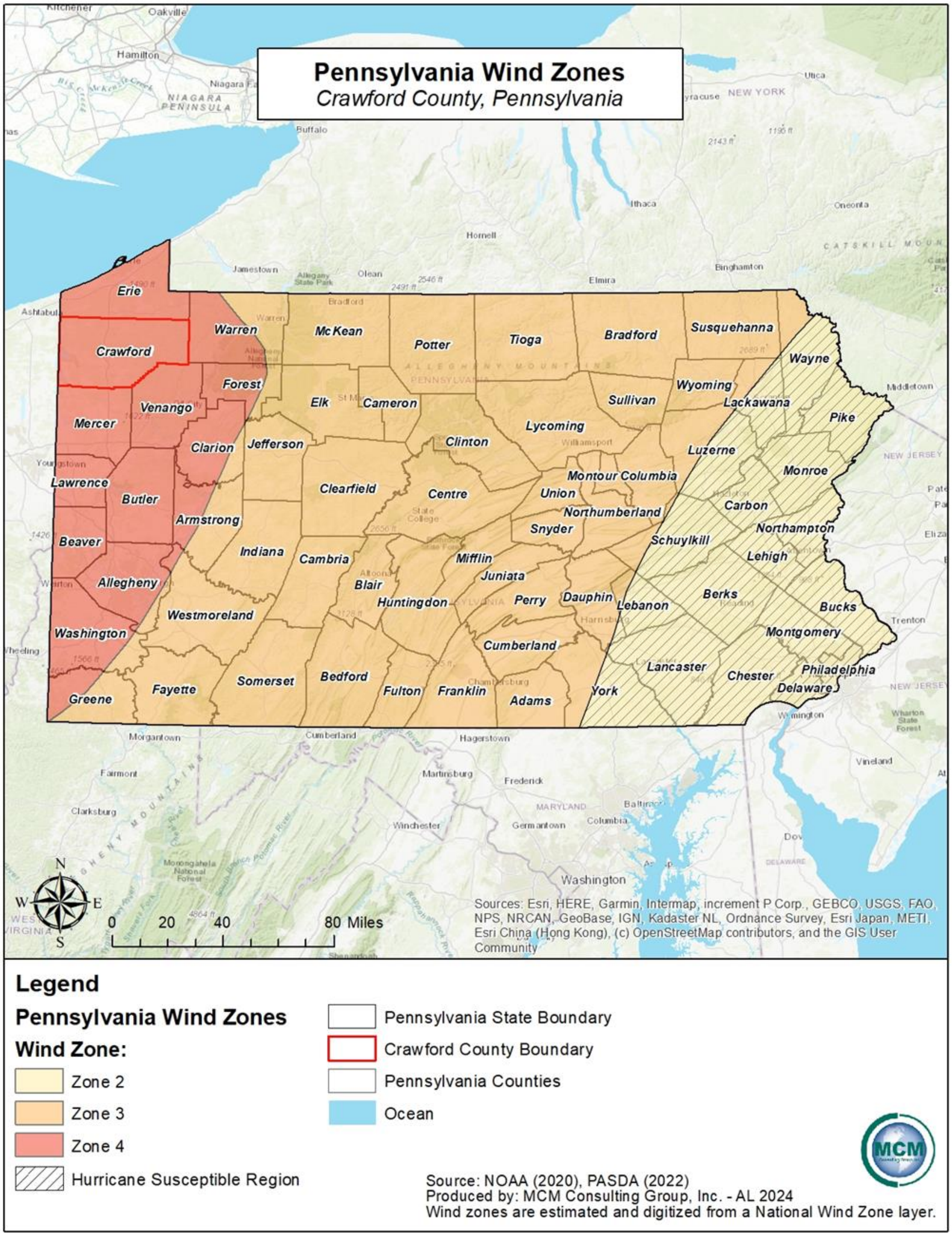


Figure 38 - Tornado Activity in Crawford County

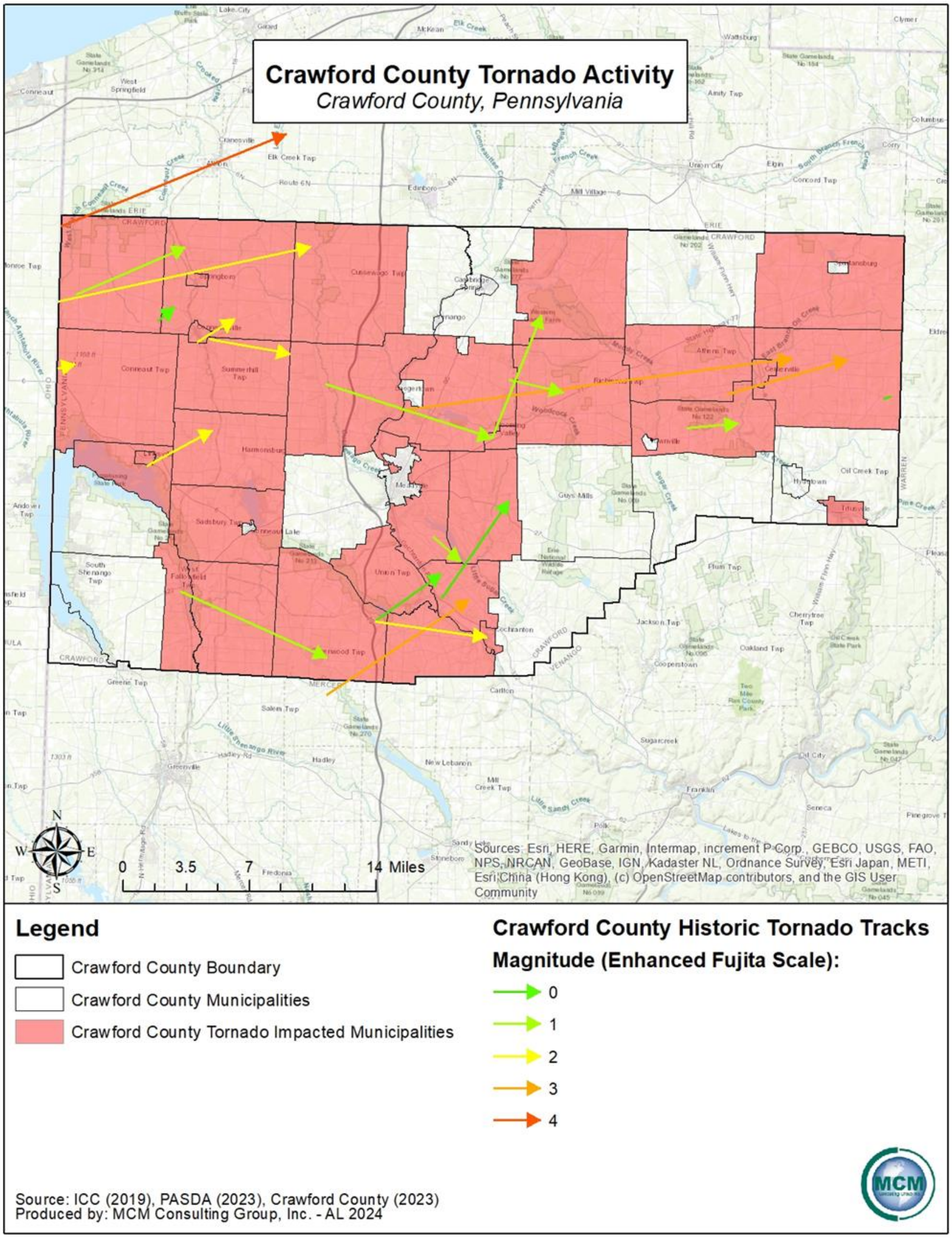
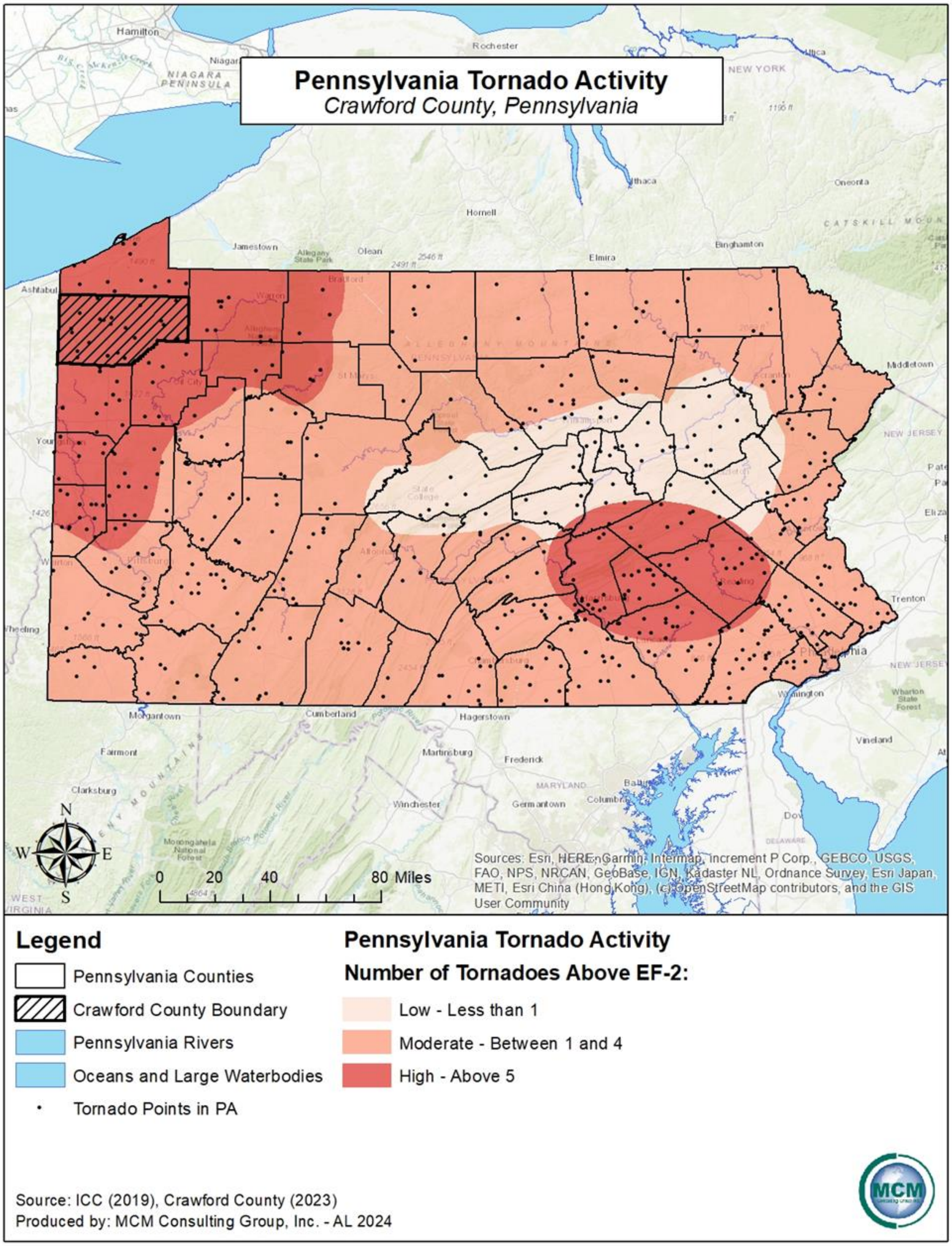


Figure 39 - Tornado Activity in Pennsylvania



4.3.14. Wildfire

4.3.14.1 Location and Extent

The most prevalent causes of devastating wildfires are droughts, lighting strikes, arson, human carelessness, and in rare circumstances, spontaneous combustion. Most fires in Pennsylvania are caused by anthropogenic fires such as debris burns that spread and get out of control. A fire, started in somebody's backyard, could travel through dead grasses and weeds into bordering woodlands starting a wildfire. Major urban fires can cause significant property damage, loss of life, and residential or business displacement. While wildfires are a natural and essential part of many native Pennsylvania ecosystems (e.g., pitch pine and scrub oak woodlands), wildfires can also cause devastating damage if they are undetected and allowed to propagate unfettered. Wildfires most often occur in less developed areas such as open fields, grass, dense brush, or forests where they can spread rapidly by feeding off of vegetation and combustible fuels. Wildfires are most prevalent under prolonged dry and hot spells, or general drought conditions.

A large portion of Crawford County is covered by either farmland or forested areas increasing the geographic extent of wildfire vulnerability in the county. Under dry conditions or droughts, wildfires have the potential to burn forests as well as croplands. For recreational enjoyment, the county boasts several local parks and natural areas that include a series of trail systems – all of which are at risk for wildfires.

4.3.14.2 Range of Magnitude

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

Almost all of the wildfires in the county occur in remote areas or areas away from residential structures. Unlike the wildland fires that occur in other parts of the country and affect vast areas of land and residential communities, most fires in Crawford County are contained before they cause damage or extensive property loss. However, the county recognizes that wildfires of some magnitude will continue to occur in Crawford County and will have more detrimental effects if development in and/or around the natural areas increases.

The United States Forest Service utilizes the Forest Fire Assessment System to classify the dangers of wildfire. *Table 50 – Wildland Fire Assessment System* identifies each threat classification and provides a description of the level.

Table 50 - Wildland Fire Assessment System

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

4.3.14.3 Past Occurrence

The Pennsylvania Department of Conservation and Natural Resources (DCNR) has an extensive history of reported wildfires in its state forestry system and districts. Historically, Crawford County experiences between two and four of these types of fires annually with all fires being relatively small. However, due to the many acres of farmland, forested areas, and open space in the county, under the right conditions the potential exists for a significant wildfire. Crawford County lies entirely in District 14 of the DCNR's Bureau of Forestry. This district encompasses all of Erie County, Warren County, Crawford County, and parts of Venango County and Forest County. In 2022, there were a total of fifty-one fires in District 14 that were responsible for destroying 29.1 acres. This accounts for only 4.9% of all wildfires in Pennsylvania, and 1.1% of total acres burned by wildfires in 2022 in Pennsylvania.

District 14 reports the following twenty-one-year wildfire summary based on observed and reported wildfires. *Table 51 – Annual Summary of Wildfire Events* illustrates the number of acres burned in a certain number of fires for District 14 from the year 2000 to the year 2022.

Table 51 - Annual Summary of Wildfire Events

Annual Summary of Wildfire Events in District 14				
Year	**Number of Fires**	**Frequency Increase or Decrease**	**Acres**	**Severity Increase or Decrease**
2000	11	-	47.1	-
2001	9	⇩	74.2	⇧
2002	2	⇩	1.6	⇩
2003	8	⇧	85.1	⇧
2004	1	⇩	2.0	⇩
2005	5	⇧	19.3	⇧
2006	11	⇧	52.5	⇧
2007	3	⇩	4.6	⇩
2008	6	⇧	9.3	⇧
2009	3	⇩	59.7	⇧
2010	17	⇧	225.2	⇧
2011	3	⇩	9.1	⇩
2012	17	⇧	123.5	⇧
2013	17	=	21.9	⇩
2014	14	⇩	5.5	⇩
2015	24	⇧	44.0	⇧
2016	59	⇧	149.3	⇧
2017	13	⇩	10.3	⇩
2018	43	⇧	116.1	⇧
2019	23	⇩	36.2	⇩
2020	61	⇧	89.3	⇧
2021	122	⇧	752.7	⇧
2022	51	⇩	29.1	⇩
Source: DCNR, 2023				

In recent years, the number of prescribed burns in Pennsylvania has been increasing. This corresponds to an understanding of the need for fire in many natural ecosystems and management strategies for reducing vulnerability to wildfire; it also improves hunting opportunities. In 2022, there were sixty-three prescribed burns that were carried out by the Pennsylvania Department of Conservation and Natural Resources (DCNR). This number is up by seventeen prescribed burns from the total number of reported prescribed burns in 2021 by the DCNR only, with a total of forty-six.

4.3.14.4 Future Occurrence

Annual occurrence of urban fires and wildfires in Crawford County are expected. Urban fires are most often the result of human errors, outdated wiring and occasionally, malintent (arson). The occurrence of large scale and intense wildfires is somewhat unpredictable and highly dependent on environmental conditions and human response. Weather conditions play a major role in the occurrence of wildfires, so in the event of drought conditions, wildfire caution should be heightened. Any fire without the quick response or attention of firefighters, forestry personnel, or visitors to the forest, has the potential to become a wildfire.

Climate change is expected to bring an elongated wildfire season and more intense and long-burning fires (Pechony & Shindell, 2010). In some regions of the United States, this is a very real concern. Northern California experienced unprecedented, devastating wildfires from 2017 through 2022. The fires that have been occurring in California are thought to be burning faster and hotter due to worsening drought conditions caused by increased climate change (Cvijanovic et al., 2017). Wildfire conditions in Pennsylvania are not nearly as severe as in Northern California, but the intensification is a signal that the changes brought by climate change are relevant to wildfires. In Pennsylvania, higher air temperatures and earlier warming in the spring are expected to continue, resulting in more wildfire prone conditions in the summer and fall (Shortle et al., 2015).

Climate change significantly influences wildfires by altering environmental conditions. Rising temperatures, prolonged droughts, and changes in precipitation patterns create drier landscapes, fostering the ignition and rapid spread of wildfires. Elevated temperatures contribute to increased evaporation, drying out vegetation and creating more fuel for fires. Altered precipitation patterns can lead to extended periods of drought, further desiccating ecosystems. Climate change also affects the timing and intensity of seasons, extending the fire-prone period. Additionally, warming temperatures facilitate the expansion of pests and diseases that weaken trees, making forests more susceptible to ignition.

4.3.14.5 Vulnerability Assessment

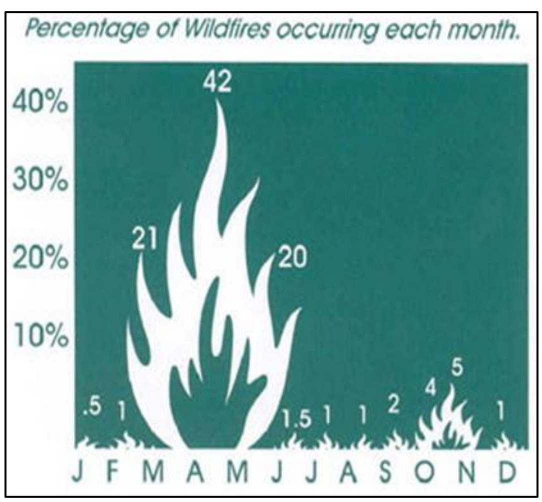
The size and impact of a wildfire depends on its location, climate conditions, and the response of firefighters. If the right conditions exist, these factors may often mitigate the effects of wildfires;

however, during a drought, wildfires can be devastating. The highest risk for wildfires in Pennsylvania occurs during the spring (March to May) and the fall (October to November) months and 99% of all wildfires in Pennsylvania are caused by people. Approximately 83% of all Pennsylvania wildfires occur in the months outlined above. In the spring, bare trees allow sunlight to reach the forest floor, drying fallen leaves and other ground debris and increasing wildfire vulnerability. In the fall, the surplus of dried leaves is fuel for fires. *Figure 40 – Seasonal Wildfire Percentage* shows the wildfire percentage occurrence during each month in Pennsylvania.

Firefighters and other first responders can encounter life-threatening situations due to forest and wildfires. Traffic accidents during a response and the impacts of fighting the fire once on scene are examples of first responder vulnerabilities.

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

Figure 40 - Seasonal Wildfire Percentage



Pennsylvania is among the states with the largest WUI and the most housing units in a WUI designated area. Pennsylvanians desire the proximity of natural beauty in their daily lives, and the growth in WUI housing noted above illustrates this. *Figure 41 – Wildland Urban Interface* shows the extent of Crawford County and the critical infrastructure facilities, functional needs facilities, and fire stations. Wildfire hazard is defined by conditions that affect wildfire ignition and/or behavior such as fuel, topography, and local weather. The many addressable structures in the Wildland Urban Interface and Intermix zones are broken up by assessed parcel use codes.

There are thirty-one departments that serve Crawford County, including five that are outside the county with jurisdiction in the county. A list of these locations can be seen in *Table 67 – Crawford County Fire Departments*. Each fire department conducts its own schedule of in-house training sessions for its members.

The response of firefighters is integral to the containment of wildfires in the county. There is a potential for fire stations and services to close, which affects response to a wildfire in Crawford County. *Figure 42 – Fire Stations Locations* illustrates the position of fire stations and the location of state game lands, state forests, and natural areas within Crawford County. It is recommended that each municipality assess vulnerabilities to department closures by building a relationship with their local providers and planning accordingly for if a local service were to close.

As seen above in Section 4.3.11.4 climate change may increase the frequency of wildfires. With this potential increase in wildfires comes disruption of systems that humans rely upon for daily activities. The systems wildfires most heavily impact include, but are not limited to transportation, water supply, power, and communications. Wildfires can block off transportation routes directly or can impact visibility of transportation routes due to the intense smoke that can be produced and settle over roadways.

As seen in *Table 3 – Population Change in Crawford County*, forty-six municipalities in Crawford County have experienced a population loss since the previous 2010 US Census. However, Blooming Valley Borough, Rome Township, Sparta Township, and Townville Borough saw minor total population growth over the same period. Based on this information, it can be speculated that these four municipalities may have an increased vulnerability to wildfire conditions, since 2010, due to the increase in population. Unserved, underserved, and socially vulnerable populations within Crawford County may be at an increased vulnerability to wildfires. This is because these populations may not have access to or the ability to relocate during wildfire events. Those that are unsheltered within Crawford County have an increased vulnerability to wildfire events due to being openly exposed to the elements, such as bad air quality from the smoke that wildfires produce.

Crawford County promotes fishing, hunting, camping, hiking, canoeing, and other outdoor activities. These land use events can increase the risk of wildfires starting. Approximately 47% of Crawford County is forest areas, including deciduous, evergreen, mixed deciduous and evergreen, forested wetlands, and emergent wetlands. Natural areas can be extremely vulnerable to wildfires within Crawford County. Ecologically, these alter landscapes, compromising soil stability and disrupting ecosystems. Conditions of drought or invasive species that could damage forested areas can lead to wildfires. Wildfires can lead to devastation which can foster landslides and flash flood events. These events can destroy the forested terrain within the county and consume acres of traditional agricultural practices in a short amount of time. In addition to widespread burning that wildfires cause, these events also pollute the air within the county and surrounding areas, as well as waterways due to run off and the settling of the air pollution to ground level.

Most of the historic and cultural properties that are located in Crawford County are at an increased vulnerability to wildfire events. Each property is of a construction type that would be vulnerable to wildfires in Crawford County. The majority of the historic properties in the county are constructed out of brick and stone, with wooden interiors that would be destroyed by fires. Also, nine historic places are within two miles of a fire station in Crawford County. These locations are Baldwin-Reynolds House, the Roueche House, Ruter Hall, the Edward Saeger House, the Judge Henry Shippen House, and the Titusville City Hall. All other historic properties in the county are farther away from fire station locations which could result in a longer response time to fires.

Municipalities with high risk due to wildfires (with areas of high-density interface or intermix):

- Bloomfield Township
- Hayfield Township
- Hydetown Borough
- Meadville City
- Oil Creek Township
- Richmond Township
- Rockdale Township
- Titusville City
- Vernon Township
- West Mead Township

Municipalities with lower risk due to wildfires (no areas of high-density interface or intermix):

- Athens Township
- Beaver Township
- Blooming Valley Borough
- Cambridge Springs Borough
- Cambridge Township
- Centerville Borough
- Cochranton Borough
- Conneaut Lake Borough

- Conneaut Township
- Conneautville Borough
- Cussewago Township
- East Fairfield Township
- East Fallowfield Township
- East Mead Township
- Fairfield Township
- Greenwood Township
- Linesville Borough
- North Shenango Township
- Pine Township
- Randolph Township
- Rome Township
- Sadsbury Township
- Saegertown Borough
- South Shenango Township
- Sparta Township
- Spartansburg Borough
- Spring Township
- Springboro Borough
- Steuben Township
- Summerhill Township
- Summit Township
- Townville Borough
- Troy Township
- Union Township
- Venango Borough
- Venango Township
- Wayne Township
- West Fallowfield Township
- West Shenango Township
- Woodcock Borough
- Woodcock Township

Figure 41 - Wildland Urban Interface

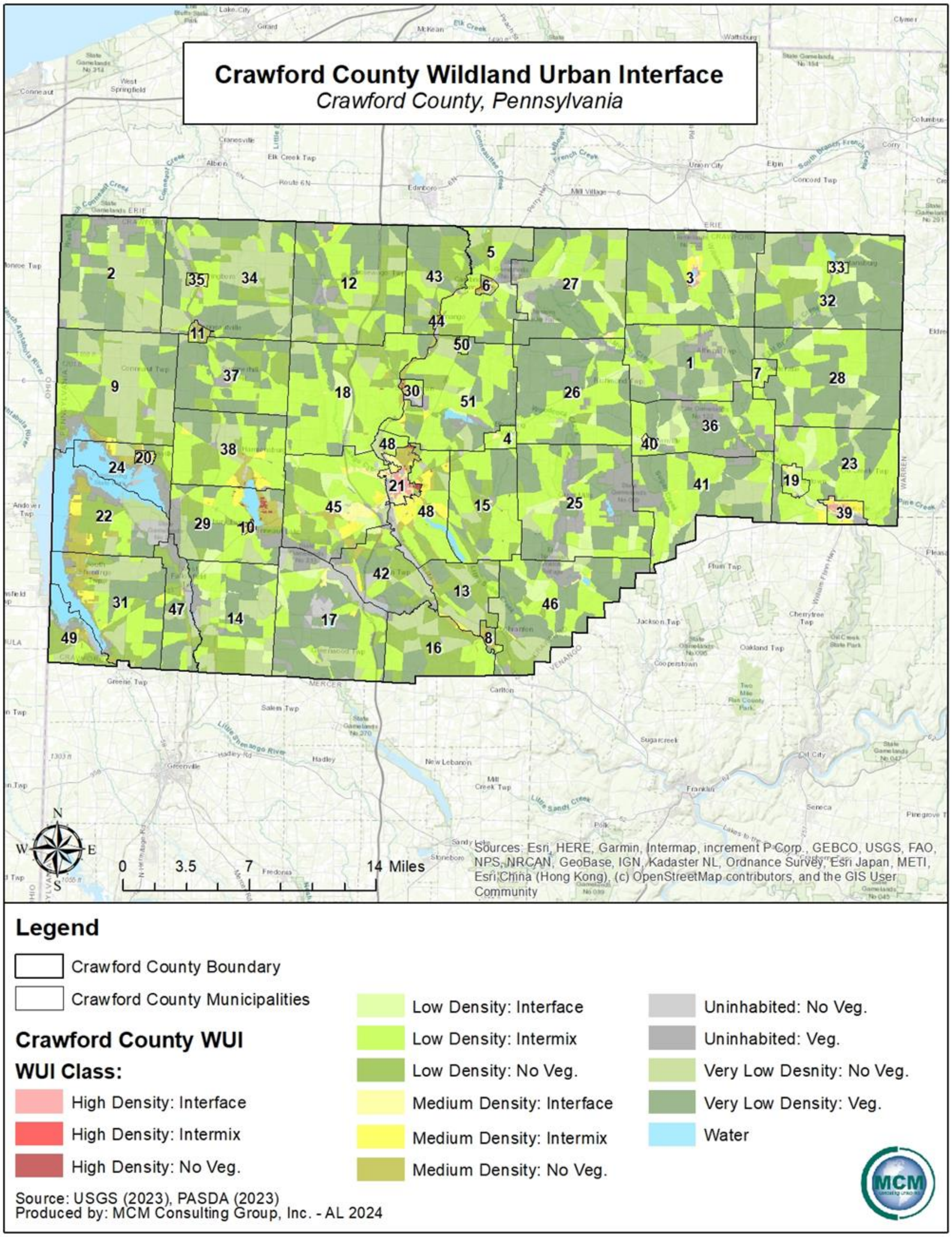
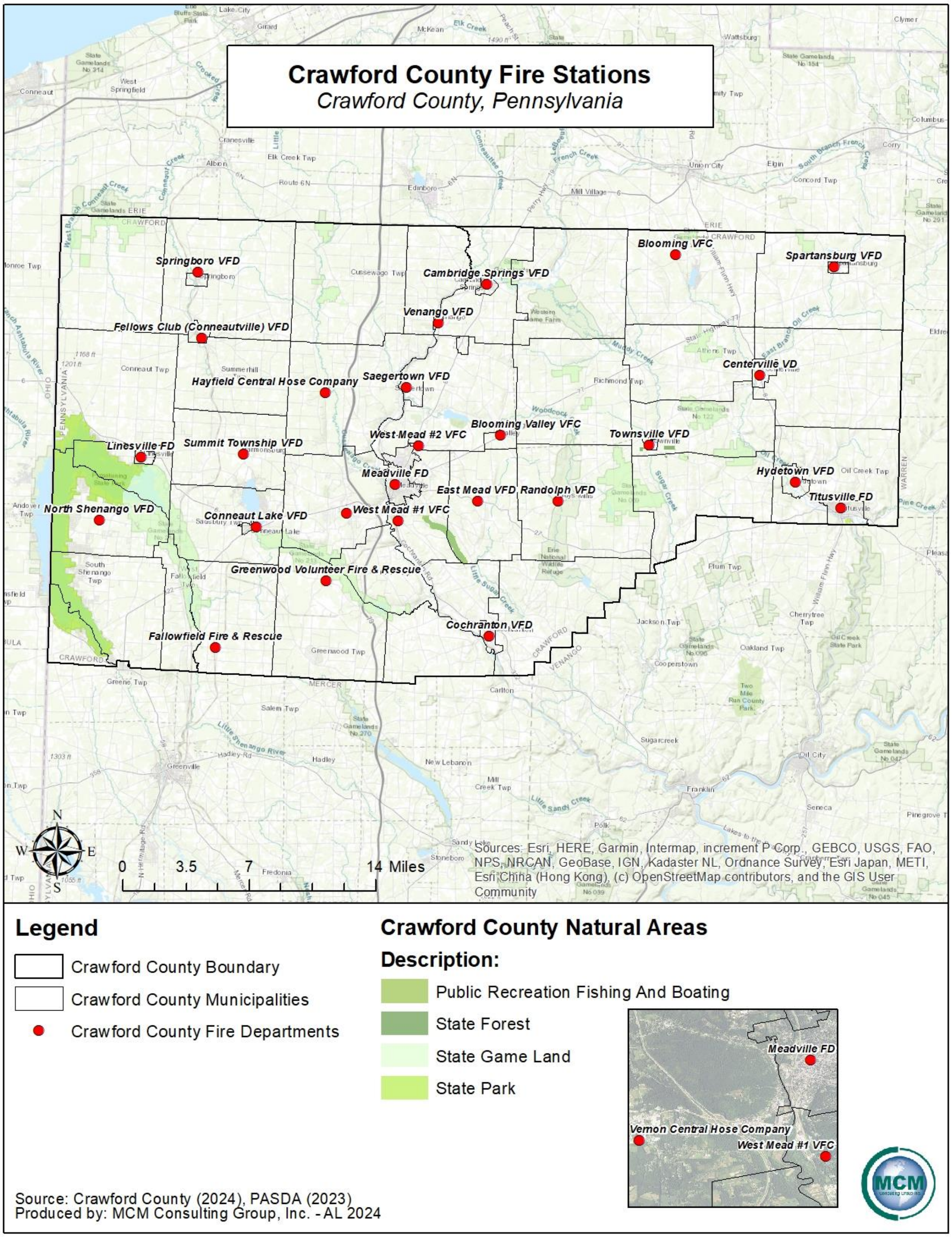


Figure 42 - Fire Stations Locations



4.3.15. Winter Storm

4.3.15.1 Location and Extent

Most severe winter storm hazards include heavy snow (snowstorms), blizzards, sleet, freezing rain, and ice storms. Since most extra-tropical cyclones (mid-Atlantic cyclones locally known as Northeasters or Nor'easters), generally take place during the winter weather months, these hazards have also been grouped as a type of severe winter weather storm. According to the Pennsylvania State Hazard Mitigation Plan (PA HMP), winter storms are frequent events for the Commonwealth and occur from late October until mid-April. These types of winter events or conditions are further defined below.

- **Heavy Snow:** According to the National Weather Service (NWS), heavy snow is generally snowfall accumulating to four inches or more in depth in twelve hours or less; or snowfall accumulating to six inches or more in depth in twenty-four hours or less. A snow squall is an intense but limited duration, period of moderate to heavy snowfall, also known as a snowstorm, accompanied by strong, gusty surface winds and possibly lightning.
- **Blizzard:** Blizzards are characterized by low temperatures, wind gusts of thirty-five miles per hour (mph) or more and falling and/or blowing snow that reduces visibility to 1/4-mile or less for an extended period of time (three or more hours).
- **Sleet of Freezing Rainstorm:** Sleet is defined as pellets of ice composed of frozen or mostly frozen raindrops or refrozen partially melted snowflakes. These pellets of ice usually bounce after hitting the ground and other hard surfaces. Freezing rain is rain that falls as a liquid but freezes into glaze upon contact with the ground.
- **Ice Storm:** An ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication. These accumulations of ice make walking and driving extremely dangerous and can create extreme hazards to motorists and pedestrians.
- **Extra-Tropical Cyclone:** Sometimes called mid-latitude cyclones, are a group of cyclones defined as synoptic scale, low pressure, weather systems that occur in the middle latitudes of the Earth. These storms have neither tropical nor polar characteristics and are connected with fronts and horizontal gradients in temperature and dew point otherwise known as "baroclinic zones". Extra-tropical cyclones are everyday weather phenomena which, along with anticyclones, drive the weather over much of the Earth. These cyclones produce impacts ranging from cloudiness and mild showers to heavy gales and thunderstorms. Tropical cyclones often transform into extra-tropical cyclones at the end of their tropical existence, usually between 30˚ and 40˚ latitude, where there is

insufficient force from upper-level shortwave troughs riding the westerlies (weather systems moving west to east) for the process of extra-tropical transition to begin. A shortwave trough is a disturbance in the mid or upper part of the atmosphere which induces upward motion ahead of it. During an extra-tropical transition, a cyclone begins to tilt back into the colder air mass with height, and the cyclone's primary energy source converts from the release of latent heat from condensation to baroclinic processes.

4.3.15.2 Range of Magnitude

The magnitude or severity of a severe winter storm depends on several factors including a region's susceptibility to snowstorms, snowfall amounts, snowfall rates, wind speeds, temperatures, visibility, storm duration, topography, and time of occurrence during the day (e.g., weekday versus weekend), and time of season. The extent of a severe winter storm can be classified by meteorological measurements, such as those above, and by evaluating its societal impacts.

The Northeast Snowfall Impact Scale (NESIS) categorizes snowstorms in this manner. Unlike the Fujita Scale (tornado) and Saffir Simpson Scale (hurricanes), there is no widely used scale to classify snowstorms. NESIS was developed by Paul Kocin of The Weather Channel and Louis Uccellini of the National Weather Service and rank high impact, northeast snowstorms. These storms have large areas of ten-inch snowfall accumulations and greater. NESIS has five ranking categories: Notable (1), Significant (2), Major (3), Crippling (4), and Extreme (5). These ranking can be seen in *Table 52 – NESIS Winter Storm Rankings*. The index differs from other meteorological indices in that it uses population information in addition to meteorological measurements. Thus, NESIS gives an indication of a storm's societal impacts. This scale was developed because of the impact of northeast snowstorms can have on the rest of the country in terms of transportation and economic impact.

Table 52 - NESIS Winter Storm Rankings

NESIS Winter Storm Rankings			
Category	**Description**	**NESIS Range**	**Definition**
1	Notable	1.0 – 2.49	These storms are notable for their large areas of 4-inch accumulations and small areas of 10-inch snowfall.
2	Significant	2.5 – 3.99	Includes storms that produce significant areas of greater than 10-inch snows while some include small areas of 20-inch snowfalls. A few cases may even include relatively small areas of very heavy snowfall accumulations (greater than 30 inches).

NESIS Winter Storm Rankings			
Category	**Description**	**NESIS Range**	**Definition**
3	Major	4.0 – 5.99	This category encompasses the typical major Northeast snowstorm, with large areas of 10-inch snows (generally between 50 and 150 x 103 mi^2 – roughly one to three times the size of New York State with significant areas of 20-inch accumulations.
4	Crippling	6.0 – 9.99	These storms consist of some of the most widespread, heavy snows of the sample and can be best described as crippling to the northeast U.S, with the impact to transportation and the economy felt throughout the United States. These storms encompass huge areas of 10-inch snowfalls, and each case is marked by large areas of 20-inch and greater snowfall.
5	Extreme	10+	The storms represent those with the most extreme snowfall distributions, blanketing large areas and populations with snowfalls greater than 10, 20, and 30 inches. These are only storms in which the 10-inch accumulations exceed 200 X 103 mi^2 and affect more than 60 million people.
Source: Kocin and Uccellini, 2004			

The climate of Pennsylvania is marked by abundant snowfall. Winter weather can reach Pennsylvania as early as October and is usually in full force by late November with average winter temperatures between 20- and 40-degrees Fahrenheit. Crawford County receives an average of about 104 inches of snowfall a year. Most areas of Crawford County experience the effects of winter storms frequently. The general indication of the average annual snowfall map shows areas that are subject to a consistent risk for large quantities of snow. *Figure 44 - Pennsylvania Average Snowfall* illustrates the long-term trends for snowfall accumulation in Pennsylvania over three decades.

4.3.15.3 Past Occurrences

Figure 43 – Winter Storm Events by County in Pennsylvania shows the number of winter storm events from 1950 – 2023 for the Commonwealth of Pennsylvania. Crawford County had forty-eight winter storm events, two winter weather events, zero blizzards, and one ice storm event. *Table 53 – Recent Annual Snowfall Estimates* show recent annual snowfall measurements as stated by NOAA. Overall, Crawford County has experienced a decrease in the annual estimated average of snowfall. On average, the annual snowfall totals have decreased in the time periods

from 2017 to 2023. A list of additional Crawford County winter storms, and other related events is outlined in *Table 54 – Crawford County Winter Storm History*.

Table 53 - Recent Annual Snowfall Estimates

Recent Annual Snowfall Estimates	
Time Span	**Snowfall Estimates (inches)**
2000-2001	145.6
2001-2002	101.7
2002-2003	140.5
2003-2004	106.6
2004-2005	107.8
2005-2006	77.2
2006-2007	104.5
2007-2008	115.7
2008-2009	141.8
2009-2010	91.4
2010-2011	108.2
2011-2012	46.4
2012-2013	104.6
2013-2014	137.9
2014-2015	110.8
2015-2016	68.3
2016-2017	78.1
2017-2018	160.3
2018-2019	90.3
2019-2020	66.3
2020-2021	60.0
2021-2022	61.4
2022-2023	52.0
Source: NOAA, 2021	

Table 54 - Crawford County Winter Weather History

Crawford County Winter Weather History		
Location	**Date**	**Event Type**
Crawford County	11/14/1997	Ice Storm
Crawford County	01/13/1998	Winter Weather
Crawford County	01/02/1999	Winter Storm
Crawford County	01/08/1999	Winter Storm
Crawford County	01/13/1999	Winter Storm

Crawford County Winter Weather History		
Location	**Date**	**Event Type**
Crawford County	12/13/2000	Winter Storm
Crawford County	03/24/2002	Winter Storm
Crawford County	12/05/2003	Winter Storm
Crawford County	01/14/2004	Winter Storm
Crawford County	01/27/2004	Winter Storm
Crawford County	12/22/2004	Winter Storm
Crawford County	01/05/2005	Winter Storm
Crawford County	01/22/2005	Winter Storm
Crawford County	03/01/2005	Winter Storm
Crawford County	04/02/2005	Winter Storm
Crawford County	11/24/2005	Winter Storm
Crawford County	02/05/2006	Winter Storm
Crawford County	02/13/2007	Winter Storm
Crawford County	12/15/2007	Winter Storm
Crawford County	01/01/2008	Winter Storm
Crawford County	02/12/2008	Winter Storm
Crawford County	02/26/2008	Winter Storm
Crawford County	03/04/2008	Winter Storm
Crawford County	03/07/2008	Winter Storm
Crawford County	12/19/2008	Winter Storm
Crawford County	01/27/2009	Winter Storm
Crawford County	02/09/2010	Winter Storm
Crawford County	02/25/2010	Winter Storm
Crawford County	02/01/2011	Winter Storm
Crawford County	02/20/2011	Winter Storm
Crawford County	03/10/2011	Winter Storm
Crawford County	12/21/2012	Winter Storm
Crawford County	12/26/2012	Winter Storm
Crawford County	02/01/2013	Winter Storm
Crawford County	03/18/2013	Winter Storm
Crawford County	11/26/2013	Winter Storm
Crawford County	02/04/2014	Winter Storm
Crawford County	03/12/2014	Winter Storm
Crawford County	12/11/2014	Winter Storm
Crawford County	02/01/2015	Winter Storm
Crawford County	04/08/2016	Winter Storm
Crawford County	03/13/2017	Winter Storm
Crawford County	01/12/2018	Winter Storm

Crawford County Winter Weather History		
Location	**Date**	**Event Type**
Crawford County	03/01/2018	Winter Storm
Crawford County	01/19/2019	Winter Storm
Crawford County	12/01/2020	Winter Storm
Crawford County	12/24/2020	Winter Storm
Crawford County	01/16/2022	Winter Storm
Crawford County	02/15/2021	Winter Weather
Crawford County	02/03/2022	Winter Storm
Crawford County	12/23/2022	Winter Storm
Source: NOAA NCEI, 2023		

4.3.15.4 Future Occurrence

Winter storm hazards in Pennsylvania are guaranteed yearly since the state is located at a relatively high latitudes resulting in winter temperatures that range between 0- and 32-degrees Fahrenheit for a good deal of the fall through early spring season (later October until mid-April). In addition, the state is exposed to large quantities of moisture from both the Great Lakes and the Atlantic Ocean. While it is almost certain that a number of significant winter storms will occur during the winter and fall season, what is not easily determined is how many such storms will occur during that time frame. Based on historical snow related disaster declaration occurrences, the Commonwealth of Pennsylvania can expect a snowstorm of disaster declaration proportions, on average, once every three to five years. Similarly, for ice storms, based on historical disaster declarations, it is expected that on average, ice storms of disaster proportions will occur once every seven to ten years within the state.

Climate change could increase the intensity of winter storms in the northeastern United States and Crawford County, Pennsylvania. With warmer air temperatures, more moisture will be held in the air, and if the temperatures on the ground are below freezing, this could result in more snow falling during a weather event like a winter storm. These events may become less frequent as the climate warms, but they could be more intense.

4.3.12.5 Vulnerability Assessment

Severe winter storms are of significant concern to Crawford County because of their frequency and magnitude in the region. Additionally, they are of significant concern due to the direct and indirect costs associated with these events; delays caused by the storms and impacts on the people and facilities of the region related to snow and ice removal, health problems, cascade effects such as utility failure and traffic accidents, and stress on community resources.

Every year, winter weather indirectly and deceptively kills hundreds of people in the United States, primarily from automobile accidents, over exertion, and exposure. Winter storms are often accompanied by strong winds creating blizzard conditions with blinding win-drive snow, drifting snow, extreme cold temperatures, and dangerous wind chill. They are considered deceptive killers because most deaths and other impacts or losses are indirectly related to the storm. Heavy accumulations of ice can bring down trees and powerlines, disabling electrical power and communications for days or weeks. Heavy snow can immobilize a region and paralyze a city, shutting down all air and rail transportation and disrupting medical and emergency services. The economic impact of winter weather each year is quite large, with costs for snow removal, damage, and loss of business in the millions each year. Heavy snow can immobilize and strand commuters as well as stopping the flow of supplies through an area or transportation corridor. In rural areas, homes and farms may be isolated for days and unprotected livestock may be lost. Bridges and overpasses are particularly dangerous because they freeze before other transportation surfaces. For the purposes of this Hazard Mitigation Plan, the entire population of Crawford County (83,938) is exposed to severe winter storm events. The elderly are considered the most susceptible to this hazard due to their increased risk of injury and death from falls, overexertion, and or attempts to clear ice and snow. The elderly population is also more vulnerable to utility outages in winter, especially when they are paired with winter storm events. Vulnerable, or underserved, populations within Crawford County 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 unsheltered populations of an area are at most risk to winter storm events.

The table below (*Table 55 – Population per Municipality under 5 Years or 65 Years or Older*) illustrates the number of citizens per municipality under the age of five or over the age of sixty-five years of age who are at an increased vulnerability to winter storms, and cascading hazards from winter storms:

Table 55 - Population per Municipality under 5 Years or 65 Years or Older

Population per Municipality under 5 Years or 65 Years or Older				
Municipality	**Number of People under 5 years of age**	**Percent of Population (%)**	**Number of People 65 years or older**	**Percent of Population (%)**
Athens Township	25	3.9	180	28.2
Beaver Township	46	5.7	95	11.9
Bloomfield Township	49	2.8	416	24.1
Blooming Valley Borough	22	5.9	94	25.1
Cambridge Springs Borough	77	3.4	293	12.8

Population per Municipality under 5 Years or 65 Years or Older				
Municipality	**Number of People under 5 years of age**	**Percent of Population (%)**	**Number of People 65 years or older**	**Percent of Population (%)**
Cambridge Township	123	7.6	300	18.5
Centerville Borough	3	1.3	57	24.6
Cochranton Borough	30	2.9	266	25.5
Conneaut Lake Borough	35	6.9	49	9.6
Conneaut Township	49	4.3	322	28.0
Conneautville Borough	78	10.5	124	16.6
Cussewago Township	70	4.5	333	21.2
East Fairfield Township	19	2.5	208	27.6
East Fallowfield Township	121	9.2	277	21.0
East Mead Township	70	5.1	253	18.4
Fairfield Township	63	5.3	295	24.6
Greenwood Township	116	8.6	249	18.4
Hayfield Township	247	8.8	578	20.7
Hydetown Borough	25	3.9	183	28.3
Linesville Borough	60	6.3	199	21.0
Meadville City	485	3.8	2,107	16.3
North Shenango Township	25	1.9	479	36.7
Oil Creek Township	93	5.3	418	24.0
Pine Township	10	2.3	124	28.3
Randolph Township	102	6.0	354	20.7
Richmond Township	73	5.2	297	21.3
Rockdale Township	72	5.4	245	18.5
Rome Township	203	11.3	225	12.5
Sadsbury Township	114	4.1	690	25.1
Saegertown Borough	42	4.3	150	15.5
South Shenango Township	58	2.9	653	32.8
Sparta Township	246	11.1	198	8.9
Spartansburg Borough	13	4.9	61	23.2
Spring Township	87	6.6	370	27.9
Springboro Borough	2	0.5	68	15.6
Steuben Township	37	4.1	335	37.1
Summerhill Township	42	3.5	380	32.1
Summit Township	58	3.6	343	21.1
Titusville City	196	3.7	1,250	23.8
Townville Borough	11	3.6	47	15.6
Troy Township	48	4.8	204	20.5
Union Township	38	4.4	155	18.1

Population per Municipality under 5 Years or 65 Years or Older				
Municipality	Number of People under 5 years of age	Percent of Population (%)	Number of People 65 years or older	Percent of Population (%)
Venango Borough	16	7.2	54	24.4
Venango Township	111	11.3	171	17.4
Vernon Township	226	4.3	1,609	30.3
Wayne Township	108	7.3	244	16.4
West Fallowfield Township	21	3.0	156	22.3
West Mead Township	410	8.2	1,166	23.2
West Shenango Township	10	2.3	104	24.3
Woodcock Borough	5	3.8	26	19.7
Woodcock Township	173	6.3	627	22.7
Source: United States Census Bureau (USCB), American Community Survey (ACS), 2022				

Approximately 5.3% of the total population of Crawford County is under the age of five years old and approximately 21.6% of the total population is sixty-years old or older. In total, 26.9% of the population is at an increased risk from exposure to winter storm events and cascading hazards.

The entire general building stock inventory in Crawford County is exposed and vulnerable to the severe winter storm hazard. In general, structural impacts include damage to roof and building frames, rather than building content. There was no historical information available that identified property damages within Crawford County due to a single severe winter storm event. Current modeling tools are not available to estimate specific losses for this hazard. All of the historic and cultural properties in Crawford County are at similar vulnerability to severe winter storms. These properties include six bridges as historic structures and ten historic buildings on the National Register of Historic Places. They are the Baldwin-Reynolds House, Bently Hall, Independent Congregational Church, Amos Kelly House, Dr. J.R. Mosier Office, Roueche House, Ruter Hall, Edward Saeger House, Judge Henry Shippen House, and the Titusville City Hall.

A specific area that is vulnerable to the severe winter storm hazard is the floodplain. At risk general building stock and infrastructure in floodplains are presented in the flood profile due to snow and ice melt. Generally, losses from flooding associated with severe winter storms should be less than that associated with a 100-year or 500-year flood.

Full functionality of critical facilities such as police, fire, and medical facilities is essential for response during and after a severe winter storm event. These critical facility structures are largely constructed of concrete and masonry; therefore, they should only suffer minimal structural damage from severe winter storm events. Backup power is recommended critical infrastructure and facilities due to the potential for power interruption. Infrastructure at risk for this hazard includes roadways that could be damaged due to the application of salt and intermittent freezing and warming conditions that can damage roads over time. Severe snowfall requires infrastructure to clear roadways and alert citizens to dangerous conditions. In spring, this type of roadway damage must be repaired. Additionally, freezing rain and ice storms impact utilities (i.e., power lines and overhead utility wires) causing power outages for hundreds to thousands of residents.

The cost of snow and ice removal and repair of roads from the freeze/thaw process can drain local financial resources. However, because severe winter storms are a regular occurrence in this area, Crawford County is generally well-prepared for snow and ice removal each season.

Winter storm risk is going to increase in Crawford County when climate change is considered. As mentioned above in Section 4.3.12.4, climate change is expected to increase the intensity of winter storms. With warmer air temperatures, more moisture will be held in the air, and if temperatures on the ground rapidly decrease, or fall below freezing, this could result in more snow falling during a weather event like a winter storm. These events may become less frequent as the global temperatures increase, but they could become more intense.

As seen in *Table 3 – Population Change in Crawford County*, forty-six municipalities in Crawford County have experienced a population loss since the previous decennial census, conducted in 2010. Four municipalities have seen a net population increase from the 2010 decennial census to the 2020 decennial census, and one municipality did not see a population change. The impact that a winter storm can have on these municipalities will vary. Municipalities with an increase in population could have more resources available as well as personnel to mitigate the impacts that a winter storm can bring to one’s community. A municipality that experienced a population decrease may not have these resources or personnel available to prepare for and mitigate against an impending winter storm. Adversely, municipalities with an increase in population could experience a more significant impact simply because they have more individuals being impacted compared to a smaller municipality. For example, the City of Meadville may experience larger cascading impacts of a winter storm because they are the most populous municipality in Crawford County with 13,050 residents, compared to Woodcock Borough which only has 140 residents. All municipalities within Crawford County are at the same level or risk to winter storms, but the direct and indirect impacts and vulnerability will vary by municipality.

Vulnerable, or underserved, populations within Crawford County 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 unsheltered populations of an area are at the highest vulnerability to winter storm events. Individuals who are also in poverty, based on information provided in the United States Census are more likely to have issues meeting economic requirements for utility bills in the winter as well. All of these populations can be considered socially vulnerable or communities that have unmet needs.

Land use and major developments will have negligible impacts on the vulnerability of Crawford County to winter storm events. Land use may impact the response capabilities of Crawford County in a winter storm event, but changes in that land use will not increase the vulnerability. Crawford County has significant capabilities to respond to winter storm events. Major development in the county will need to be planned to allow for winter storm response, including size and make up of transportation routes, and location of snow removal areas.

Winter storms may also negatively impact the natural resources in Crawford County. According to the Pennsylvania Department of Transportation, 446,991 tons of salt were used in the commonwealth, including Crawford County, during the 2022 through 2023 winter storm weather season. Although the use of salt and other anti-skid materials protects life safety by improving roadway conditions, there can also be unintended consequences. When salt used on roadways permeates the surrounding soil, it can infiltrate groundwater and contaminate wells. Hence, any groundwater sources near roadways, in Crawford County, may be vulnerable to degradation.

Roadway salt can also pose a threat to freshwater aquatic life near the routes of transportation treated with minerals. Salt that makes its way into soil or freshwater becomes a persistent hazard, damaging plants and wildlife that are not adapted to coexist with high salinity. Its persistent nature is due to a lack of any known biological system that can remove it from the environment in which it exists. Although it may be diluted with water, such a treatment would not be sufficient in isolation, and some intervention would likely be necessary to extract the salt from the environment which it pollutes.

Figure 43 - Winter Storm Events by County in Pennsylvania

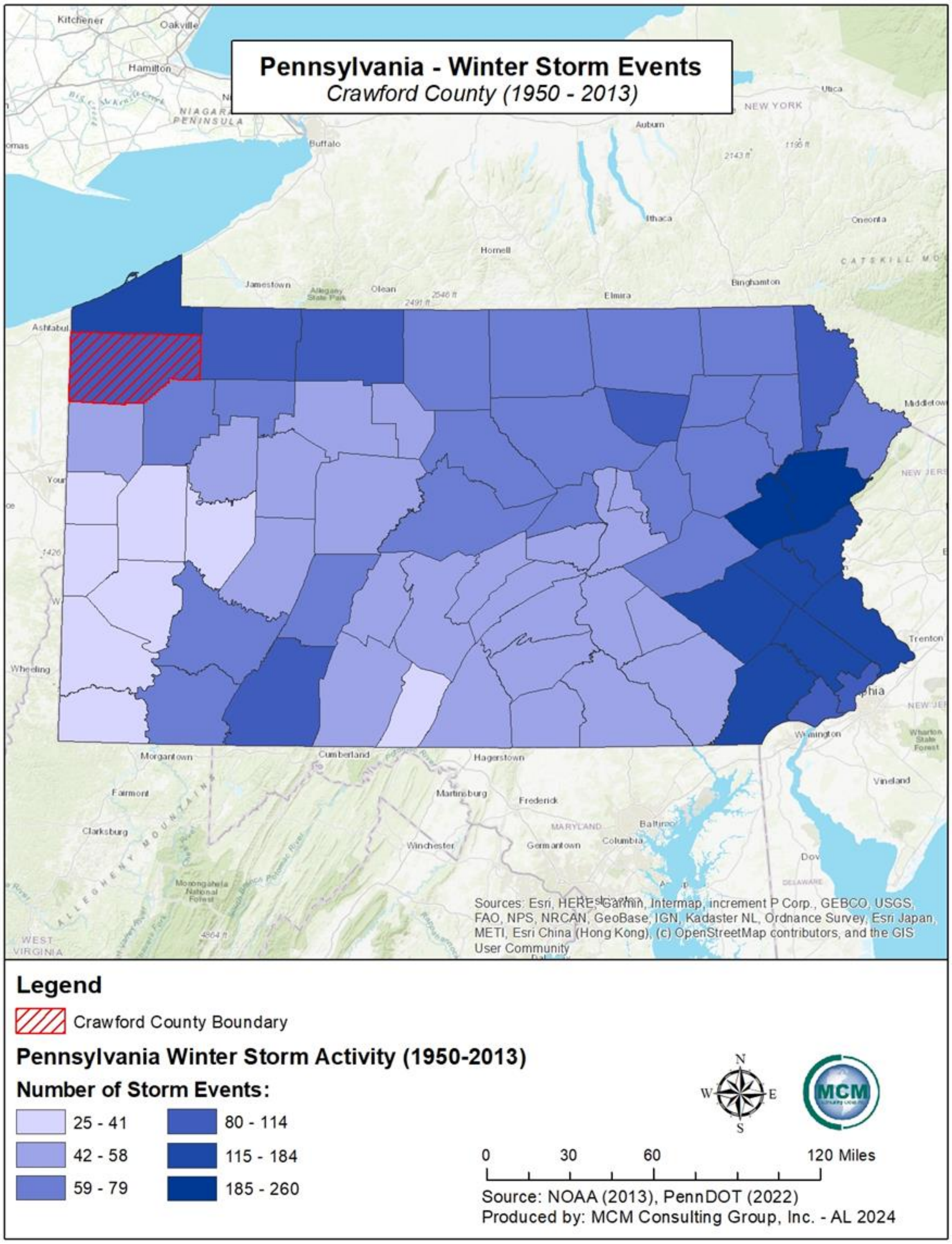
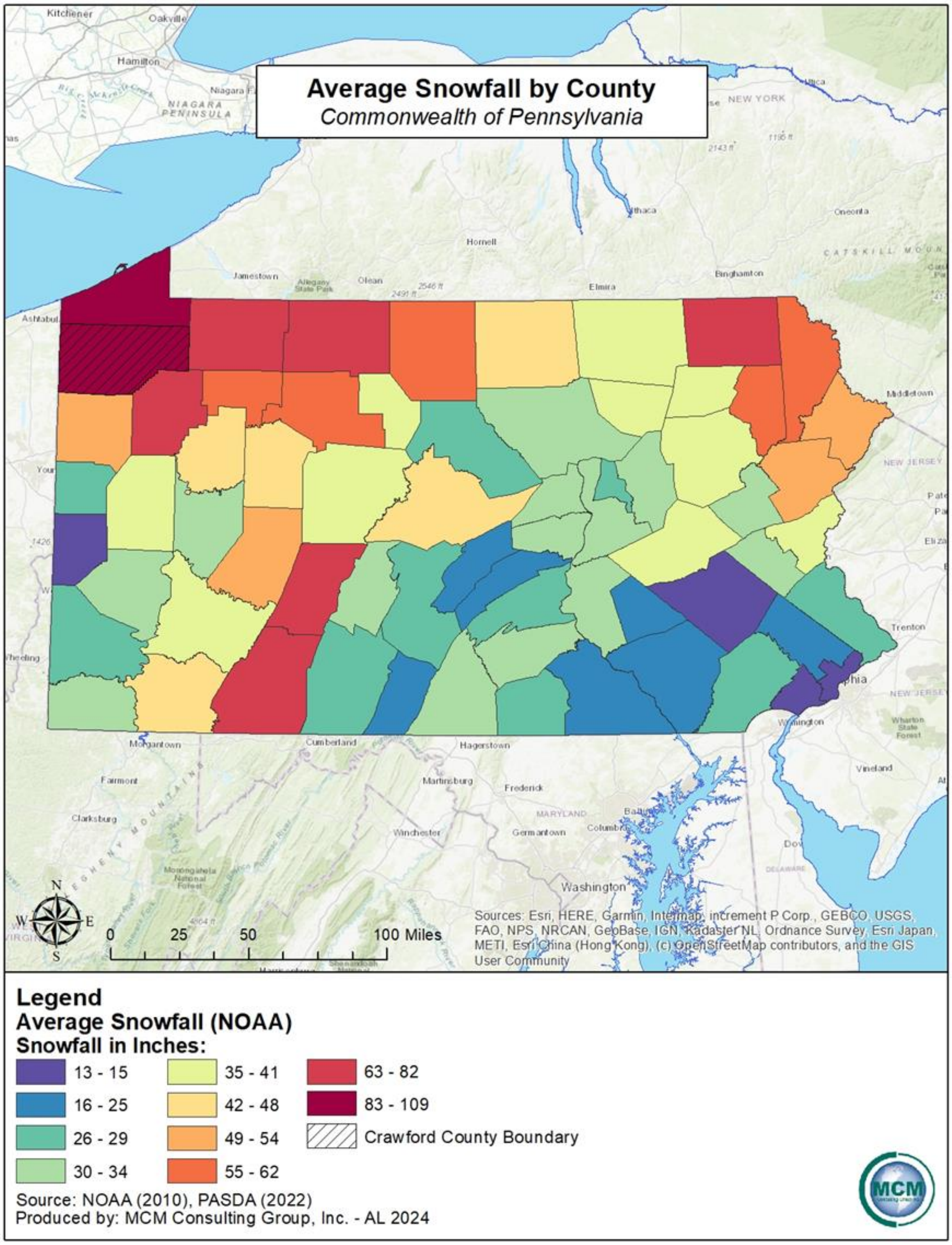


Figure 44 - Pennsylvania Average Snowfall



4.3.16. Blighted Properties

4.3.16.1 Location and Extent

The presence of blighted properties in Crawford County is a nuisance for both residents and visitors to the county on a year-round basis. Blighted properties include areas of the county where the infrastructure is damaged and aging beyond occupation, habitation, and/or commercial use.

Blighted properties are described by the Pennsylvania State Statute 1945 Act 385 as:

1. Any premises which because of physical condition or use is regarded as a public nuisance at common law or has been declared a public in accordance with the local housing, building, plumbing, fire, and related codes.
2. Any premises which because of physical condition, use, or occupancy is considered an attractive nuisance to children, including but not limited to abandoned wells, shafts, basements, excavations, and unsafe fences or structures.
3. Any dwelling which because it is dilapidated, unsanitary, unsafe, vermin-infested, or lacking in the facilities and equipment required by the housing code of the municipality, has been designated by the department responsible for enforcement of the code as unfit for human habitation.
4. Any structure which is a fire hazard or is otherwise dangerous to the safety of persons or property.
5. Any structure from which the utilities, plumbing, heating, sewage, or other facilities have been disconnected, destroyed, removed, or rendered ineffective so that the property is unfit for its intended use.
6. Any vacant or unimproved lot or parcel of ground in a predominantly built-up neighborhood, which by reason neglect or lack of maintenance has become a place for the accumulation of trash or debris, or a haven for rodents or other vermin.
7. Any unoccupied property which has been tax delinquent for a period of two years prior to the effective date of Pennsylvania State Statute 1945 Act 385 or local municipality regulations and those in the future having a two-year tax delinquency.
8. Any property which is vacant but not tax delinquent, which has not been rehabilitated within one year of the receipt of notice to rehabilitate from the appropriate code enforcement agency.
9. Any abandoned property.

4.3.16.2 Range of Magnitude

Crawford County has a large number of blighted properties that are located in urban environments, including Meadville and Titusville. Most of the blighted properties in Crawford County are unsecured and highly unsafe due to one or more of the following issues: structure rot, infestation from vermin including but not limited to rats, mice, and insects, and occupation by squatters. These properties can create a risk for the county because they are unsafe for occupation and future construction.

4.3.16.3 Past Occurrence

The number of blighted properties in Crawford County has increased in recent years. Although there are some properties that are considered to be blighted in Crawford County, the ones that have been removed have been demolished by the municipality in which they were constructed, through the money they receive from the county. With recent market trends in real estate, many vacant buildings in Crawford County are sold prior to them being blighted.

4.3.16.4 Future Occurrence

Blighted properties in Crawford County will continue to increase unless blighted property procedures are put into practice at the county and local levels. With the requisite policies put into place the number of blighted properties in Crawford County is liable to decrease.

4.3.16.5 Vulnerability Assessment

Blighted properties are a significant concern when the health and safety of the citizens of Crawford County are impacted. Blighted properties, while being an eye sore, are also a threat to the health and safety of individuals. Buildings that are blighted often can be unsafe due to building materials exposed to the environment or to unintentional consumption by humans. Buildings that have utilized asbestos in construction can become a major health hazard if the building is not maintained, the asbestos exposed, and people breath in those particles because the property has become abandoned and blighted. Another large health issue is mold in blighted properties and buildings. After a property becomes blighted, the functional systems that prevent mold from growing and spreading are often rendered useless, thus facilitating the growth of harmful mold and fungi that pose a threat to human health.

Just as blighted properties can adversely affect the health and safety of humans, it can also hurt the environment of an area. The leaching of building materials from an open or fallen property into water features, such as streams and creeks, can damage the wildlife in a water feature and hurt the public supply of drinking water. As mentioned above, asbestos is a large concern if the blighted property is of older construction. Also, potential chemicals from a blighted property, like paints and oils, can make their way into water tables, streams, and creeks, thus polluting the water features.

Blighted properties also offer shelter for animals and vermin that may not be able to find a home, and an area for breeding in the wild. This can result in the spread of rats and other pests in an area with a large concentration of blighted properties. Along with the accumulation of pests like rats, there is also a high chance of that area also attracting vermin like cockroaches. The increase in vermin can also pose a threat to human health, as vermin and pests can carry diseases which can be contracted due to close contact.

Blight can also adversely affect the infrastructure and its ability to function if the blighted properties in Crawford County are adjacent to or near critical facilities and functional needs facilities. If a blighted property abuts a critical facility, it may be best for that structure to be torn down so that potential negative effects from the blighted property do not cause damage or limit the function of the critical facility.

Finally, blighted properties can be a problem for tourism and attracting new residents to Crawford County. If blighted properties flourish in the county, people who travel to Crawford County for pleasure, whether that be for summer vacations or seasonal hunting, might reconsider that travel due to the presence of blighted properties.

4.3.17. Civil Disturbance

4.3.17.1 Location and Extent

Civil disturbance refers to mass acts of disobedience where participants can become hostile to authority and there is a threat to maintaining public safety and order. Such disturbances can often be forms of protest in the face of socio-political problems. Riots have not been frequent occurrences throughout the history of the Commonwealth, however when they occur, they can cause significant property damage, injury and even loss of life. The scale and scope of civil disturbance events varies widely. Government facilities, local landmarks, prisons, and universities are common sites where crowds and mobs may gather.

Criminal activity refers to all criminality, including enemy attack, sabotage, physical or information break of security, workplace or school violence, harassment, discrimination, and other crimes. Criminal activity is a very broad hazard category and similar to civil disturbance, the scale and scope of incidents or events vary widely.

4.3.17.2 Range of Magnitude

Civil disturbances can take the form of small gatherings or large groups blocking or impeding access to a building or disrupting normal activities by generating noise and intimidating people. They can range from a peaceful sit-in to a full-scale riot, in which a mob burns or otherwise destroys property and terrorizes individuals. Even in its more passive forms, a group that blocks roadways, sidewalks, or buildings interferes with public order. There are two types of large gatherings typically associated with civil disturbances: a crowd and a mob. A crowd may be defined as a casual, temporary collection of people without a strong, cohesive relationship. Crowds can be classified into four categories:

Casual Crowd: A casual crowd is merely a group of people who happen to be in the same place at the same time. Violent conduct does not occur.

Cohesive Crowd: A cohesive crowd consists of members who are involved in some type of unified behavior. Members of this group are involved in some type of common activity, such as worshipping, dancing, or watching a sporting event. Although they may have intense internal discipline, they require substantial provocation to arouse to action.

Expressive Crowd: An expressive crowd is one held together by a common commitment or purpose. Although they may not be formally organized, they are assembled as an expression of common sentiment or frustration. Members wish to be seen as a formidable influence. One of the best examples of this type is a group assembled to protest.

Aggressive Crowd: An aggressive crowd is comprised of individuals who have assembled for a specific purpose. This crowd often has leaders who attempt to arouse the members or motivate them to action. Members are noisy and threatening and will taunt authorities.

They may be more impulsive and emotional and require only minimal stimulation to arouse violence. Examples of this type of crowd could include demonstrators and strikers, though not all demonstrators and strikers are aggressive.

A mob can be defined as a large disorderly crowd or throng. Mobs are usually emotional, loud, tumultuous, violent, and lawless. Similar to crowds, mobs have different levels of commitment and can be classified into four categories:

Aggressive Mob: An aggressive mob is one that attacks, riots, and terrorizes. The object of violence may be a person, property, or both. An aggressive mob is distinguished from an aggressive crowd only by lawless activity. Examples of aggressive mobs are the inmate mobs in prisons and jails, mobs that act out their frustrations after political defeat, or violent mobs at political protests or rallies.

Escape Mob: An escape mob are those groups which attempt to flee from something such as a fire, bomb, flood, or other catastrophe. Members of escape mobs are generally difficult to control and can be characterized by unreasonable terror.

Acquisitive Mob: An acquisitive mob is one motivated by a desire to acquire something. Riots caused by other factors often turn into looting sprees. This mob exploits a lack of control by authorities in safeguarding property.

Expressive Mob: An expressive mob is one that expresses fervor or revelry following some sporting event, religious activity, or celebration. Members experience a release of pent-up emotions in highly charged situations.

In the event of a significant civil disturbance or criminal activity incident, local government operations and the delivery of services in the community may experience short-term disruptions. The greatest secondary effect is the impact on the economic and financial conditions of the affected community, particularly in relation to the property, facilities, and infrastructure damaged as a result of the disturbance. More serious acts of vandalism may result in limited power failure or hazardous material spills, leading to a possible public health emergency. Altered traffic patterns may increase the probability of a transportation accident.

Crawford County's greatest likelihood for civil disturbance is in Meadville, the county seat. Citizens, property, and infrastructure could be affected if a large-scale disorder were to take place. Typically, government facilities, landmarks, prisons, and universities are common sites where crowds or mobs may gather. Crawford County is home to five universities and post-secondary education centers, including: Allegheny College, University of Pittsburgh at Titusville, and Crawford Tech.

4.3.17.3 Past Occurrence

The county has not experienced any *significant* civil disturbance events.

Following the death of African-American George Floyd in Minneapolis, Minnesota in May 2020 at the hands of law enforcement, civil unrest erupted across the nation. A Proclamation of Disaster Emergency was established by the Governor's Office for the entire Commonwealth of Pennsylvania on April 15, 2021. This gave the Pennsylvania Emergency Management Agency Director command and control of the statewide emergency operations and directed all agencies and departments to utilize all resources and personnel to cope with the magnitude and severity of the event.

4.3.17.4 Future Occurrence

While unlikely, civil disturbances may occur in Crawford County, and it is difficult to accurately predict the probability of future occurrence for civil disturbance events over the long-term. However, *Table 56 - Civil Disturbance Events Reported to PEMA 2018-2023*, depicts the range of potential civil disturbances in Pennsylvania and gives the county some background for consideration of future occurrences.

Table 56 - Civil Disturbance Events Reported to PEMA 2018-2023

Table 4.3.18-4 Civil Disturbance Events Reported to PEMA-KC, 2018- 2023 (PEMA, 2023).

EVENT TYPE	2018	2019	2020	2021	2022	2023*
Demonstration	4	2	35	14	10	1
Juvenile Detention Center	7	0	0	0	0	0
Prison Disturbance	0	1	5	3	2	0
Detainee Escape	0	0	0	0	0	0
Protest	8	17	172	42	16	7
Large gathering	8	4	16	3	7	1
Riot	0	0	4	0	1	0
School Threat	0	0	0	0	0	0
Assault	0	0	0	0	0	0
Gun/Bomb Incident	0	0	0	0	0	0

According to the Pennsylvania State Hazard Mitigation Plan, from 2018 to 2023, the commonwealth experienced an average of eighty-one civil disturbance events each year. While that number is relatively low and the occurrences in Crawford County are rare, the local planning team (LPT) decided civil disturbance should be regarded as a low-risk hazard due to the current political trends and frictions across the country.

4.3.17.5 Vulnerability Assessment

All municipalities in Crawford County can be vulnerable to civil disturbance and criminal activity; however. the anticipated impact from such events is minimal. These events may be sparked for varying reasons and the seriousness of the event may well be exacerbated by how authorities handle the crowd. At the writing of this plan, the political temperature of the country as a whole continues to run high, making this hazard vulnerability one for consistent monitoring by public safety officials.

4.3.18. Dam and Levee Failure

4.3.18.1 Location and Extent

Dams

A dam restricts the flow of water or underground streams and often creates reservoirs for water storage. The reservoirs created by these barriers not only suppress floods but also provide water for activities such as irrigation, human consumption, industrial use aquaculture, and navigability.

Dam failures occur usually as a secondary effect of massive amounts of rainfall and flooding, causing too much water to enter the spillway system. This type of failure occurs with little to no warning. Spring thaws, severe thunderstorms, and heavy rainfall are also contributing factors to potential dam failures. Depending on the size of the body of water where the dam is constructed, additional water may come from distant upstream locations. Water contributions may also come from dam failures in adjoining counties that are along the same riverine or water features.

FEMA considers the following to be the most frequent causes of dam failures:

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

Poor engineering or poor maintenance may also cause dam failure. The Pennsylvania Department of Environmental Protection (PA DEP) and the United States Army Corps of Engineers (USACE) awards permits for dams and also share inspection responsibilities. Inspection results are characterized as either safe or unsafe.

The National Inventory of Dams (NID) is a registry that captures information about structures that are greater than or equal to 25 feet in height or impound 50-acre-feet or more of water (an acre-foot is equal to 325,851 gallons of water); it includes structures above 6 feet in height where failure would potentially cause damage downstream. The dams are classified in terms of hazard potential as “High”, “Significant”, or “Low”, with high-hazard dams requiring emergency action plans (EAPS) There are eight high-hazard and thirteen low-hazard dams in Crawford County that are both publicly and privately owned and are registered with the USACE in the NID. There are also three dams with a hazard classification as significant. There are eight dams within the county that are high-hazard and require an emergency action plan. *Table 58 – Crawford County Dam Inventory* illustrates the dams located in Crawford County. *Table 57 – High-Hazard Dams*

Municipal Summary summarizes the high-hazard dams in Crawford County by municipality. The municipalities not listed do not have high-hazard dams. *Table 59 – Dam Name and Purpose* lists the dams located in Crawford County and their purpose code, and the description of purpose based on the Pennsylvania DEP codes.

Table 57 - High-Hazard Dams Municipality Summary

High-Hazard Dams – Municipal Summary	
Municipality	**Number of High-Hazard Dams**
Cambridge Township	1
Conneautville Borough	1
East Fairfield Township	1
East Fallowfield Township	1
Meadville, City of	2
South Shenango Township	1
West Mead Township	1
Total:	**8**
Source: PA DEP, 2023	

Table 58 - Crawford County Dam Inventory

Crawford County Dams							
Dam Name	**River**	**Owner Name**	**Year Completed**	**Dam Height (feet)**	**Drainage Area (acres)**	**Hazard**	**EAP**
Woodcock Creek Dam	Woodcock Creek	USACE-Pittsburgh District	1973	90	29,440	High	Yes
Pymatuning	Shenango River	DCNR	1933	50	102,400	High	Yes
Conneautville	Thatcher Run	Borough of Conneautville	1984	41	198.40	High	Yes
Rainbow (Pa-460)	Mill Run	City Of Meadville	1964	40	5,094.4	High	Yes
Tamarack Lake A (pa-461a)	Mill Run	PA Fish & Boat Commission	1962	23	3,193.60	High	Yes
Tamarack Lake B (pa-461b)	Mud Run	PA Fish & Boat Commission	1962	21	3,193.60	High	Yes

Crawford County Dams							
Dam Name	**River**	**Owner Name**	**Year Completed**	**Dam Height (feet)**	**Drainage Area (acres)**	**Hazard**	**EAP**
Lower (Pa-487a)	Crooked Creek	PA Game Commission	1973	20	12,864	High	Yes
Cambridge Springs	TR French Creek	PA Department of Corrections	N/a	14	704	High	Yes
Van Meter	TR Cussewago Creek	Larry Mcclure	N/a	33	883.20	Significant	No
Pa-107	French Creek	PA Game Commission	N/a	12	N/a	Significant	No
Clear Lake	East Branch Oil Creek	Spartanburg Borough	1855	11	9024	Significant	No
Erie Pool #9	Lake Creek	US Fish and Wildlife Service	1968	15	7,040	Low	No
Shenango Lakes Lower	TR Pymatuning Lake	Shenango Lakes Allotment, Inc.	N/a	20	384	Low	No
Erie Pool #7 Dam	Lake Creek	US Fish and Wildlife Service	1967	15	477,440	Low	No
Little Sugar Creek	N/a	PA Game Commission	1966	14	640	Low	No
Pa-106	TR Cussewago Creek	PA Game Commission	1978	12	1,561.60	Low	No
Erie Pool #4 Dam	Lake Creek	US Fish and Wildlife Service	1980	12	2,624	Low	No
Erie Pool K Dam	TR to Lake Creek	US Fish and Wildlife Service	1971	11	691.20	Low	No
Hartstown No 15	Shenango River	PA Game Commission	1989	10	3,884.80	Low	No

Crawford County Dams							
Dam Name	**River**	**Owner Name**	**Year Completed**	**Dam Height (feet)**	**Drainage Area (acres)**	**Hazard**	**EAP**
Meyers Pond Dam	TR-Lake Creek	US Fish and Wildlife Service	1967	10	76.80	Low	No
Custards	Conneaut Outlet	PA Game Commission	1972	8	49,920	Low	No
Conneaut Marsh	Conneaut Creek	PA Game Commission	1955	8	43,520	Low	No
Lake La Tsuga	TR French Creek	Lakeview Manor LLC	1877	8	384	Low	No
Pa-104	French Creek	PA Game Commission	1975	7.8	268.80	Low	No
Source: Crawford County							

Table 59 - Dam Name and Purpose

Crawford County Dams and Purposes		
Dam Name	**Purpose Code**	**Purpose Code Description**
Woodcock Creek Dam	C	Flood Risk Reduction
Pymatuning	C	Flood Risk Reduction
Conneautville	C	Flood Risk Reduction
Rainbow (Pa-460)	C	Flood Risk Reduction
Tamarack Lake A (pa-461a)	C	Flood Risk Reduction
Tamarack Lake B (pa-461b)	C	Flood Risk Reduction
Lower (Pa-487a)	C	Flood Risk Reduction
Cambridge Springs	R	Recreation
Van Meter	R	Recreation
Pa-107	R	Recreation
Clear Lake	R	Recreation
Erie Pool #9	F	Fish and Wildlife Pond
Shenango Lakes Lower	O	Other
Erie Pool #7 Dam	F	Fish and Wildlife Pond
Little Sugar Creek	R	Recreation
Pa-106	R	Recreation
Erie Pool #4 Dam	F	Fish and Wildlife Pond
Erie Pool K Dam	F	Fish and Wildlife Pond
Hartstown No 15	R	Recreation
Meyers Pond Dam	F	Fish and Wildlife Pond

Crawford County Dams and Purposes		
Dam Name	**Purpose Code**	**Purpose Code Description**
Custards	R	Recreation
Conneaut Marsh	R	Recreation
Lake La Tsuga	O	Other
Pa-104	C	Flood Risk Reduction
Source: PA DEP, 2019 and NID, 2023		

The Pennsylvania Department of Environmental Protection defines a high-hazard dam as "Any dam so located as to endanger populated areas downstream by its failure". High-hazard dams receive two inspections each year, once by a professional engineer on behalf of the owner and once by a PA DEP inspector (DEP, 2008).

Levees

Levee failures have the potential to place large numbers of people and 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 of damage during a flooding event. Levees do not serve a purpose beyond flood protection, unlike dams, which can serve to store water or generate energy in addition to protecting areas from flooding. The National Levee Database (NLD), like its counterpart of the National Inventory of Dams (NID), is maintained by the USACE and tracks levees across the United States. Crawford County is home to one levee section, which are detailed in *Table 60 – Crawford County Levee Inventory*.

Table 60 - Crawford County Levee Inventory

Crawford County Levee Inventory				
Levee Name	**Flood Source**	**Levee Type**	**Levee Bank Side**	**Levee Length (miles)**
Meadville, PA- Mill Run	N/a	Flood Risk Reduction	N/a	0.14
Source: NLD, 2023				

4.3.18.2 Range of Magnitude

Dams

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 from a dammed impoundment or water body. *Figure 45 – Crawford County Dams* shows the location of dams within Crawford County as well as their hazard designation.

Levees

Levee failure can be caused by a number of factors, and they can also cause catastrophic effects. Damage to the area beyond a levee, if it fails, could be more significant than if the levee was not present. Levees are designed to provide a specific level of protection, so flooding events could overtop the levees if these events exceeded the levee specifications. Additionally, levees can also fail if they are allowed to deteriorate or decay. Regular maintenance of levees is critical. The levee location in Crawford County is shown in *Figure 46 – Levee Location - Meadville*.

A Levee failure of 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 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.

4.3.18.3 Past Occurrence

Dams

There have been no past occurrences of dam failure or major incidence occurring at the locations of dams within Crawford County. Smaller incidences have occurred but have not had significant impacts in the county.

There have been a few historically destructive dam failures in Pennsylvania over the course of the past two hundred years. The most destructive dam failure in United States history took place in Johnstown, Pennsylvania (Cambria County) in 1889, claiming 2,209 lives. Another significant dam failure took place in Austin, Pennsylvania (Potter County) in 1911, claiming seventy-eight lives. Similarly, a dam failure in West Taylor Township, Pennsylvania (Cambria County) claimed the lives of forty people when the Laurel Run Dam, No. 2 failed during the Johnstown Flood in the early morning hours of July 20th, 1977.

Levees

The National Levee Database (NLD) lists no occurrence of levee failures or major incidents occurring in Crawford County.

Some of the worst levee failures in the history of the United States have occurred in the American South, along parts of the Mississippi River delta. Levee failures in New Orleans, Louisiana during Hurricane Katrina from August 23 to August 31, 2005 resulted in an enormous amount of property damage and loss of lives. There were approximately fifty-three levee failures in constructed levees around the City of New Orleans. Hurricane Katrina precipitated the creation of more strict levee requirements for inspection and construction on the local, state, and federal level.

4.3.18.4 Future Occurrence

Dam

Although dam failures can occur at any time, given the right circumstances, the likelihood of a dam failure in Crawford County is considered to be unlikely.

The presence of structural integrity and inspection programs significantly reduces the potential for major dam failure events to occur. The PA DEP inventories and regulates all the dams that meet or exceed the following criteria (PA, DEP, 2008):

- Impound water from a drainage area of greater than 100 acres
- Have a maximum water depth greater than 15 feet
- Have a maximum storage capacity of 50 acre-feet or greater

The construction, operation, maintenance, and abandonment of dams is reviewed and monitored by the PA DEP Division of Dam Safety. Dams are evaluated based on those categories such as slope stability, undermining seepage, and spillway adequacy. With more strict construction and design procedures in place, the future occurrence of a dam failure is increasingly small. The new procedures and rules protect public safety and both public and private property. Newly constructed dams are thoroughly examined by professional engineers to prevent future dam failure events.

Levees

Although levee failures can occur at any time, given the right circumstances, the future occurrence of levee failures in Crawford County can be considered unlikely. Most levees are designed to meet a specified level of flooding. While FEMA focuses on mapping levees that will reduce the risk of a 1% annual chance flood, other levees may be designed to protect against both smaller and larger floods.

4.3.18.5 Vulnerability Assessment

Dams

Property and populations located downstream from any dams are vulnerable to dam failures. The Pennsylvania Code (§105.91 Classification of dams and reservoirs) classifies doth dams by size and the amount of loss of life and economic loss expected in a failure event. *Table 61 – Dam Classification* displays the dam classification guide for the Commonwealth of Pennsylvania. Although the size of a dam may result in varying impacts, the hazard potential classification of category one dams is a more important indicator, since that will indicate the level of potential substantial loss of life and excessive economic loss.

Table 61 - Dam Classification

Dam Classification		
Dam Size Classification		
Class	**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
Dam Damage Classification		
Category	**Loss of Life**	**Economic Loss**
1	Substantial	Excessive
2	Few	Appreciable
3	None Expected	Minimal
Source: PA Code, 1980		

Climate change has the potential to increase certain vulnerability aspects for dam failures in Crawford County. Dam failures could occur on a more frequent basis, as a cascading result from other natural hazards that could see an increase in frequency. Stronger hurricanes and tropical storms could result in more intense precipitation over longer periods of time, potentially stressing the load capacity of dams in Crawford County. Also, increased precipitation can erode the foot and outer structure of earthen dams if the rainfall and precipitation events last for prolonged periods of time. Overtopping of these dams could also occur if the impounded water level exceeds the dam's capacity.

Dam failures can cause significant environmental effects, as the resulting flood from a dam failure is likely to disperse debris and hazardous materials downstream that can damage local ecosystems. Debris carried downstream can block roads, cause traffic accidents, disrupt traffic patterns, and delay the delivery of essential services along major traffic corridors. Debris flow can also cause landslides along steep slopes and embankments with low slope stability. The economic and financial impact from damage and recovery ranges from minimal to severe, depending on the magnitude of damage and scale of failure event.

Emergency action plans are developed by the owners of high-hazard dams. These plans are then disseminated to first responders and other planning partners within the county. Vulnerable populations are those residents and businesses located downstream from a high-hazard dam within the inundation area. The emergency action plan identifies a call list to notify downstream at-risk populations. Emergency action plan exercises are held every five to seven years depending on local policy.

The characteristics of the eight high-hazard dams in Crawford County vary greatly. The Erie Pool #7 Dam, has the largest drainage area with a total of 477,440 acres. The dams that were constructed most recently are the Hartstown No 15 dam located in East Fallowfield Township, which was constructed in 1989, and Conneautville (Pa-112) dam which is in Conneautville Borough, which was constructed in 1984. The dam that is the oldest in the county is Clear Lake dam, which was constructed in 1855. The Woodcock Creek dam is the tallest in the county with a height of 90 feet. The Pennsylvania Game Commission owns the most dams in Crawford County with a total of eight. These dams are the Lower (Pa-487a), PA-107, Little Sugar Creek, PA-106, Hartstown No 15, Custards, Pa-104. The dams in Crawford County are owned by a mix of public and private owners and vary in almost every aspect. The county dams are distributed relatively evenly throughout the county and municipalities, with an even mix of high and low hazard dams in the municipalities.

The failure or partial failure of a high-hazard potential dam can have impacts that affect many different jurisdictions across Crawford County and the counties adjacent to Crawford County. A failure at any of the dams in Crawford County would result in some inundation in at least those municipalities adjacent to the dam in question. A more comprehensive examination of risk inundation areas from high-hazard potential dams can be conducted in future iterations of the Crawford County Hazard Mitigation Plan. Until that time, open source data can be used to estimate the vulnerability of areas directly to adjacent high-hazard dams. More comprehensive datasets are not readily available at the time of this writing. Each of the municipalities in Crawford County could see critical infrastructure and community lifelines inundated due to a dam failure. This information is discussed in greater detail further in this vulnerability assessment for dam failures.

Crawford County is at risk when high-hazard potential dams are considered. There are three types of risk related to high-hazard potential dams. Those types are incremental risk, non-breach risk, and residual risk. Those risk types are listed below in *Table 62 – High-Hazard Potential Dams Risk Types* and are described in that table.

Table 62 - High-Hazard Potential Dams Risk Types

High-Hazard Potential Dams – Risk Type	
Type of Risk	**Description**
Incremental Risk	The risk (likelihood and consequences) to the pool areas and downstream floodplain occupants that can be attributed to the presence of the dam should the dam breach prior or subsequent to overtopping, or undergo component malfunction or mis-operation, where consequences considered are over and above those that would occur without dam breach. The consequences typically are due to downstream inundation, but loss of the pool can result in significant consequences in the pool area upstream of the dam.
Non-Breach Risk	The risk in the reservoir pool area and affected downstream floodplain due to 'normal' dam operation of the dam (e.g., large spillway flows within the design capacity that exceed channel capacity) or 'overtopping of the dam without breaching' scenarios.
Residual Risk	The risk that remains after all mitigation actions and risk reduction actions have been completed. With respect to dams, FEMA defines residual risk as "risk remaining at any time" (FEMA, 2015, p A-2). It is the risk that remains after decisions related to a specific dam safety issue are made and prudent actions have been taken to address the risk. It is the remote risk associated with a condition that was judged to not be a credible dam safety issue.
Source: "Rehabilitation of High-Hazard Potential Dams Grant Program Guidance," June, 2020	

Although data limitations are present, one of the open source datasets used for planning is the Resilience Analysis and Planning Tool (RAPT) administered by FEMA. This tool can be used to overlay areas of interest around certain features. In *Table 63 – High-Hazard Dam Vulnerability (RAPT)*, a 2-mile distance was calculated around each high-hazard dam in Crawford County. Those location were then used to determine how many people or households are vulnerable to a dam failure based strictly on distance. Some of the indicators used for this analysis were total population, households without a vehicle, households with limited English, and housing units that are mobile homes.

Table 63 - High-Hazard Dam Vulnerability (RAPT)

High-Hazard Dam Vulnerability Data				
Dam	**Total Population**	**Households without a vehicle**	**Households with limited English**	**Housing units that are mobile homes**
Cambridge Springs	999	73	2	94
Conneautville (PA-112)	511	47	3	98
Little Shenango PA 487B	601	78	12	148
Lower (PA-487-A)	577	80	13	136
Pymatuning	900	63	0	243
Rainbow (PA-460)	12,476	3,081	50	267
Tamarack Lake A	6,583	1,182	15	62
Tamarack Lake B	1,083	63	3	116
Woodcock Creek Dam	1,371	95	9	281
Total	**25,101**	**4,762**	**107**	**1,445**
Source: RAPT, ACS, 2017-2021, Table B08201, Table S1602, and Table DP04 Note: This data should not be considered authoritative. Authoritative data should be derived from Crawford County GIS data. This is for general vulnerability assessments.				

An analysis was also conducted for high priority infrastructure within 2-miles of high-hazard dams in Crawford County. The information in the table below illustrates which infrastructure was located in that vulnerability zone. This can be seen in *Table 64 – High-Hazard Dam Vulnerability (RAPT) Infrastructure*.

Table 64 - High-Hazard Dam Vulnerability (RAPT) Infrastructure

High-Hazard Dam Vulnerability Data – Infrastructure				
Dam	**Hospitals**	**Nursing Homes**	**Fire Stations**	**Public Schools**
Cambridge Springs	0	0	1	2
Conneautville (PA-112)	0	1	1	1
Little Shenango PA 487B	0	0	0	0
Lower (PA-487-A)	0	0	1	0
Pymatuning	0	0	1	2
Rainbow (PA-460)	1	2	3	6
Tamarack Lake A	0	1	2	5
Tamarack Lake B	0	0	0	0
Woodcock Creek Dam	0	1	0	0
Source: RAPT, Homeland Infrastructure Foundation-Level Data, 2024				

High-Hazard Dam Vulnerability Data – Infrastructure				
Dam	**Hospitals**	**Nursing Homes**	**Fire Stations**	**Public Schools**
Note: This data should not be considered authoritative. Authoritative data should be derived from Crawford County GIS data. This is for general vulnerability assessments.				

The table below provides more information on the infrastructure located within that 2-mile

vulnerability zone around each high-hazard dam. This information includes each location in the categories listed above. This is *Table 65 – High-Hazard Dam Vulnerability (RAPT) Additional Information*.

Table 65 - High-Hazard Dam Vulnerability (RAPT) Additional Information

High-Hazard Dam Vulnerability Data – Infrastructure Names	
Dam	**Additional Information**
Cambridge Springs	Fire Stations: 1. Cambridge Springs Volunteer Fire Department Public Schools: 1. Cambridge Springs Elementary 2. Cambridge Springs Junior/Senior High School
Conneautville (PA-112)	Nursing Homes: 1. Rolling Fields, Inc. Fire Stations: 1. Fellow's Club Volunteer Fire Department and Ambulance Public Schools: 1. Conneaut Valley Elementary School
Little Shenango PA 487B	N/A
Lower (PA-487-A)	Fire Stations: 1. Fallowfield Township Volunteer Fire & Rescue
Pymatuning	Fire Stations: 1. Jamestown Volunteer Fire Department Public Schools: 1. Jamestown Area Elementary School 2. Jamestown Area Junior/Senior High School
Rainbow (PA-460)	Hospitals: 1. Meadville Medical Center Nursing Homes: 1. Crawford Care Center 2. Wesbury United Methodist Community Fire Stations: 1. West Mead Township District 1 – Alden Street 2. Meadville Central Fire Department 3. West Mead Township District 1 – Liberty Street

High-Hazard Dam Vulnerability Data – Infrastructure Names	
Dam	**Additional Information**
	Public Schools: 1. Neason Hill Elementary 2. Crawford County CTC 3. Meadville Middle School 4. Meadville Senior High School 5. Second District Elementary School 6. First District Elementary School
Tamarack Lake A	Nursing Homes: 3. Meadville Medical Center Transitional Care Fire Stations: 4. West Mead Township District 1 – Alden Street 5. West Mead Township District 1 – Liberty Street Public Schools: 7. Neason Hill Elementary 8. Crawford County CTC 9. Meadville Middle School 10. Meadville Senior High School 11. Second District Elementary School
Tamarack Lake B	N/A
Woodcock Creek Dam	Nursing Homes: 1. Crawford Care Center
Source: RAPT, Homeland Infrastructure Foundation-Level Data, 2024 Note: This data should not be considered authoritative. Authoritative data should be derived from Crawford County GIS data. This is for general vulnerability assessments.	

Levees

Each levee that is located in Crawford County is of different length and each protects areas from a different section of waterway and flood way. Mill Run levee is the largest in Crawford County with a length of 0.14 miles.

The entire leveed areas for Crawford County do not directly protect any address points within the county. There are no facilities points within Crawford County that are protected by levees. Each levee in Crawford County is a mainline levee and protects along a variety land feature. A failure of levee in the urban areas in Crawford County would be catastrophic to life and property.

There are a large number of community lifeline facilities within the levee protection areas for the levees around Crawford County. *Table 66 – Number of Vulnerable Structures within Leveed Areas* shows the number of addressable structures and facility type points in the largest levee protection areas within Crawford County based on NLD information from 2023. The features included in the table are particularly vulnerable to levee failure because they are protected by the system. Should the levee systems fail, the structures would be at an increased risk by their flood sources.

Table 66 - Number of Vulnerable Structures within Leveed Areas

Number of Vulnerable Structures within Leveed Areas		
Leveed Area Name	**Addressable Structures in Leveed Area**	**Facility Type Points in Leveed Area**
Mill Run Levee	0	0
Totals:	**0**	**0**

Note on Further Vulnerability Assessments

For each high hazard dam in Crawford County, please refer to the corresponding EAPs for dam structure, operational procedures, vulnerability areas, and overall dam characteristics. Most dam EAPs are considered confidential documents not for public release.

Figure 45 - Crawford County Dams

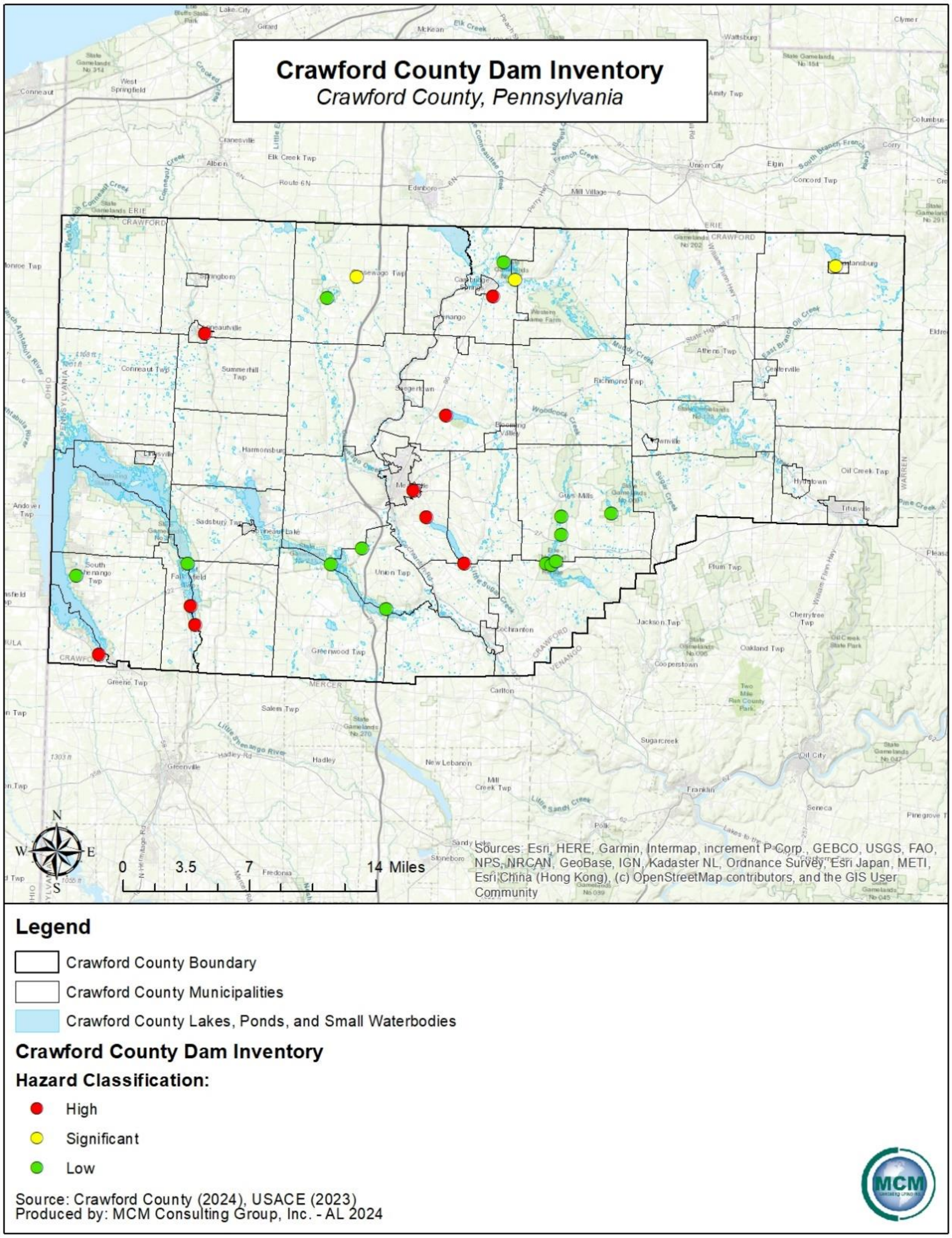
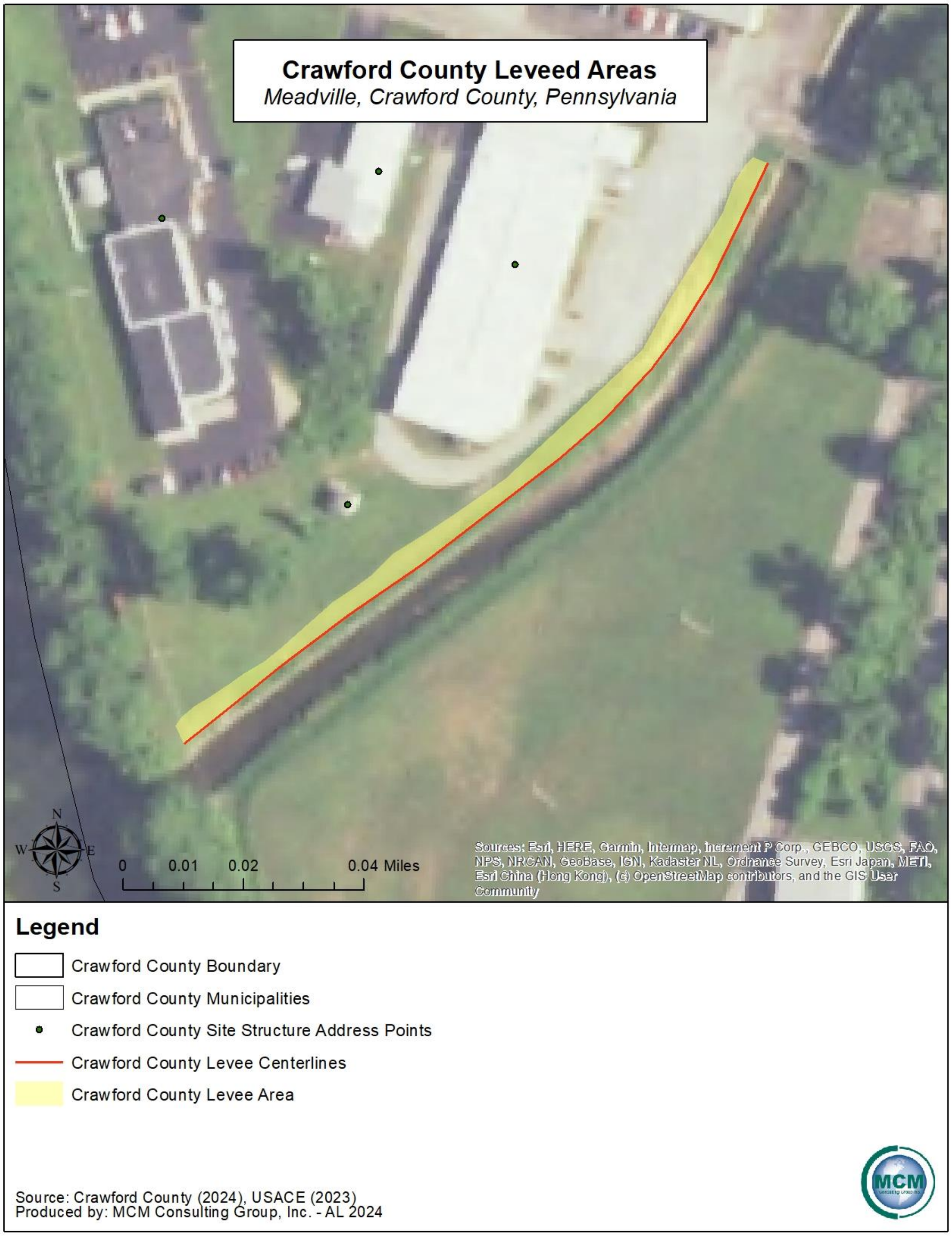


Figure 46 - Levee Locations – Meadville



4.3.19. Emergency Services

4.3.19.1 Location and Extent

Fire, emergency medical services (EMS), local emergency management coordinators (LEMC), and law enforcement service agencies are defined per municipality in Crawford County. In addition to the local services, the county hosts numerous special teams. Regional and state-wide services are also available.

With the exception of law enforcement, most areas are served by volunteers instead of career personnel, which increases response time due to volunteer availability. Volunteers provide emergency services above separately from their regular careers. Often agencies struggle with the availability of skilled personnel and resources at certain times of the day. The number of responders in general has decreased, in part due to issues including funding and retention of personnel.

Additionally, the time and expense obligations of required training are a factor in the decrease in number of responders. The initial training time for fire, EMS, and law enforcement can take several months to complete. Emergency medical services, requires a regular schedule of continued education to maintain certification. In the fire service, after the initial training, there are specialty courses offered, which are recommended, but not required. For law enforcement, skills such as firearms proficiency must be maintained, and updates to new laws and regulations continues throughout the officer’s career.

4.3.19.2 Range of Magnitude

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

Two fundamental, yet misunderstood, topics are the financial and economic variables that drive emergency service systems. These systems typically generate revenue through tax subsidies, memberships, direct sales, diversification into other lines of business, grants, or fundraising. They spend most of these revenues on direct and indirect labor, and benefits. The remaining dollars go into infrastructure, fuel, medical supplies, insurances, fleet maintenance, dispatch, and other essential items, with hopefully, some left over for recapitalization or fund balance development. The range of the issues related to emergency service shortages are felt across the entire United States of America and the Commonwealth of Pennsylvania. Crawford County has felt emergency shortages and these shortages have had adverse effects on emergency response in the county.

4.3.19.3 Past Occurrence

There have been no official records kept on shortages to emergency services. However, there has been a decrease in the number of new volunteers in the fire service for several years. Most agencies are private organizations that lack local funding and exist based on tax dollars, fund raising, and donations received from their community. The need for fund raising adds to availability issues of volunteers. Most services past practices are not sustaining the current needs for funding and manpower. Without financial support from the communities, services may not be able to remain in operation to serve those same communities. Recruitment and personnel retention are a key to success.

Crawford County has had multiple events that were caused by emergency service shortages, most significantly from 2020 to 2022, exacerbated by the COVID-19 pandemic. Crawford County has been experiencing a shortage on local emergency services especially during and after the COVID-19 pandemic. However, it is important to note that this shortage has not been caused exclusively by the COVID-19 pandemic and was occurring before the pandemic across Crawford County and the Commonwealth of Pennsylvania.

4.3.19.4 Future Occurrence

Historically, it has been difficult for small communities to have a paid fire or EMS service, therefore requiring volunteers. Fewer volunteers to perform the tasks associated with fire, medical, and rescue operations, can negatively affect a service's ability to respond to emergencies. Additionally, operational needs are impacted if there are fewer volunteers to raise funds. Without fundraising and community support these fire departments and volunteer EMS agencies will experience broader challenges. Municipalities can help offset some of the financial burdens to their local fire company with a fire tax.

There are also challenges for individuals who volunteer, including dedicating time beyond their current employment, family, and community commitments to dedicate to training, responding, and fundraising. Training is essential to provide for the general knowledge and safety of volunteers. Becoming certified as a firefighter requires hundreds of hours of training. With a decrease in the numbers of new volunteers, many current volunteers are aging and unable to perform at the same levels they once were.

Fire departments and EMS agencies often are tasked with responding to a variety of emergencies, including not only fire and medical emergencies, but also incidents requiring rescue, containment of hazardous materials, or assistance to law enforcement. Volunteers need to be well trained and able to respond to different scenarios as needed.

The future occurrence of emergency service shortages is likely to continue in Crawford County and across the Commonwealth of Pennsylvania. With a lack of new recruits and officers for emergency services, response will continue to be hindered and response times will continue to be high. Institutional change is the most efficient way to decrease the likelihood of emergency service shortages in Crawford County, but that type of change is slow and often long-term.

4.3.19.5 Vulnerability Assessment

The possibility that EMS agencies and fire services could fail creates a vulnerability to all Crawford County communities. Occasionally, residents of communities mistakenly think that their local fire department is a paid service. Most municipal fire departments are volunteer agencies and need the support of their communities to maintain their departments.

Personnel shortages have been occurring in law enforcements for several reasons. More students are pursuing other professional careers instead of becoming public safety professionals than previously. This trend could be an effect of the recent changes in the social climate toward law enforcement, the increased number of college students pursuing graduate school degrees, or many other factors. As with any profession, becoming a law enforcement officer requires a commitment of time and money for training at local, state, or federal levels. The selection of law enforcement officers includes not only physical and mental aptitudes, but also a comprehensive physiological screening.

If any current public service agency fails to provide enough personnel to perform their required duties, then those duties must be provided for by another service agency that may be many miles away, creating an increased response time. An increased response time could lead to additional or greater severity in injury or property damage. Many communities in Pennsylvania have already experienced the closure of emergency response agencies.

It is recommended that each municipality assess their own vulnerabilities by maintaining and building relationships with their local providers and working with them to make to plan accordingly for if a local service were to close its operations. Consolidation of services is a possible solution for agencies that are struggling to maintain operations. Statistics, response times, and all times associated with units dispatched are easily obtainable from the county 911 center. Municipalities should research all of the factors which would be part of a consolidation of emergency services with neighboring communities.

The emergency services departments in Crawford County need to be supported to create and or discover new ways to not only recruit but to retain volunteers. If left unattended, the issue will continue and the lack of response will grow, leaving communities more vulnerable to loss of life and loss of property. Community education is a key factor in the maintenance of emergency response agencies. In addition, continued support, and efforts to inform legislature could all prove to be important in assuring that these services remain in operation into the future. At the time of the writing of this plan, a number of bills has been introduced in both the House of Representative and the Senate as a result of a two-year study initiated by Senate Resolution 6 (SR6). The final report can be found here: http://pehsc.org/wp-content/uploads/2014/05/SR-6-REPORT-FINAL.pdf.

Emergency response agencies that currently provide services within Crawford County are identified in the following tables, *Table 67 – Crawford County Fire Departments* identifies the municipalities served. Almost all fire departments in Crawford County are volunteer. *Table 68 – Crawford County EMS Agencies* identifies each emergency medical service agency, and the municipalities served. *Table 69 – Crawford County Law Enforcement Agencies* identifies each police department to include the Pennsylvania State Police (PSP) and the municipalities served. The services highlighted in red are located outside the county, but provide coverage to communities within Crawford County. *Table 70 – Crawford County Specialty Teams* lists the teams and their specialty. This information was provided by the Crawford County Emergency Services.

Table 67 - Crawford County Fire Departments

Crawford County Fire Departments	
Station Name	**Municipalities Covered**
Bloomfield Township VFD	Athens Township, Bloomfield Township
Blooming Valley VFD	Blooming Valley Borough, Richmond Township, Woodcock Township
Cambridge Springs VFD	Cambridge Township, Cambridge Springs Borough, Cussewago Township, Richmond Township, Rockdale Township, Venango Township, Woodcock Borough, Woodcock Township
Centerville VFD	Athens Township, Centerville Borough, Rome Township, Steuben Township
Chapmanville VFD	Troy Township
Cochranton VFD	Cochranton Borough, East Fairfield Township, Fairfield Township, Wayne Township
Conneaut Lake VFD	Conneaut Lake Borough, Sadsbury Township
East Mead VFD	East Mead Township
Edinboro VFD	Cussewago Township, Venango Township
Fallowfield Fire & Rescue	East Fallowfield Township, West Fallowfield Township

Crawford County Fire Departments	
Station Name	**Municipalities Covered**
Fellows Club (Conneautville) VFD	Beaver Township, Conneaut Township, Conneautville Borough, Spring Township, Summerhill Township
Greenwood Volunteer Fire & Rescue	Greenwood Township
Hayfield Central Hose Company	Cussewago Township, Hayfield Township, Summerhill Township
Hydetown VFD	Hydetown Borough, Oil Creek Township, Troy Township
Jamestown VFD	South Shenango Township, West Shenango Township
Linesville VFD	Conneaut Township, Linesville Borough, Pine Township
Meadville Fire Department	Meadville City
Mill Village VFC	Rockdale Township
North Shenango VFD	North Shenango Township
Pleasantville VFD	Oil Creek Township
Randolph VFD	Randolph Township, Richmond Township
Saegertown VFD	Cussewago Township, Hayfield Township, Saegertown Borough, Woodcock Township
Spartansburg VFD	Rome Township, Sparta Township, Spartansburg Borough
Springboro VFD	Beaver Township, Cussewago Township, Spring Township, Springboro Borough
Summit Township VFD	Summit Township
Titusville Fire Department	Titusville City
Townville VFD	Athens Township, Richmond Township, Steuben Township, Townville Borough, Troy Township
Venango VFD	Cambridge Township, Cussewago Township, Hayfield Township, Venango Borough, Venango Township, Woodcock Borough, Woodcock Township
Vernon Central Hose Company	Union Township, Vernon Township
West Mead #1 VFC	West Mead Township
West Mead #2 VFD	West Mead Township, Woodcock Township

Table 68 - Crawford County EMS Agencies

Crawford County EMS Agencies	
Station Name	**Municipalities Covered**
	Areas Served
Bloomfield Vol. Ambulance Service	Athens Township, Bloomfield Township
Centerville Vol. Ambulance Service	Athens Township, Centerville Borough, Rome Township, Steuben Township

Crawford County EMS Agencies	
Station Name	Municipalities Covered
	Areas Served
Conneaut Lake Ambulance Service	Conneaut Lake Borough, Greenwood Township, North Shenango Township, Sadsbury Township, South Shenango Township, Union Township, Vernon Township
Edinboro Vol. Ambulance Service	Cussewago Township, Venango Township
EmergyCare (Greenville)	South Shenango Township, West Shenango Township
EmergyCare (Titusville)	Hydetown Borough, Oil Creek Township, Titusville City
Fallowfield VFD Ambulance	East Fallowfield Township, West Fallowfield Township
Fellows Club VFD Ambulance Service (Conneautville)	Beaver Township, Conneaut Township, Conneautville Borough, Cussewago Township, Spring Township, Summerhill Township
Linesville VFD Ambulance Service	Conneaut Township, Linesville Borough, Pine Township
Meadville Area Ambulance Service	Blooming Valley Borough, Cambridge Township, Cambridge Springs Borough, Cochranton Borough, Cussewago Township, East Fairfield Township, East Mead Township, Fairfield Township, Hayfield Township, Randolph Township, Richmond Township, Rockdale Township, Saegertown Borough, Union Township, Venango Borough, Venango Township, Vernon Township, Wayne Township, West Mead Township, Woodcock Borough, Woodcock Township
Meadville Fire Department Ambulance	Meadville City
Mill Village VFD Ambulance Service	Rockdale Township
Spartansburg VFD Ambulance Service	Rome Township, Sparta Township, Spartansburg Borough
Springboro VFD Ambulance Service	Beaver Township, Cussewago Township, Spring Township, Springboro Borough
Summit Township VFD Ambulance Service	Hayfield Township, Summerhill Township, Summit Township, Vernon Township

Crawford County EMS Agencies	
Station Name	Municipalities Covered Areas Served
Townville Volunteer Ambulance Service	Athens Township, Randolph Township, Richmond Township, Steuben Township, Townville Borough, Troy Township

Table 69 - Crawford County Law Enforcement Agencies

Crawford County Police Departments	
Station Name	Municipalities Covered
Allegheny College DPS	Allegheny College campus in Meadville City
Cambridge Springs PD	Cambridge Springs Borough
Cochranton PD	Cochranton Borough
Conneaut Lake Regional PD	Conneaut Lake Borough, North Shenango Township, Sadsbury Township
Crawford County Sheriff	Crawford County
Linesville PD	Linesville Borough
Meadville PD	Meadville City, Vernon Township
PA State Police - Corry	Eastern Crawford County: Athens Township, Bloomfield Township, Centerville Borough, Hydetown Borough, Oil Creek Township, Rome Township, Sparta Township, Spartansburg Borough, Steuben Township, Townville Borough, Troy Township
PA State Police - Meadville	Central & Western Crawford County
Pymatuning State Park Police	Pymatuning State Park in Conneaut Township, North Shenango Township, Pine Township, South Shenango Township, West Shenango Township
Pymatuning State Park Police	Pymatuning State Park in Conneaut Township, North Shenango Township, Pine Township, South Shenango Township, West Shenango Township
Titusville PD	Titusville City
University of Pittsburgh at Titusville PD	University of Pittsburgh at Titusville Campus in Titusville City
West Mead Township Police Department	West Mead Township

Table 70 - Crawford County Specialty Teams

Crawford County Specialty Teams	
Team Name	**Specialty**
Crawford County Firefighters Search and Recovery Scuba Team	Search and Rescue Operations
McCutcheon Enterprises Incorporated	HazMat Operations
Northwest Pennsylvania K9 Search and Rescue	Search and Rescue Operations
Crawford County Amateur Radio Society	Radio Operations
Crawford County SERT	SERT Operations
Crawford County Emergency Behavioral Health.	Emergency Behavioral Health Operations
US Civil Air Patrol	Air Patrol Operations

4.3.20. Environmental Hazards

4.3.20.1 Location and Extent

<u>Transportation</u>

Environmental hazards are most commonly due to hazardous materials incidents occurring when such materials are manufactured, used, stored, or transported. Most hazardous materials incidents are unintentional, however hazardous materials could also be released in a criminal or terrorist act. A release, whether it is intentional or accidental, can result in injury or death and may contaminate air, water and/or soils. Hazardous materials incidents can be generally broken down into the subcategories of transportation and fixed facility. This section will focus on environmental hazards and how they relate to transportation of hazardous materials.

Tanker trucks, tractor trailers, and rail cars often are used to transport hazardous materials. When there are transportation incidents involving these types of vehicles, hazardous materials can be released in significant quantities. *Figure 49 – Environmental Hazard Transportation Vulnerability* shows major transportation routes through Crawford County, including I-79, US 6, US 19, US 322, PA 8, PA 18, PA 27, PA 77, PA 86, PA 89, PA 98, PA 99, PA 102, PA 173, PA 198, PA 285, PA 408, PA 428.

<u>Fixed Facility</u>

Hazardous materials incidents can be broken down into the subcategories of transportation and fixed facility. This section of the report focuses on environmental hazardous materials at fixed facilities.

In Pennsylvania, facilities that use, manufacture, or store hazardous materials must comply with Title III of the federal Superfund Amendments and Reauthorization Act (SARA), and the Commonwealth's reporting requirements under the Hazardous Materials Emergency Planning and Response Act (1990-165), as amended. There are 408 SARA Title III facilities in Crawford County. These facilities listed as SARA sites should not be considered an exhaustive and comprehensive list of all locations where hazardous materials reside in the county. *Figure 48 – Hazardous Waste Locations* and *Table 73 - SARA Facilities* identifies SARA Title III facilities as well as several other locations that consume, store, or release potentially hazardous materials and wastes.

Fixed facilities are also monitored by the Environmental Protection Agency (EPA). The EPA has identified hazardous materials sites, not regulated by SARA Title III, and are known as Toxic Releases Inventory (TRI) sites. Facilities which employ ten or more full time employees, and which manufacture or process more than 25,000 pounds (or use more than 10,000 pounds) of any

SARA Section 313-listed toxic chemical in the course of a calendar year are required to report TRI information to the EPA. The EPA is the federal enforcement agency responsible for SARA Title III and PEMA classifications. As of 2024, there are seventeen toxic release inventory (TRI) facilities in Crawford County, these TRI facilities are located throughout the county.

Oil and gas extraction facilities can also be sources of hazardous material release. Most wells in the county are active, but there are also many inactive and abandoned wells. *Figure 47 – Oil & Gas Well Locations* shows the location of all oil and gas wells in the county along with their proximity to surface waters.

4.3.20.2 Range of Magnitude

<u>Transportation</u>

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

Hazardous material release can contaminate air, water, and soil, and can possibly cause injuries, poisonings, or deaths. Hazardous materials fall into nine hazards classes. These hazard classes are as follows:

- Class #1: Explosives
- Class #2: Gases (flammable, non-flammable, non-toxic, and toxic)
- Class #3: Flammable and Combustible Liquids
- Class #4: Flammable Solids (spontaneously combustible and dangerous when wet materials/water reactive substances)
- Class #5: Oxidizing substances and organic peroxides
- Class #6: Toxic Substances and Infectious Substances
- Class #7: Radioactive Materials
- Class #8: Corrosive Substances
- Class #9: Miscellaneous Hazardous Materials / Substances

All nine hazard classes can be found in transportation incidences.

<u>Fixed Facility</u>

All nine hazard classes can be found at fixed facilities. Certain conditions can exacerbate release incidents and these events include fixed facilities:

- Micrometeorological effects of buildings and terrain which alters the dispersion of hazardous materials.
- Proximity to surface water and ground water resources.
- Compliance with applicable codes (e.g., building or fire codes) and maintenance failures (e.g., fire protection and containment features can substantially increase the damage to the facility itself and to surrounding buildings.

The type of material released, distance, and related response time of emergency responders also significantly impact severity and scope of hazardous material releases and clean-up efforts. Areas most proximal to the release are usually at the greatest level of risk, but depending on the material, a release can travel great distances or remain present in the environment for long periods of time (centuries or millennia for some radioactive materials) resulting in chronic and extensive impacts on people and the environment.

Oil and gas well drilling can have a variety of effects on the environment. Abandoned oil and gas wells, not properly plugged can contaminate groundwater and consequently drinking water wells. Surface waters and soil are sometimes polluted by brine, a salty wastewater product of oil and gas well drilling, and from oil spills occurring at the drilling site or from a pipeline breach. A pipeline breach or an accidental dispersal can spoil public drinking water supplies and can be particularly detrimental to vegetation and aquatic animals, making water safety an important factor in oil and gas extraction. In some cases, associated with hydraulic fracturing (fracking), methane has been found contaminating drinking water in surrounding areas.

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

4.3.20.3 Past Occurrence

Transportation

In the past, deaths have resulted from a fuel oil truck fire. Crawford County has experienced several transportation accidents since the last HMP update. It can be speculated that with some of these transportation accidents, hazardous materials were released from the vehicles that were involved in the accidents. More recent events are recorded in the WebEOC and county reporting software and are summarized in *Table 71 – Hazardous Material Incidents*. Transportation accidents that involved hazardous materials were included in the table below.

Table 71 - Hazardous Material Incidents

Hazardous Material Incidents		
Municipality	**Date**	**Event**
Greenwood Township	01/23/2024	Chemical Spill
Meadville City	06/23/2023	HazMat Bravo
Vernon Township	05/31/2023	Fire at Facility
Saegertown Borough	05/18/2023	Chemical Reaction
East Fallowfield Township	05/10/2023	Agricultural Wastewater Spill
Townville Borough	04/06/2023	Chemical Spill
Summit Township	03/22/2023	Oil in Creek
Source: WebEOC, County Reporting System, 2024		

Hazardous materials can be transported by air, sea, and land (over the road or through pipelines). Transportation accidents along roadways is a regular occurrence and a large number of hazardous materials are transported by roadway every day.

<u>Fixed Facility</u>

There have been a number of hazardous material incidents in Crawford County in the past but few of those events have been related to fixed facilities in the county. In May of 2023 there was a fire at a fixed facility in Vernon Township. More recent events are recorded in WebEOC and county reporting software and are summarized in *Table 71 – Hazardous Material Incidents*.

The EPA tracks the management of hazardous materials in facilities that handle significant amounts of hazardous materials. The seventeen TRI facilities in Crawford County as of 2024 are summarized in *Table 72 – TRI Facilities*. Production-related waste managed is a collective term to refer to how much of a chemical is recycled, combusted for energy recovery, treated for destruction, or disposed of, or otherwise released on and off site.

Table 72 - TRI Facilities

Toxic Release Inventory Facilities				
Name	**Zip code**	**Industry Sector**	**Chemical**	**Production-related Waste Managed (lbs)**
Advanced Cast Products INC.	18771	331- Primary Metals	Copper, Lead, Nitrate compounds, Sodium nitrite	176,279
AHF Products	16354	321- Wood Products	Lead	2
Ainsworth Pet Nutrition LLC.	16335	311- Food	Zinc compounds	260
Channellock INC.	16335	332- Fabricated Metals	Nitrate compounds	2,082
Meadville Forging Co.	16403	332- Fabricated Metals	Chromium, Manganese, Nickel	0
Meadville Forging Co.	16335	332- Fabricated Metals	Chromium, Manganese, Nickel	266
Molded Fiber Glass Tray Co.	16424	326- Plastics and Rubber	Styrene	15,626
Orrville Bronze & Aluminum LLC.	16335	331- Primary Metals	Copper	19
Parker Lord Corp.	16433	325- Chemicals	Benzoyl peroxide, Bromine, Certain glycol ethers, Dichloromethane, Diisocyanates, Ethylbenzene, Lead compounds, Methanol, Methyl isobutyl ketone, Methyl methacrylate, Phenol, Phthalic anhydride, Sodium nitrite, Toluene, Trichloroethylene, Xylene, Zinc compounds.	47,279

Toxic Release Inventory Facilities				
Name	**Zip code**	**Industry Sector**	**Chemical**	**Production-related Waste Managed (lbs)**
PTR Tool and Plastics LLC.	16335	326-Plastics and Rubber	Mixture	0
Roser Technologies LLC.	16354	332-Fabricated Metals	Copper	325
Suit-Kote Meadville	16335	324-Petroleum	Benzo Perylene, Polycyclic aromatic compounds.	1
Tapco Tube Co.	16335	331-Primary Metals	Certain glycol ethers, Copper, Manganese, Nickle.	8,359
Universal Stainless & Alloy Products Inc.	16354	331-Primary Metals	Chromium, Copper, Manganese, Nickel.	154
US Bronze Foundry & Machine INC.	16335	331-Primary Metals	Copper, Lead.	334
Viking Tool & Gage.	16316	332-Fabricated Metals	Copper, Manganese.	10
Vetro Meadville Flat Glass INC.	16314	327-Nonmetallic Metals	Cobalt compounds, Selenium compounds.	32,660
Source: EPA, 2024				

Table 73 - SARA Facilities

***SARA* Facilities**	
Name	***Municipality***
Kastle Resources Ent Inc.	Beaver Township
Kastle Resources Ent Inc.	Beaver Township
Kastle Resources Ent Inc.	Beaver Township

SARA Facilities	
Name	***Municipality***
Kastle Resources Ent Inc.	Beaver Township
Kastle Resources Ent Inc.	Beaver Township
Kastle Resources Ent Inc.	Beaver Township
Ows Energy	Beaver Township
Bloomfield Twp Sewage Authority	Bloomfield Township
Verizon Pennsylvania Inc	Bloomfield Township
Cambridge Springs Boro	Cambridge Springs Borough
Centerra Coop	Cambridge Springs Borough
Doren Inc Cambridge Plant	Cambridge Springs Borough
Meadville Forging Company	Cambridge Springs Borough
Parker Hannifin Corporation	Cambridge Springs Borough
Pa Army National Guard	Cambridge Township
Southall Gas LLC	Centerville Borough
Southall Gas LLC	Centerville Borough
Windstream Communications Inc	Cochranton Borough
Municipal Authority Of Conneaut Lake Borough	Conneaut Lake Borough
Sheetz Inc	Conneaut Lake Borough
Windstream Communications Inc	Conneaut Lake Borough
Buckeye Aluminum Foundry Inc	Conneaut Township
Ows Acquistion Co LLC	Conneaut Township
Ows Energy LLC	Conneaut Township
Ows Energy LLC	Conneaut Township
Kastle Resources Ent Inc	Cussewago Township
Diversified Gas & Oil	East Fallowfield Township
Diversified Gas & Oil	East Fallowfield Township
Diversified Gas & Oil	East Fallowfield Township
Hillandale Farms - Atlantic	East Fallowfield Township
Air Products Chemicals Inc	Greenwood Township
Diversified Gas & Oil	Greenwood Township
Diversified Gas & Oil	Greenwood Township
Diversified Gas & Oil	Greenwood Township
JM Manufacturing Co Inc.	Greenwood Township
US Army Reserve 99th Div(R)	Greenwood Township
Vitro Meadville Flat Glass LLC	Greenwood Township
Diversified Gas & Oil	Hayfield Township
Diversified Gas & Oil	Hayfield Township
Diversified Gas & Oil	Hayfield Township
Diversified Gas & Oil	Hayfield Township
Diversified Gas & Oil	Hayfield Township
Diversified Gas & Oil	Hayfield Township
Diversified Gas & Oil	Hayfield Township
Greenleaf Corporation	Hayfield Township
Saegertown Borough	Hayfield Township
Suburban Propane LLC	Hayfield Township
Linesville Borough Municipal Authority	Linesville Borough

SARA Facilities	
Name	***Municipality***
Allegheny College	Meadville City
Channellock Inc	Meadville City
CJ Industries	Meadville City
Meadville Medical Center	Meadville City
Meadville Medical Center	Meadville City
Voodoo Brewing Company	Meadville City
Windstream Communications Inc	Meadville City
Baillie Lumber Co LP	Oil Creek Township
Choice wood Lumber	Oil Creek Township
Northwest Hardwoods Inc	Oil Creek Township
Oil Creek Plastics Inc	Oil Creek Township
Titusville, City Of	Oil Creek Township
Linesville Pine Joint Municipal Authority	Pine Township
Molded Fiber Glass Companies	Pine Township
Pa Fish Boat Commission	Pine Township
Cobra Resources, LLC	Randolph Township
Cobra Resources, LLC	Randolph Township
Cobra Resources, LLC	Randolph Township
Cobra Resources, LLC	Randolph Township
Pin Oak Energy Partners	Randolph Township
Conneaut Lake JT Mun Auth	Sadsbury Township
Diversified Gas & Oil	Sadsbury Township
Diversified Gas & Oil	Sadsbury Township
Diversified Gas & Oil	Sadsbury Township
Ferrellgas	Sadsbury Township
Harned Oil Inc	Sadsbury Township
Lindy Paving, Inc.	Sadsbury Township
Viking Tool & Gage, Inc.	Sadsbury Township
Federal Signal Corp	Saegertown Borough
Maclean Fogg	Saegertown Borough
Parker Hannifin Corporation	Saegertown Borough
Progress For Industry, Inc	Saegertown Borough
Saegertown Area Sewer Authority	Saegertown Borough
Saegertown Borough	Saegertown Borough
Saegertown Borough	Saegertown Borough
Saegertown Borough	Saegertown Borough
Saegertown Borough	Saegertown Borough
Saegertown Borough	Saegertown Borough
Clear Lake Lumber	Spartansburg Borough
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township

SARA Facilities	
Name	***Municipality***
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
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Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Kastle Resources Ent Inc	Spring Township
Northwest Crawford County Sewer Authority	Springboro Borough
Springboro Area Water Authority	Springboro Borough

SARA Facilities	
Name	***Municipality***
Crown Castle USA	Summerhill Township
Kastle Resources Ent Inc	Summerhill Township
Kastle Resources Ent Inc	Summerhill Township
Kastle Resources Ent Inc	Summerhill Township
Kastle Resources Ent Inc	Summerhill Township
Kastle Resources Ent Inc	Summerhill Township
Kastle Resources Ent Inc	Summerhill Township
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Kastle Resources Ent Inc	Summerhill Township
Kastle Resources Ent Inc	Summerhill Township
OWS Energy LLC	Summerhill Township
OWS Energy LLC	Summerhill Township
OWS Energy LLC	Summerhill Township
OWS Energy LLC	Summerhill Township
Anderson Coach Travel	Summit Township
Aym LLC	Titusville City
Cunova Service USA	Titusville City
Cygnus Home Service, LLC Dba Yelloh	Titusville City
Giant Eagle Inc	Titusville City
Grand Valley Mfg	Titusville City
International Waxes, Inc.	Titusville City
ITU Absorbtech, Inc.	Titusville City
Sheetz Inc	Titusville City
Titusville Area Hospital	Titusville City
Titusville Dairy Products Company	Titusville City
Titusville, City Of	Titusville City
Universal Stainless Alloy Products	Titusville City
Verizon Pennsylvania Inc	Titusville City
Wl Plastics	Titusville City
Crown Castle USA	Union Township
Crown Castle Usa	Vernon Township

SARA Facilities	
Name	***Municipality***
Diversified Gas & Oil	Vernon Township
Diversified Gas & Oil	Vernon Township
Diversified Gas & Oil	Vernon Township
Diversified Gas & Oil	Vernon Township
Diversified Gas & Oil	Vernon Township
Diversified Gas & Oil	Vernon Township
Grede-Meadville	Vernon Township
Home Depot Usa Inc	Vernon Township
Meadville Area Water Authority	Vernon Township
Penndot - Crawford County	Vernon Township
Post Consumer Brands	Vernon Township
Vantage Home Medical	Vernon Township
Vernon Township Sanitary Authority	Vernon Township
Vernon Township Sanitary Authority	Vernon Township
Klasen Mcquiston Energy Corporation	Wayne Township
Meadville Forging Company	West Mead Township
Meadville Redi-Mix Concrete, Inc.	West Mead Township
Penelec	West Mead Township
Peters Heat Treating Inc	West Mead Township
Suit-Kote Corporation	West Mead Township
Sunbelt Rentals, Inc.	West Mead Township
Tapco Tube Company	West Mead Township
Us Bronze Foundry & Machine, Inc.	Woodcock Township
Source: EPA, 2024	

As of 2024, Crawford County is home to 2,605 active natural gas wells.

4.3.20.4 Future Occurrence

Transportation

While many incidents involving hazardous material releases have occurred in Crawford County in the past, they are generally difficult to predict. The nature of traffic accidents is that there is little to no warning for their occurrence, and they can have disastrous results. An occurrence is largely dependent upon the accidental or intentional actions of a person or group.

Fixed Facility

Hazardous material release incidents are generally difficult to predict, but the presence of such dangerous materials warrants preparation for accidental or intentional release events. Emergency response agencies in Crawford County should be prepared to handle the types of hazardous materials housed and used the SARA Title III facilities, TRI facilities, and oil and gas wells that are located within the county. The Federal Superfund Amendments and Reauthorization Act

(SARA) is also known as the Emergency Planning and Community Right-to-Know Act (EPCRA), and the Local Emergency Planning Committees (LEPCs) are designed by EPCRA to ensure that state and local communities are prepared to respond to potential chemical accidents.

4.3.20.5 Vulnerability Assessment

Transportation

Quick response to transportation accidents involving hazardous materials minimizes the volume and concentration of hazardous materials that are transported and dispersed through the air, water, and soil. Every municipality within Crawford County is vulnerable to a hazardous materials incident caused along a transportation route. These incidents can occur along highways, railways, and pipelines. *Figure 49 – Environmental Hazard Transportation Vulnerability Map* identified the 2,000-foot hazard corridor for all major highways in Crawford County. *Figure 50 – Annual Truck Traffic Percentages* identifies the annual truck traffic percentages for all of the roadways in Crawford County.

Fixed Facility

Populations, critical infrastructure, and natural habitats within 1.5 miles of SARA Title III and Toxic Release Inventory sites are vulnerable to hazardous material incidents.

Private water suppliers such as domestic drinking water wells in the vicinity of oil and gas wells are at risk of contamination from brine and other pollutants, including methane, which can pose a fire and explosive hazard. Ideally, vulnerability of private drinking well owners would be established by comparing the distance of drinking water wells to known oil and gas well locations, but this extensive detailed data is not readily available. Private drinking water is largely unregulated and information on these wells is voluntarily submitted to the Pennsylvania Topographic and Geologic Survey by water well drillers, and the existing data is largely incomplete and/or not completely accurate. Spring Township contains the most oil and gas wells within the county. West Mead Township contains the most drinking water wells, meaning that Spring Township and West Mead Township are the most vulnerable to water contamination from oil and gas wells. *Table 74 – Oil and Gas Wells & Drinking Water Wells* illustrates the type of well and the local domestic drinking water wells for each municipality.

Table 74 - Oil and Gas Wells & Drinking Water Wells

Oil & Gas Wells in Crawford County (2024)					
Municipality	**Type of Well**				**Domestic Drinking Water Wells**
	Active	**Abandoned**	**Inactive**	**Proposed**	
Athens Townships	69	0	0	0	57
Beaver Township	126	0	0	0	149
Bloomfield Township	53	0	0	0	220
Blooming Valley Borough	1	0	0	0	27
Cambridge Springs Borough	1	0	0	0	100
Cambridge Township	20	0	0	0	11
Centerville Borough	2	0	0	0	7
Cochranton Borough	3	0	0	0	13
Conneaut Township	86	0	0	0	301
Conneautville Borough	1	0	0	0	7
Cussewago Township	114	0	0	0	201
East Fairfield Township	73	0	0	0	98
East Fallowfield Township	112	0	0	0	231
East Mead Township	47	0	0	0	165
Fairfield Township	142	0	0	0	180
Greenwood Township	153	0	0	0	267
Hayfield Township	72	0	0	0	498
Hydetown Borough	7	0	0	0	34
North Shenango Township	1	0	0	0	469
Oil Creek Township	104	0	0	0	192
Pine Township	1	0	0	0	104
Randolph Township	160	0	0	0	191
Richmond Township	144	0	0	0	152
Rockdale Township	78	0	0	0	70

Oil & Gas Wells in Crawford County (2024)					
Municipality	**Type of Well**				**Domestic Drinking Water Wells**
	Active	**Abandoned**	**Inactive**	**Proposed**	
Rome Township	171	0	0	0	103
Sadsbury Township	27	0	0	0	426
South Shenango Township	4	0	0	0	510
Sparta Township	52	0	0	0	87
Spring Township	195	0	0	0	313
Steuben Township	24	0	0	0	67
Summerhill Township	83	0	0	0	271
Summit Township	41	0	0	0	542
Troy Township	102	0	0	0	103
Union Township	10	0	0	0	252
Venango Township	30	0	0	0	131
Vernon Township	27	0	0	0	812
Wayne Township	175	0	0	0	183
West Fallowfield	3	0	0	0	108
West Mead Township	18	0	0	0	624
West Shenango Township	1	0	0	0	71
Woodcock Township	72	0	0	0	376
Total:	**2,605**	**0**	**0**	**0**	**8,723**
Source: PA DEP, 2024					

Figure 47 - Oil and Gas Well Locations

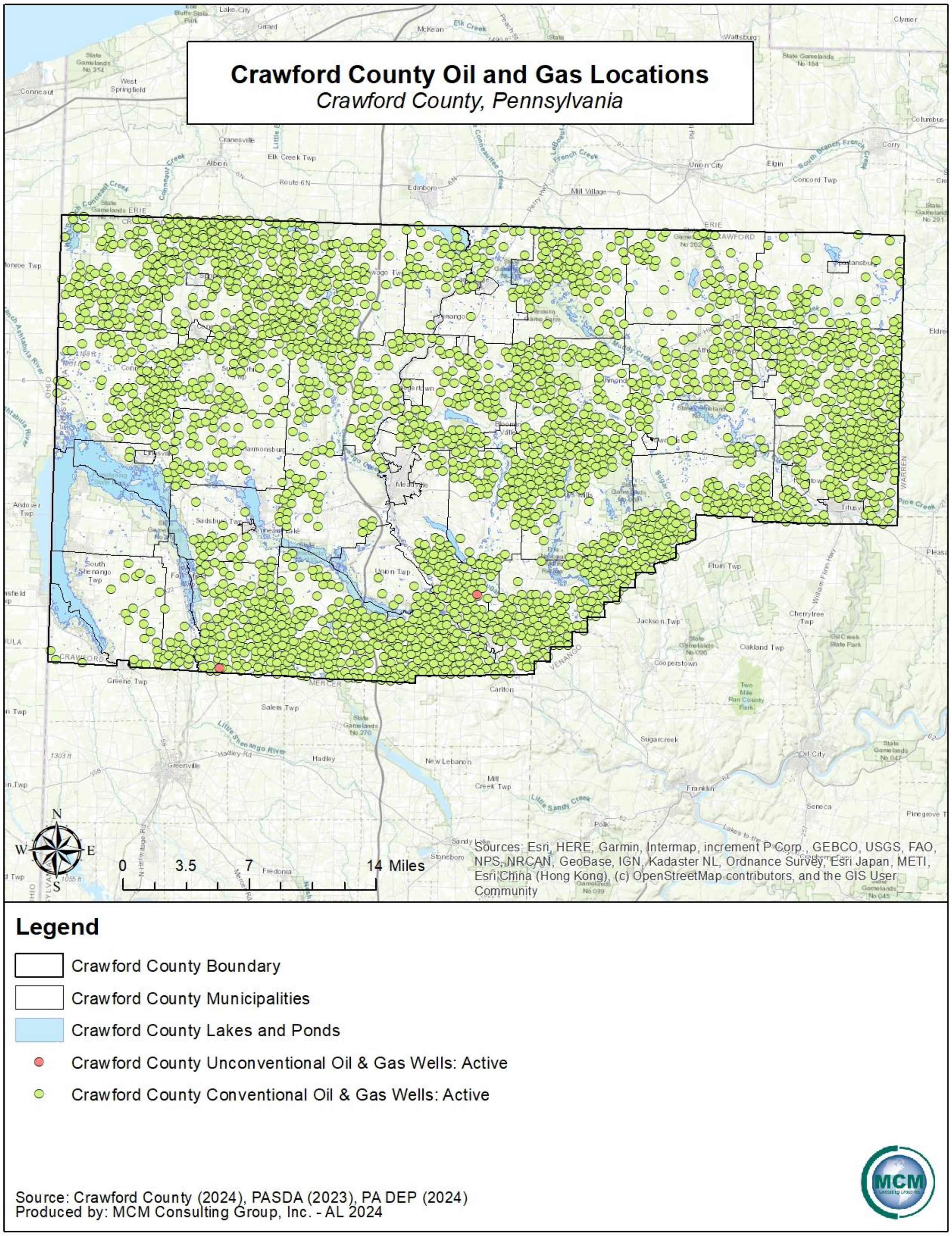


Figure 48 - Hazardous Waste Locations

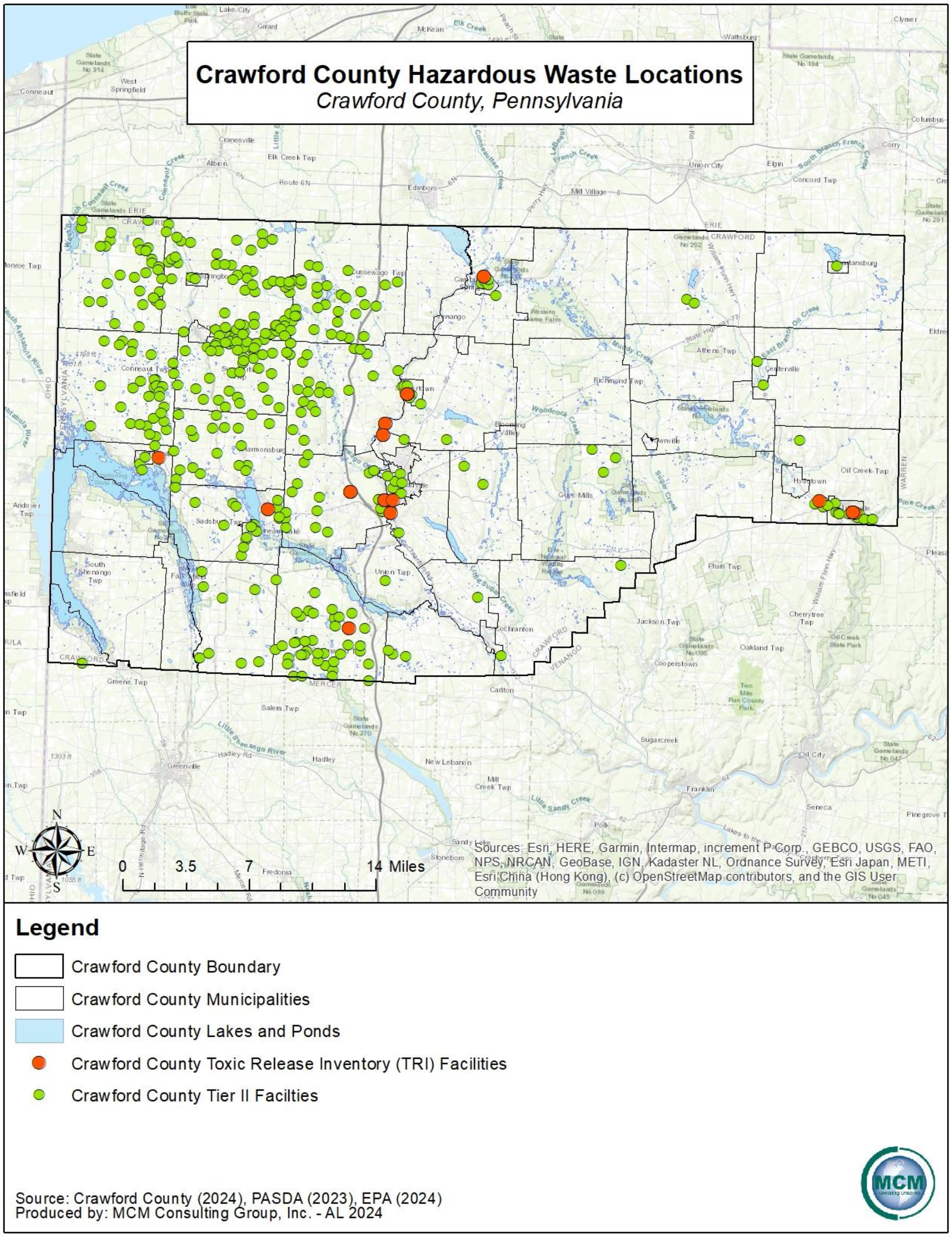


Figure 49 - Environmental Hazard Transportation Vulnerability

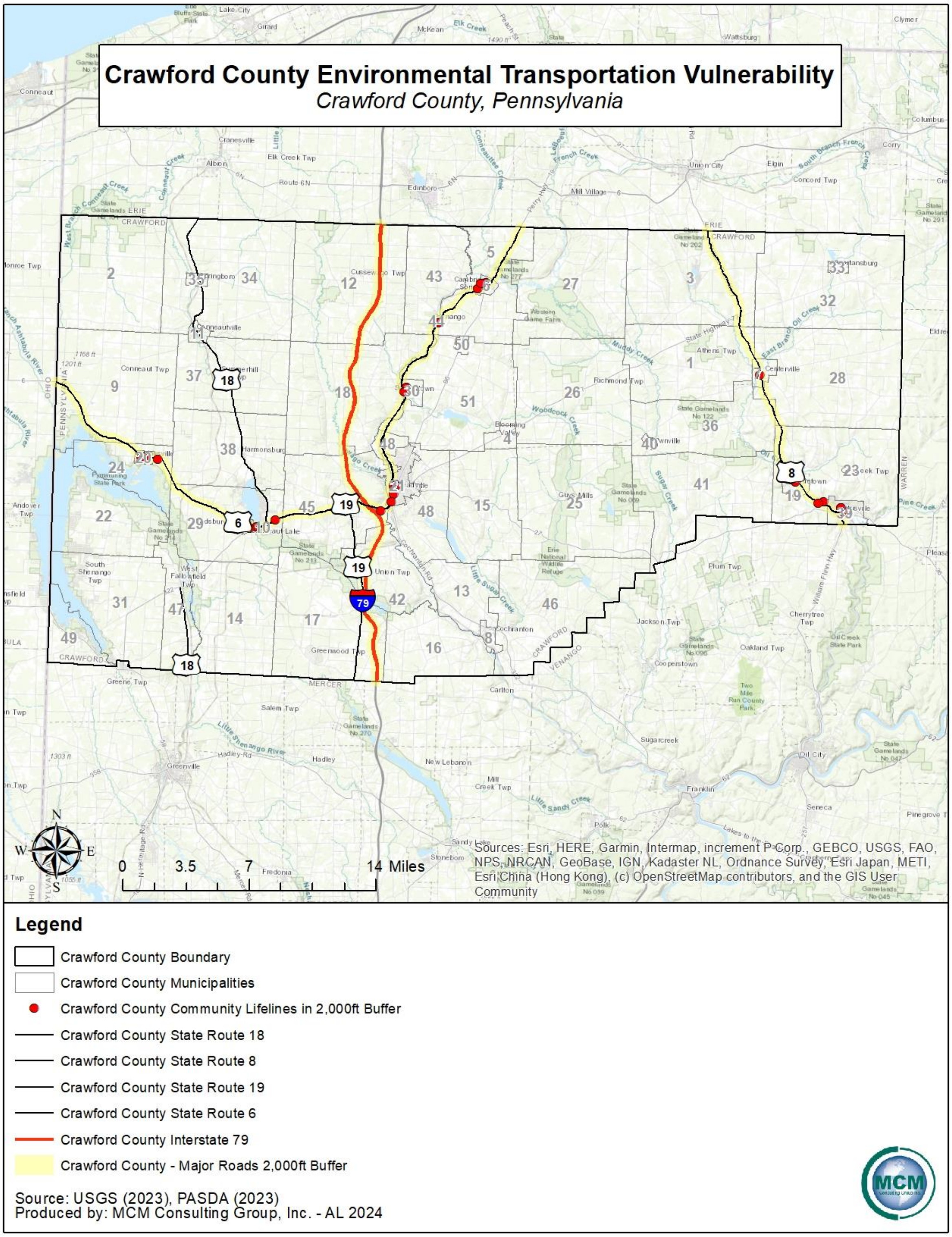
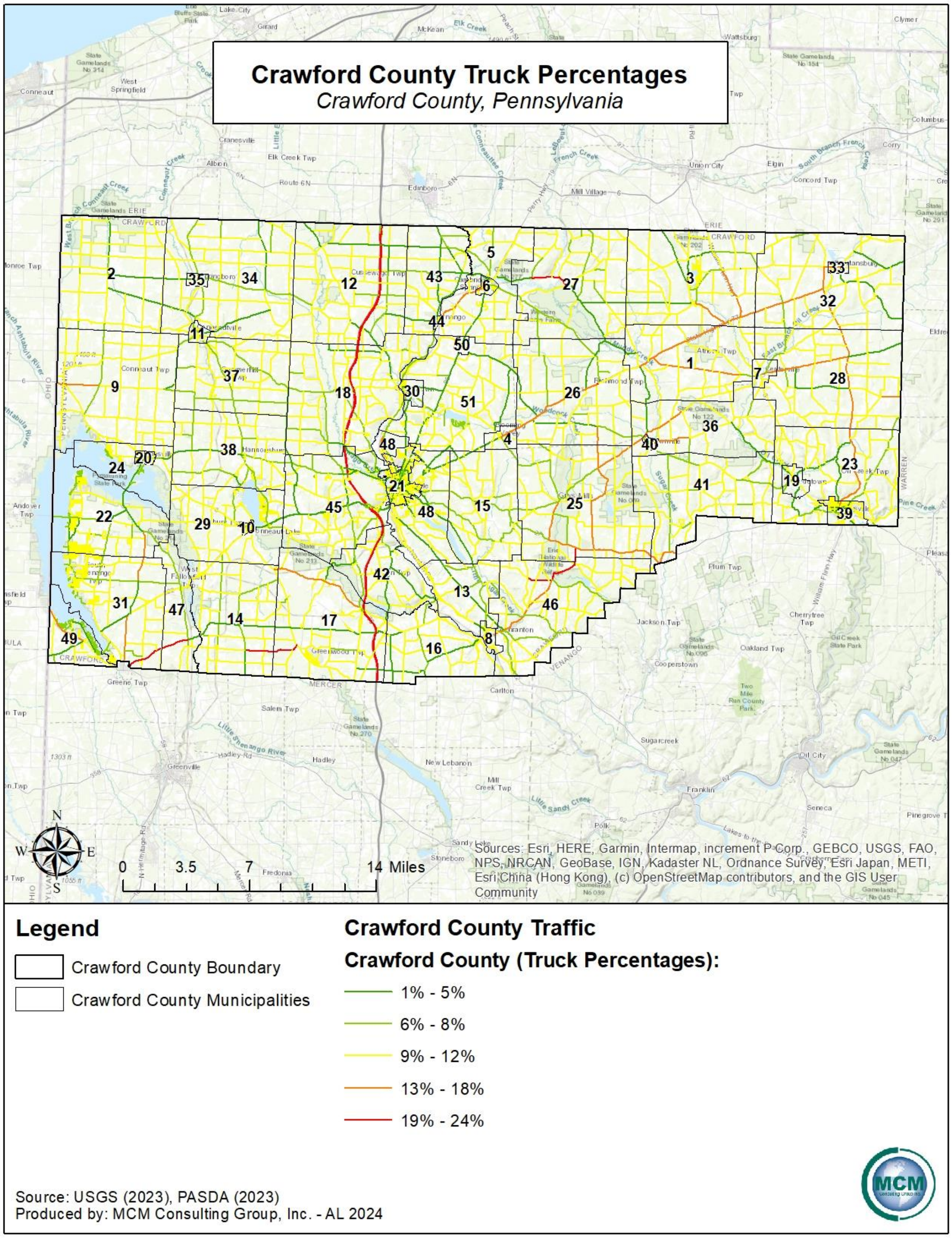


Figure 50 - Annual Truck Traffic Percentages



4.3.21. Nuclear Incidents

4.3.21.1 Location and Extent

Nuclear hazards and incidents generally refer to incidents involving (1) a release of significant levels of radioactive materials or (2) exposure of workers or the general public to radiation. Primary concerns following a nuclear incident or accident are:

- the impact on public health from direct exposure to a radioactive plume
- inhalation of radioactive materials
- ingestion of contaminated food, water, and milk
- long-term exposure to deposited radioactive materials in the environment that may lead to acute health effects (e.g., death, burns, severe impairments), chronic health effects (e.g., cancer), and psychological effects

Nuclear accidents/incidents can be placed into three categories:

1. Criticality accidents which involve loss of control of nuclear assemblies or power reactors
2. Loss-of-coolant accidents which result whenever a reactor coolant system experiences a break or opening large enough that the coolant inventory in the system cannot be maintained by the normally operating make-up system
3. Loss-of-containment accidents which involve the release of radioactivity

A nuclear power facility makes electricity by continuously splitting uranium atoms. Within the Commonwealth of Pennsylvania, there are five nuclear power stations. These are:

- Beaver Valley Power Station, Beaver County;
- Limerick Generating Station, Montgomery County;
- Peach Bottom Atomic Power Station, York County;
- Susquehanna Steam Electric Station, Luzerne County; and,
- Three Mile Island Nuclear Generating Station, Dauphin County. (This station’s license expired in 2019 and its owners have begun the decommissioning process; at the time of the writing of this plan, the station was for sale, but it must still adhere to many of the tenets of federal and state emergency response plans.)

There is one nuclear power station within fifty miles of the Crawford County border. That power station is the Perry Nuclear Power Plant in Painesville Ohio.

Half of the county is within the fifty-mile planning zone of Perry Nuclear Power Plant. The other five Commonwealth nuclear facilities are more than fifty miles away from Crawford County and considered minimal threats. In the event of an emergency, evacuees from distant EPZs may seek shelter in Crawford County or pass through the county and use local services.

4.3.21.2 Range of Magnitude

The Nuclear Regulatory Commission encourages the use of Probabilistic Risk Assessments (PRAs) to estimate quantitatively the potential risk to public health and safety considering the design, operations, and maintenance practices at nuclear power plants. PRAs typically focus on accidents that can severely damage the core and that may challenge containment. The Federal Emergency Management Agency (FEMA), the Pennsylvania Emergency Management Agency (PEMA), and county governments have formulated Radiological Emergency Response Plans that include a Plume Exposure Pathway Emergency Planning Zone (EPZ) with a radius of about ten miles from each nuclear power facility and an Ingestion Exposure Pathway EPZ with a radius of about fifty miles from each facility. See *Table 75 - Emergency Planning Zones*. The exact size and configuration of the EPZ may vary in relation to local emergency response capabilities, topography, road networks, and political boundaries.

Table 75 - Emergency Planning Zones

Emergency Planning Zones	
EPZ	**Description**
Plume Exposure Pathway (PEP)	Has a radius of about 10 miles from each reactor site. Predetermined protective action plans are in place and include sheltering, evacuation, and the use of potassium iodide where appropriate.
Ingestion Exposure Pathway (IEP)	Has a radius of about 50 miles from each reactor site. Predetermined protective action plans are in place and are designed to avoid or reduce dose from potential ingestion of radioactive materials. These actions include a ban of contaminated food and water.
Source: U.S. Nuclear Regulatory Commission http://www.nrc.gov/about-nrc/emerg-preparedness/about-emerg-preparedness/planning-zones.html	

The magnitude of a nuclear incident differs for those within the Plume Exposure Pathway EPZ and those within the Ingestion Exposure Pathway EPZ. The Plume Exposure Pathway refers to whole-body external exposure to gamma radiation from a radioactive plume and from deposited materials and inhalation exposure from the passing radioactive plume. The duration of primary exposures could range in length from hours to days. The Ingestion Exposure Pathway refers to exposure primarily from ingestion of water or foods such as milk and fresh vegetables that have been contaminated with radiation.

Fixed facility incidents are not the only types of incidents that could affect Crawford County. Other types of incidents such as transportation or terrorism could also pose a hazard.

In the event of a nuclear disaster, radioactive fallout would be the main danger of an incident within a fifty-mile radius. Invisible gamma rays from this fallout can cause radiation sickness due to physical and chemical changes in the cells of the body. If a person would receive a large dose of radiation, that person would die in a very short time. Non-lethal doses in varying degrees would cause radiation sickness among the survivors. Depending on the location of the event all of Crawford County could be in the Ingestion Exposure Pathway.

The Nuclear Regulatory Commission uses four classification levels for nuclear incidents:

1. Unusual Event: Events are in process or have occurred which indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring offsite response or monitoring is expected unless further degradation occurs.
2. Alert: Events are in process or have occurred which involve an actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the EPA Protective Action Guides (PAGs).
3. Site Area Emergency: Involves events in process or which have occurred that result in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material are not expected to exceed the EPA PAGs except near the site boundary.
4. General Emergency: Involves actual or imminent substantial core damage or melting of reactor fuel with the potential for loss of containment integrity. Radioactive releases during a general emergency can reasonably be expected to exceed the EPA PAGs for more than the immediate site area.

The nuclear industry has adopted predetermined, site-specific Emergency Action Levels (EALs). The EALs provide the framework and guidance to observe, address, and classify the severity of site-specific incidents and conditions that are communicated to off-site emergency response organizations (Nuclear Regulatory Commission, 2008). There are additional EALs that specifically deal with issues of security, such as threats of airborne attack, hostile action within the facility, or facility attack. These EALs ensure that appropriate notifications for the security threat are made in a timely manner. Each facility is also equipped with a public alerting system, which includes several sirens to alert the public located in the Plume Exposure Pathway EPZ. This alerting system is activated by the counties of each specific EPZ. Emergency notifications and instructions are communicated to the public via the Emergency Alert System as activated by the Commonwealth Resource Coordination Center (formerly Pennsylvania State Emergency

Operations Center). State officials also have the capability to send emergency messages as text messages to mobile devices.

During and after a nuclear incident, the primary concern is the effect on the health of the population near the incident. The duration of primary exposure could range in length from hours to months depending on the proximity to the point of radioactive release. External radiation and inhalation and ingestion of radioactive isotopes can cause acute health effects (e.g., death, severe health impairment), chronic health effects (e.g., cancers) and psychological effects.

Potential environmental impacts specific to the fifty-mile Ingestion Exposure Pathway EPZ, and therefore of most concern to Crawford County, include the long-term effects of radioactive contamination in the environment and in agricultural products. Crawford County can expect some radioactive contamination in very small amounts in the case of a nuclear incident at either of the two stations nearest it. This is not a significant concern in terms of external exposure and immediate health risks, but even a small amount of radiation will require the protection of the food chain, particularly milk supplies. Small amounts of radiation ingested over time could lead to future health issues. As a result, in the case of a nuclear incident, foodstuffs, crops, milk, livestock feed and forage, and farm water supplies will need to be protected from and tested for contamination. Additionally, spills and releases of radiologically active materials from accidents can result in the contamination of soil and public water supplies. Areas underlain by limestone and some types of glacial sediments are particularly susceptible to contamination.

The worst-case scenario for Crawford County would be a General Emergency at Perry Nuclear Power Plant that leaked sufficient radiation to create longer-term damage in the form of contaminated water, soil, and food supplies.

4.3.21.3 Past Occurrence

Nuclear incidents rarely occur, but the incident at Three Mile Island in Dauphin County is the worst fixed nuclear facility accident in U.S. history. The resulting contamination and state of the reactor core led to the development of a 14-year cleanup and scientific effort. Additionally, the *President's Commission on the Accident at Three Mile Island* examined the costs of the accident, concluding that "the accident at Three Mile Island on March 28, 1979, generated considerable economic disturbance. Some of the impacts were short term, occurring during the first days of the accident. Many of the impacts were experienced by the local community; others will be felt at the regional and national levels." The report concluded: "It appears clear that the major costs of the TMI Unit 2 accident are associated with the emergency management replacement power and the plant refurbishment or replacement. The minimum cost estimate of nearly one billion dollars supports the argument that considerable additional resources can be cost effective if spent to guard against future accidents."

Despite the severity of the damage, no injuries due to radiation exposure occurred. However, numerous studies were conducted to determine the measurable health effects related to radiation and/or stress. More than a dozen epidemiological and stress-related studies conducted to date have found no discernible direct health effects on the population in the vicinity of the plant. However, one study conducted by the Pennsylvania Department of Health's *Three Mile Island Health Research Program* did find evidence of psychological stress, "lasting in some cases for five to six years." According to the program chief, "the people suffering from stress perceived their health as being poorer than it actually was when the health department checked the medical records."

The accident at Three Mile Island had a profound effect on residents, the emergency management community, government officials, and nuclear industry, not only in Pennsylvania, but nationwide. There were minimal requirements for off-site emergency planning for nuclear power stations prior to the accident. Afterward, comprehensive, coordinated, and exercised plans were developed for the state, counties, school districts, special facilities (hospitals, nursing homes, day care centers, and detention facilities) and municipalities to ensure the safety of the populations. Costs associated with an incident at one of the Commonwealth's nuclear facilities, be it real or perceived, are significant. The mitigation efforts put in place immediately following the 1979 accident continue until today. The Commonwealth's nuclear/radiological plan, which is a successor of the original "Annex E," is a result of the Commonwealth's efforts to address the many components of mitigation planning. The comprehensive planning involving its five nuclear facilities is an ongoing effort. Plans are reviewed and amended on an annual basis.

Another incident occurred at Three Mile Island on February 7, 1993, when an individual drove his car through a chain-link fence and then slammed into a roll-up garage door leading into the facility's turbine building. Plant officials, fearing the worst, immediately declared a Site Area Emergency. Fortunately, the person who crashed the gate was found and apprehended. Other than property damage caused by the forcible entry through physical structures, there was no lasting damage to the facility.

Crawford County has not been affected by a fixed nuclear facility incident from any of the two local or other state facilities. The county has not been affected by any type of nuclear incident.

4.3.21.4 Future Occurrence

Pennsylvania is the site of the only nuclear power plant in the country with an incident rated as a General Emergency. Since the Three Mile Island incident, nuclear power has become significantly safer and is one of the most heavily regulated industries in the nation. Despite the knowledge gained since then, there is still the potential for a similar accident to occur again at any of the nuclear generating facilities nearest the county. The Nuclear Energy Agency of the

Organization for Economic Co-Operation and Development notes that studies estimate the chance of a breach of protective barriers in a modern nuclear facility at less than one in 100,000 per year (Nuclear Energy Agency, 2005). Nuclear incident occurrences may also happen because of intentional actions, but these terrorist acts are rare. Nuclear incidents in or near Crawford County should be considered unlikely.

4.3.21.5 Vulnerability Assessment

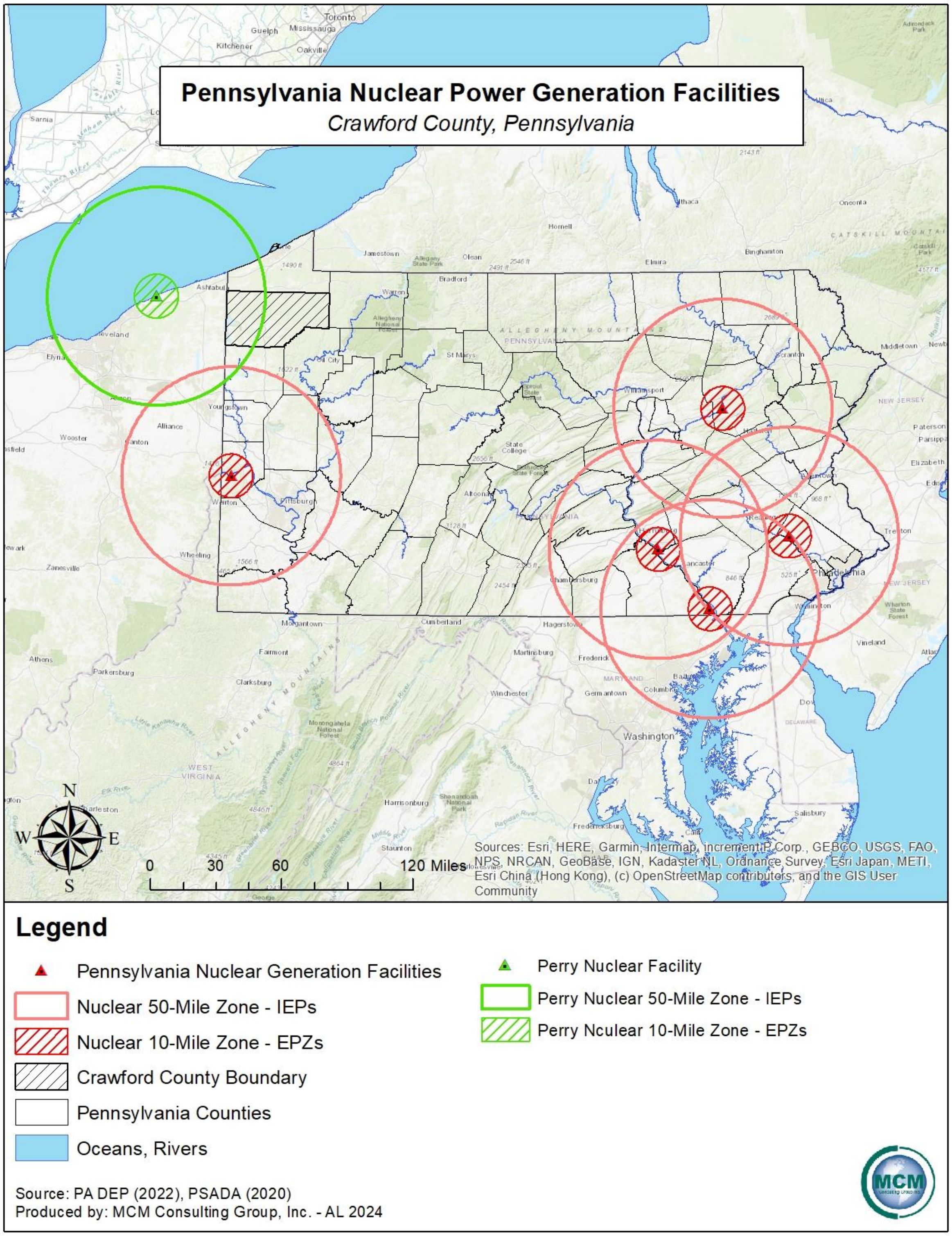
The county would unlikely be directly affected by incidents from any of the other nearby nuclear facilities, including the Beaver Valley Power Station. However, evacuation of residents from these areas could lead to increased population or through-traffic in the county. County residents could be negatively impacted through the psychological effects of a nuclear incident as the effects and likelihood of radiation contamination are not always well understood by the public.

The county's primary vulnerability to nuclear incidents comes in the form of food, soil, and water contamination. In terms of vulnerable land, the majority of the 194,447 acres of farmland held in Crawford County's 1,091 farms are vulnerable to radiological contamination in a nuclear incident. In 2022, the market value of all agricultural products of these farms was nearly $130.8 million.

Water contamination is also a concern in nuclear incidents. There are several public water suppliers that operate in or provide water to the county; the largest of them are the Meadville Area Water Authority and the Vernon Township Water Authority. These water supplies, coupled with the county's domestic drinking water wells, are all vulnerable to the effects of a nuclear incident.

While unlikely that all agricultural products would be lost in the event of a nuclear incident, the county could expect some portion of that $130.8 million to be lost. Time of year also impacts the vulnerability and losses estimated for a nuclear incident. An incident that occurs during the prime growing and harvesting season will have a larger impact on the county. For example, the incident at Three Mile Island occurred in the off-season; as a result, the Pennsylvania Department of Agriculture estimated that agricultural losses for the entire Commonwealth were not more than $1 million.

Figure 51 - Pennsylvania Nuclear Power Stations



4.3.22. Substance Use Disorder

4.3.22.1 Location and Extent

Substance Use Disorder (SUD) is a chronic condition characterized by compulsive drug or alcohol use despite the harmful consequences. According to the American Addiction Centers substance use disorder affects brain function and behavior, leading to an inability to control substance intake.(Fuller 2023). Symptoms include intense cravings, tolerance, withdrawal symptoms, and continued use despite negative effects on health, relationships, and responsibilities. Substance use disorder can impact anyone regardless of age, gender, or background, and often requires comprehensive treatment involving therapy, medication, and support to achieve recovery.

Substance use disorder escalates into opioid addiction through a progression that often starts with the legitimate medical use of prescription opioids for pain relief. Over time, individuals may develop a tolerance, requiring larger doses for the same effect. This can evolve into physical dependence, where the body experiences withdrawal symptoms without the drug. Psychological factors, such as seeking relief from stress, trauma, or co-occurring mental health disorders, may compel individuals to continue using opioids despite negative consequences. Eventually, the compulsive need to use opioids takes over, characterized by addiction, where obtaining and using the drug becomes a central focus of life.

According to the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) ten classes of substance use disorder exist. These substances use related mental illnesses are alcohol use disorder, cannabis use disorder, phencyclidine use disorder, other hallucinogen use disorder that differ from phencyclidine, inhalant use disorder, opioid use disorder, sedative, hypnotic or anxiolytic use disorder and lastly stimulant use disorder which accompanies cocaine or methamphetamine.

Pennsylvania and the United States at large have been experiencing a substance use disorder epidemic which can lead to opioid drug abuse. According to the Pennsylvania Department of Health, the opioid overdose epidemic is the worst public health crisis in Pennsylvania. It affects Pennsylvanians across the state, from big cities to rural communities. Substance use disorder and opioid addiction has increased drastically over the last year due to the hardships faced from the COVID-19 pandemic. Opioid use has increased since the beginning of the COVID-19 pandemic which is being attributed to the uncertainty people are feeling due to the pandemic.

Opioids, mainly synthetic opioids (other than methadone), are currently the main driver of drug overdose deaths. According to the Center for Disease Control and Prevention (CDC), 72.9% of opioid-involved overdose deaths involved synthetic opioids. Opioid addiction occurs when an individual becomes physically dependent on opioids. Opioids are a class of drug that reduces pain by interacting with receptors on nerve cells in the body and brain. The use of opioids is a broad term and includes opiates, which are drugs naturally extracted from certain types of poppy plants, and narcotics. Opioids can also be synthetically made to emulate opium. Opioid drugs are highly addictive and typically result in increasing numbers of overdose deaths both prescribed (e.g. fentanyl) and illicit (e.g. heroin) opioids. Overdose deaths from opioids occur when a large dose slows breathing, which can occur when opioids are combined with alcohol or antianxiety drugs. While generally prescribed with good intentions, opioids can be over-prescribed, resulting in addiction.

According to the Drug Enforcement Administration (DEA), opioids come in various forms such as tablets, capsules, skin patches, powder, chunks in various colors from white to brown/black, liquid form for oral or injection use, syrups, suppositories, and lollipops. The Centers for Disease Control and Prevention (CDC) defines the following as the three most common types of opioids:

- **Prescription Opioids**: Opioid medication prescribed by doctors for pain treatment. These can be synthetic oxycodone (OxyContin), hydrocodone (Vicodin), or natural (morphine).
- **Fentanyl**: A powerful synthetic opioid that is 50 to 100 times more powerful than morphine and used for treating severe pain; illegally made and distributed fentanyl is becoming more prevalent.
- **Heroin**: An illegal natural opioid processed from morphine which is becoming more commonly used in the United States.

Opioids are highly addictive. They block the body’s ability to feel pain and can create a sense of euphoria. Additionally, individuals often build a tolerance to opioids, which can lead to misuse and overdose.

While other addictive substances such as methamphetamines and alcohol can be problematic for the health of individuals in Crawford County, this profile focuses on opioid drugs and the substance use disorder epidemic. The opioid crisis along with substance use disorder was declared to be a public health emergency on October 26, 2017. While the declaration provides validation for the scope and severity of the problem, it was not accompanied by any release of funding for mitigating actions. On January 10, 2018, Governor Tom Wolf declared the opioid epidemic to be a statewide public health disaster emergency for Pennsylvania. The declaration is intended to enhance response and increase access to treatment.

4.3.22.2 Range of Magnitude

Substance use disorder may lead to a narcotic addiction which could lead to an overdose and can sometimes be fatal. The most dangerous side effect of an overdose can include depressed breathing. Lack of oxygen to the brain causes permanent brain damage, leading to organ failure, and eventually death. Signs and symptoms include respiratory depression, drowsiness, disorientation, pinpoint pupils, and clammy skin. Substance use dependency can also be passed from mother to child in the womb. This condition, known as neonatal abstinence syndrome, has increased five-fold, according to the National Institute on Drug Abuse (NIDA). This results in an annual estimate of 20,000 babies born in the United States with this condition.

4.3.22.3 Past Occurrence

In 2023, there was an estimated total of 105,384 drug-related overdose deaths in the United States. This is the highest number of overdose deaths ever recorded in a 12-month period, according to the recent provisional date from the CDC. *Table 76 – Drug Overdose Mortality In Crawford County* shows death rates and deaths per month in Crawford County from 2020 to 2023. Crawford County has experienced an increase in death rates from drug overdose. The most common age group for opioid abuse in Crawford County is the 25-34 years of age demographic. In Crawford County the overdose rate of males is greater than the overdose rate of females. Whites have the highest total rate of overdose deaths in Crawford County, while Blacks have the highest per capita rate of overdose deaths when adjusted for population size. The most used opioid in Crawford County are fentanyl, heroin, cocaine, benzodiazepines, and Rx opioids. Data sets for 2024 were not available at the time of writing this plan.

Table 76 - Drug Overdose Mortality in Crawford County

Drug Overdose Mortality in Crawford County	
Year	**Deaths Per Year**
2020	21
2021	36
2022	12
2023	20

Table 77 - Drugs Present in 2020 Pennsylvania Overdose Deaths

Drugs Present in 2020 PA Overdose Deaths	
Drug Category	**Percent Reported Among 2020 Decedents**
Cannabis	25%

Drugs Present in 2020 PA Overdose Deaths	
Drug Category	**Percent Reported Among 2020 Decedents**
Cocaine	20%
Heroin	15%
Fentanyl	14%
Methamphetamine	10%
Prescription Opioids	5.5%
Cathinones	5.5%
Benzodiazepines	5%
Source: DEA, 2020	

4.3.22.4 Future Occurrence

Both Crawford County, and Pennsylvania as a whole, have seen a steady rise in substance use disorder and the use of opioids over the last several years, with drug-related death rates increasing at a high percentage. Substance use disorder is a pressing issue in Pennsylvania, with far-reaching implications for public health, safety, and the well-being of individuals. Future occurrences of substance use, and opioid addiction are unclear as the state moves forward with overdose prevention initiatives through the use of Naloxone, alternative pain treatments, improvement of tools for families and first responders, and expansion of treatment access. The Pennsylvania government has taken various approaches to help with the prevention of mass future occurrences across the Commonwealth. To help prevent future drug abuse and protect individual health among communities in Pennsylvania, the Pennsylvania's Prescription Drug Monitoring Program (PA DMP) collects information on all filled prescriptions for controlled substances. This information helps health care providers safely prescribe controlled substances and helps patients get correct treatment. The PA DMP also has drug take-back boxes located in the counties for an easy, convenient location where anyone can dispose of their unused, expired, or unwanted prescriptions to help lower potential drug overuse. In Crawford County, there are sixteen drug take-back boxes located throughout the county. The drug take-back box locations include Crawford County Sheriff's Department, Meadville Medical Center, West Mead Township Police Department, PA State Police (Meadville Station), Conneaut Lake Regional Police Department, Cambridge Springs Police Department, Linesville Borough Police Department, Titusville Police Department.

In the event of an opioid overdose, death can sometimes be prevented with the use of the drug naloxone. The former Pennsylvania Secretary of Health, Dr. Rachel Levine, in 2020, signed updated standing order prescriptions of naloxone. Naloxone is a medication that can reverse an overdose that is caused by an opioid drug (i.e., prescription pain medication or heroin). Naloxone is used to block the effects of opioids and is sold under the brand name of Narcan. When administered during an overdose, naloxone blocks the effects of opioids on the brain and restores breathing within two to eight minutes. Naloxone has been used safely by medical professionals for more than forty years and its only function is to reverse the effects of opioids on the brain and respiratory system in order to prevent death. Also, with the January 10, 2018 disaster declaration, emergency medical technicians (EMTs) are now allowed to leave naloxone behind at a scene of a recent overdose further increasing the distribution and accessibility of the lifesaving medication. According to a study published in September 2018, drug users reported that users often have multiple overdoses in the course of their drug use, and availability of naloxone has saved many lives. While the introduction of naloxone has been a significant benefit to the fight against opioid abuse, efforts to prevent future overdoses are still underway. Naloxone is another way to reduce future occurrences of the opioid epidemic from occurring in Crawford County. According to the National Library of Medicines, supervised injection sites can provide disordered substance users with a secure location to reduce the risk of overdose, while also weaning them off of addictive substances.

Opioid drugs have been a problematic and addictive method for patients to deal with pain. Employing alternative approaches to pain management could prevent patients from ever being introduced to addictive opioids, especially considering the most common overdose drugs in Crawford County have been prescription opioids. A possible alternative pain treatment comes from hemp extracted cannabidiol, or CBD. Unlike THC (the psychoactive constituent of cannabis), CBD is non-psychoactive and does not have the same intoxicating effect as THC; however, CBD can provide relief from pain, inflammation, anxiety, and even psychosis. CBD is legal without a prescription throughout the United States of America.

4.3.22.5 Vulnerability Assessment

Opioid overdoses have resulted in many tragic deaths in Pennsylvania and many people have been affected by the epidemic through the loss of either a family member, a close friend, or member of their community. Substance use disorder is a direct detriment to the personal wellbeing of addicts, a burden to their families and communities, and a strain to the emergency response system that cares for overdose victims. In general, jurisdictions that are more densely populated are more vulnerable to opioid addiction threats as access to the drugs increases. However, rural communities in general experience larger per-capita opioid-related deaths. Jurisdictional losses in the opioid addiction crisis stem from lost wages, productivity, and resources rather than losses to buildings or land. Many counties across the Commonwealth, including Crawford County, have seen an increase of time and resources devoted to the opioid epidemic as overdose and response increase.

While Substance use disorder and opioid addiction is often viewed as a criminal problem, it can also be viewed as a chronic disease. This paradigm shift moves away from faulting the abuser and incentivizing quick cures, to viewing the abuser as a patient and working towards long-term management of the disease. In general, it is important to consider alternative approaches to pain treatment.

According to the National Institute of Mental Health, substance use disorder often stems from underlying mental health issues such as depression, anxiety, trauma, or unresolved psychological struggles. Individuals may turn to substances as a coping mechanism to alleviate emotional pain or distress. However, prolonged substance abuse can exacerbate mental health symptoms and lead to a vicious cycle of dependency. Additionally, genetic predispositions and environmental factors can also contribute to the development of both substances use disorders and mental health disorders (National Institute of Mental Health, 2023).

The vulnerability in the county depends on the number of additional risk factors on the vulnerable population such as genetic, psychological, and environmental factors that play a role in addiction. The known risk factors of opioid misuse and addiction include poverty, unemployment, family and/or personal history of substance abuse, history of criminal activity, history of severe depression or anxiety, and prior drug/alcohol rehabilitation. In addition, women have a unique set of risk factors for opioid addiction. Women are more likely than men to have diagnosed chronic pain. Compared with men, women are also more likely to be prescribed opioid medications, to be given higher doses, and to use opioids for longer periods of time. Women may also have biological tendencies to become dependent on prescription pain relievers more quickly than men. Therefore, if the county were to have a population with a great amount of these risk factors, the county would be very vulnerable to the opioid epidemic.

The COVID-19 pandemic and its periods of quarantine caused vulnerability in opioid users throughout Crawford County. It is likely that the emergence of COVID-19 and subsequent disruptions in health care and social safety nets combined with social and economic stressors has fueled the opioid epidemic. The COVID-19 pandemic challenged vulnerable populations, including those with opioid use disorders. The opioid epidemic and COVID-19 pandemic intersected and presented unprecedented challenges for families and communities. Opioid use affects respiratory and pulmonary health which may make those with opioid use disorders more susceptible to COVID-19. In addition, chronic respiratory disease is already known to increase overdose mortality risk among people taking opioids, and decreased lung capacity from COVID-

19 could lead to similar health effects. Secondary impacts from the COVID-19 pandemic included disruption of treatment and recovery services, limited access to mental health services and peer support, disrupted routines, loss of work, and increased stress which led to increased opioid use and risk of relapse for those in recovery. Additionally, the pandemic took away the attention from the media, from legislators, and from public health agencies that was being focused on the opioid crisis. The opioid epidemic in Pennsylvania increased 63% since the end of the pandemic.

Risk factors may arise from indirect factors including housing instability and incarceration. Those with substance use disorder and opioid use disorders are potentially at a higher risk for housing insecurity, homelessness, and incarceration. Congregate living facilities such as homeless shelters, jails, and prisons are high-risk environments for virus transmission, and there are challenges in implementing recommendations from the CDC such as social distancing and quarantine.

Additionally, first responders and medical personnel are also a vulnerable population when dealing with the substance use disorder and opioid epidemic. First responders face exposure risk due to an increase in emergency calls due to an increase in the crisis, particularly to synthetic fentanyl. Fentanyl and related substances are hazardous materials, which cause the environment and the people around the substance to be vulnerable. Unintentional fentanyl contact can impact first responders and others that are in close proximity to the opioid user. Depending on the potency of the drug, it can take as little as a few milligrams of fentanyl to cause fatal health complications, the equivalent of a few grains of sand. There have been several reports nationally of first responders accidentally overdosing on fentanyl through brief skin contact or the drug becoming airborne. It is best for first responders to remain wary to avoid any potential exposure. The American College of Medical Toxicology (ACMT) and the American Academy of Clinical Toxicology (AACT) suggest that nitrile gloves provide sufficient protection for handling fentanyl, and for "exceptional circumstances where the drug particles or droplets suspended in the air, an N95 respirator provides sufficient protection". Other environmental structures such as streams, rivers, and lakes have been known to contain traces of opioids and other drugs within them. These traces come from excreted human urine and feces, or improper disposal of medications. The Environmental Protection Agency (EPA) suggests that while the risks of pharmaceuticals found in wastewater, ambient water, and drinking water are low, further research is needed. A worst-case scenario with substance use in Crawford County would be a high number of overdoses among residents and insufficient first responder personnel and material resources.

Figure 52 – Opioid Overdose Deaths in Pennsylvania 2021 and *Figure 53 – Opioid Overdose Deaths in Pennsylvania 2022* illustrate the number of deaths per county in the Commonwealth of Pennsylvania.

Figure 52 - Opioid Overdose Deaths in Pennsylvania 2021

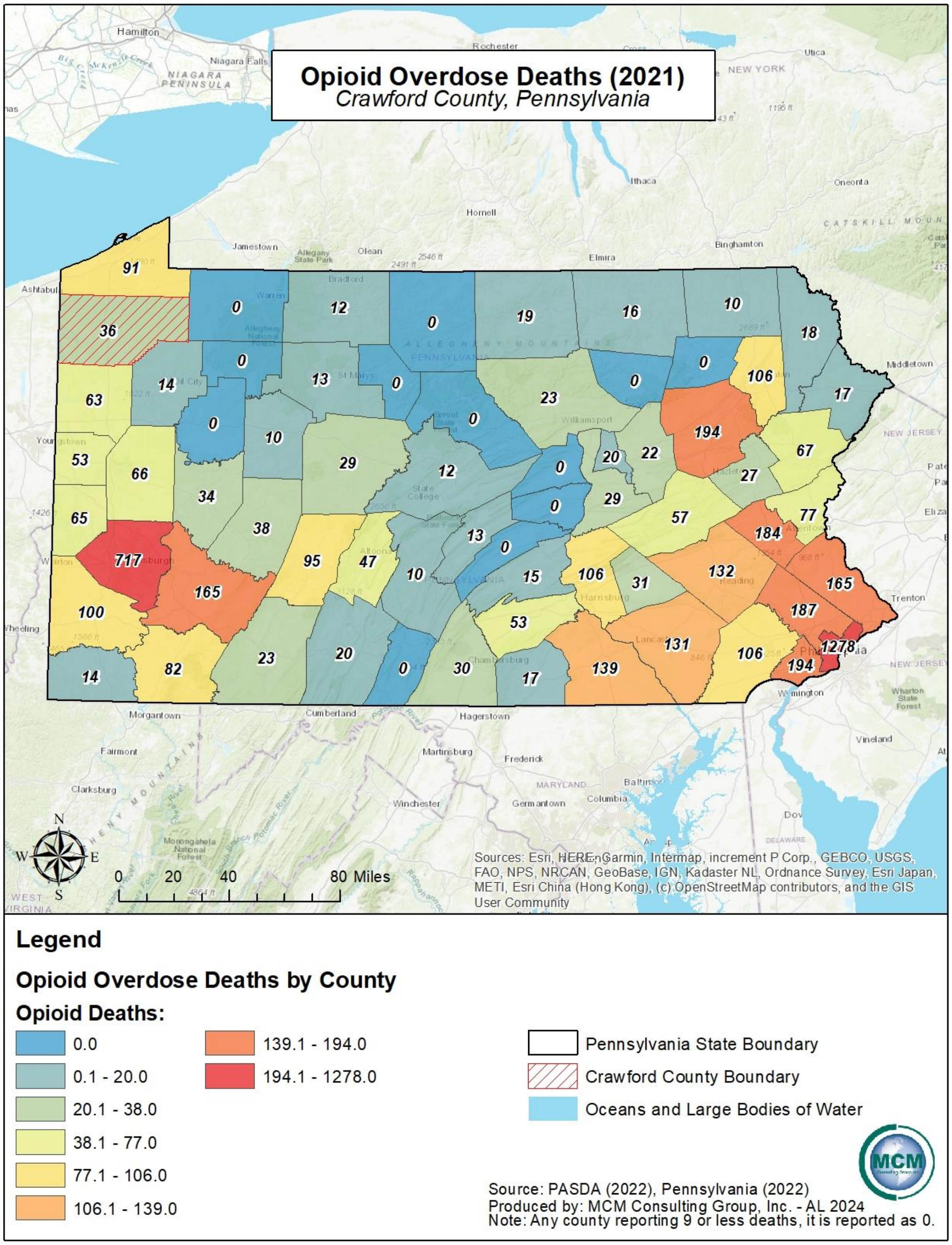
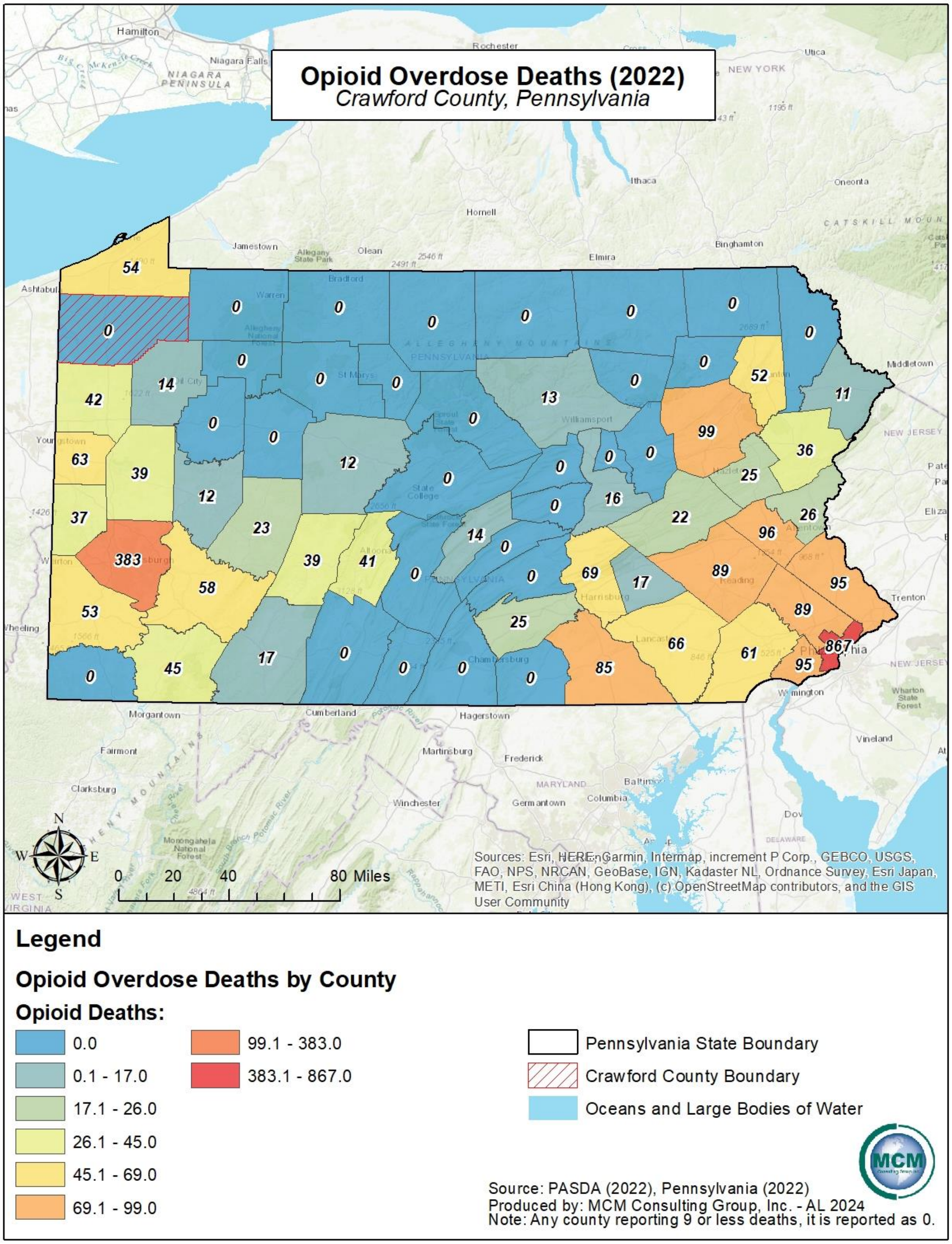


Figure 53 - Opioid Overdose Deaths in Pennsylvania 2022



4.3.22. Terrorism

4.3.22.1 Location and Extent

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

Cyber-terrorism is the unlawful use of force and violence over technological methods to cause harm to financial security, identity information, personal information, and attacking personal computers, mobile phones, gaming systems, and other Bluetooth or wirelessly connected devices. Cyber-terrorism can be just as damaging to infrastructure as conventional terrorism, due to the large amount of business that is carried out over the internet, through wirelessly connected devices, or from employees of companies working remotely.

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

Community lifeline facilities are either in the public or private sector that provide essential products and/or services to the general public. Community lifeline facilities are often necessary to preserve the welfare and quality of life in the county, or fulfill important public safety, emergency response, and/or disaster recovery functions. Community lifeline facilities identified in the county are hospitals and health care facilities, schools, childcare centers, fire stations, police departments, municipal buildings, and hazardous waste facilities. In addition to critical facilities, the county contains at risk populations that should be factored into a vulnerability assessment. These populations include not only the residents and workforce in the county, but also the tourists that visit the area on a daily basis, those that are traveling through the county on any major highway and marginalized groups such as LGBTQ persons and racial, religious, or other minorities.

Potential targets include:

- Commercial facilities
- Family planning clinics/organizations associated with controversial issues
- Education facilities
- Events attracting large amounts of people
- Places of worship
- Industrial facilities, especially those utilizing large quantities of hazardous materials
- Transportation infrastructure
- Historical sites
- Cultural sites
- Government facilities

4.3.22.2 Range of Magnitude

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

Terrorist methods can take many forms including:

- Active assailant
- Agri-terrorism
- Arson/incendiary attack
- Armed attack
- Assassination
- Biological agent
- Chemical agent
- Cyber-terrorism
- Conventional bomb or bomb threat
- Hijackings
- Release of hazardous materials
- Kidnapping
- Nuclear bomb

- Radiological agent

Active assailant incidents and threats can disrupt the learning atmosphere in schools, interfere with worship services, cause traffic to be re-routed, and use taxpayer assets by deploying police, EMS and/or fire units. Crawford County has five districts (public schools K through 12th grade) that include twenty-four primary, secondary, and high schools. Crawford County is home to five universities and post-secondary education centers, including Allegheny College, University of Pittsburgh at Titusville, and Crawford Tech.

The areas along major transportation routes can be susceptible to forms of public transit terrorist attacks. More populated areas of the county, including the county seat of Meadville, can be susceptible to chemical, biological, radiological, nuclear, or explosive (CBRNE) events due to the concentration and density of residential communities and government activity and buildings. Secondary effects from CBRNE incidents can be damaging as well. Mass evacuations could result in congestion of roadways and possibly result in breakdown of civil order, further exacerbating the situation. Government operations may be disrupted due to the need to displace or operate under reduced capacity. Radiation fallout, hazardous chemical introduction into the groundwater or biologic/germ agents can cause long-term environmental damage.

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

Ransomware continues to be the leading threat, with Maze ransomware accounting for nearly half of all known cases in 2020. Cybercriminals have increasingly begun to steal proprietary – and sometimes embarrassing – data before encrypting it. The cybercriminal will then threaten to publicly release the stolen files if the victims do not provide financial transactions.

4.3.22.3 Past Occurrence

No major terrorism or cyber terrorism events have occurred in Crawford County, Pennsylvania. Cyber terrorism events are becoming more common in areas of local government, and these include counties near Crawford County, PA.

Significant international terrorism incidents in the United States include the World Trade Center bombing in 1993, the bombing of the Murrow Building in Oklahoma City in 1995, and the

September 11th, 2001, attacks on the World Trade Center and the Pentagon. One of the aircrafts hijacked in the September 11th attacks crash landed in Somerset County, Pennsylvania before it reached its intended target. While fatalities and destruction at the intended target were avoided, all passengers on the flight perished.

While the largest scale terrorist incidents have often had international stimuli, many other incidents are caused by home grown actors who may have become radicalized through hate groups either in person or via the internet, and who may struggle with mental health issues. Hate groups such as the Ku Klux Klan (KKK), Aryan Nation, the New Black Panther Party, and more recently, the Alt-Right, Antifa, anarcho-communists, Proud Boys, plus conspiracy theorist believers/promoters such as QAnon, have been part of domestic terrorism in different forms. During the May 2020 George Floyd protests, anti-police individuals associated with one or more of the groups created incendiary devices to burn down the Minneapolis Third Precinct. On January 6, 2021, individuals associated with one or more of the groups, stormed the United States Capitol to disrupt the certification of the 2020 presidential election, resulting in five deaths and evacuation of Congress.

Active Shooters

An active assailant (shooter), as defined by the U.S. Department of Homeland Security, is an individual actively engaged in killing or attempting to kill people in a confined area, in most cases, active shooters use firearms and there is not necessarily a pattern or method to their selection of victims. Throughout the year in 2023, there were a total of at least 636 mass shooting incidents in the United States according to the Gun Violence Archive. Often these shooters are HVEs. Two significant events have occurred in Pennsylvania in recent history: one occurred on October 27, 2018, when eleven people were killed by a gunman in the Pittsburgh neighborhood of Squirrel Hill; the gunman was a homegrown violent extremist and attacked the congregation of the Tree of Life Synagogue in a shooting that targeted the Jewish population and was fueled by the gunman's anti-Semitic, anti-immigrant, and anti-refugee sentiments. Another event occurred in January of 2019, where a gunman killed two people and permanently injured one inside P.J. Harrigan's bar in State College and later killed a homeowner and himself. One of the most tragic recent active shooters occurred in Uvalde, Texas, where an armored and masked gunman entered the Robb Elementary School on May 24, 2022 and killed nineteen students and two teachers. Another active shooter event occurred on November 22, 2022 when an employee at a Walmart in Chesapeake, Virginia entered the breakroom of the Chesapeake Walmart and killed six individuals before taking his own life.

Other active shooter events in the United States in recent years include Virginia Tech (April 2007), Sandy Hook Elementary School (December 2012), San Bernardino, California (December 2015), an Aurora, Colorado movie theater (July 2012) a church in Charleston, South Carolina

(June 2015). An *Active Shooter Incidents 20-Year Review* by the FBI concluded that there has been a significant recent increase in frequency of active shooter incidents, and that most shooters were male. The report documents data from all the incidents, including location, commercial environments, educational environments, open spaces, military and other government properties, residential locations, houses of worship, and health care facilities (FBI, 2021). *Figure 54 – Active Shooter Incidents – 20 Year Active Shooter Summary* is one page from the report that illustrates a numerical breakdown of shooting events for those twenty years. *Figure 55 – Education Environments* shows two more summary pages from the report that detail active shooter statistics in educational environments.

The complete report may be found here: https://www.fbi.gov/file-repository/active-shooter-incidents-20-year-review-2000-2019-060121.pdf/view.

Cyber-Threats

While Crawford County has not been the target of any critical cyber terrorist events, the county has seen multiple security breaches due to online phishing and other scams.

One hack attack took down the largest fuel pipeline in the U.S. and led to massive gasoline shortages; it was the result of a single compromised password. Hackers gained entry into the networks of Colonial Pipeline Company on April 29, 2021 through a virtual private network account, which allowed employees to remotely access the company's computer network. On May 7, 2021, a ransom of $4.4 million was demanded by the hackers, causing Colonial to shut down the entire supply line, immediately prompting temporary gasoline shortages and panic buying up and down the East Coast. The hackers, who were an affiliate of a Russian-linked cybercrime group known as *DarkSide*, were paid the ransom. The hackers also stole nearly 100 gigabytes of data from Colonial Pipeline and threatened to leak it if the ransom was not paid, according to Bloomberg News.

Then, in early June 2021, JBS, the world's largest meat company by sales, paid an $11 million ransom to cybercriminals who temporarily knocked out plants that process roughly one-fifth of the nation's meat supply. The ransom payment, in bitcoin, was made to shield JBS meat plants from further disruption and to limit the potential impact on restaurants, grocery stores and farmers that rely on JBS, according to the company.

The attack on JBS was part of a wave of incursions using ransomware, in which companies are hit with demands for multimillion-dollar payments to regain control of their operating systems. The attacks show how hackers have shifted from targeting data-rich companies such as retailers, banks and insurers to essential-service providers such as hospitals, transport operators and food companies.

4.3.22.4 Future Occurrence

The likelihood of Crawford County being a primary target for a major international terrorist attack is small and unlikely. More likely terrorist activity in Crawford County includes bomb threats or other incidents at schools. Crawford County has five school districts consisting of twenty-four public schools. Several private schools and colleges/universities are also located in Crawford County. These locations are considered soft targets and may be vulnerable, especially to domestic incidents.

4.3.22.5 Vulnerability Assessment

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

Although previous events have not resulted in what are considered to be significant terrorist attacks, the severity of a future incident cannot be predicted with a total level of certainty. One of the major concerns with agroterrorism is that acts can be carried out with minimal planning, effort, or expense.

Acronis, a global technology company that develops on-premises and cloud software for backup, disaster recovery, and secure file sync and share and data access, issues an annual threat scape report on cybercrime. Entitled *The Acronis Cyberthreats Report*, it contains an in-depth review of the current threat landscape and projections for the coming year. Based on the protection and security challenges that were amplified by the shift to remote work during the COVID-19 pandemic, Acronis warns aggressive cybercrime activities will continue as criminals pivot their attacks from data encryption to data exfiltration.

The major points illustrated in the report are as follows:

- Attacks against remote workers will increase due to the movement of workers to less secure working areas.
- Ransomware will look for new victims and will become more automated.

- Legacy IT and technical solutions will struggle to keep pace with ransomware and cybercrime attacks.

According to a study carried out on the data sourced from the Federal Bureau of Investigation, Pennsylvania is ranked second worst among states when it comes to handling cyber-attacks. The study made by Information Network Associates – an international security consulting company – says an increase of 25% was witnessed in cyber-attacks between 2016 and 2017. This illustrates the amount of preparation that must occur in the commonwealth so that it can better respond to potential cybercrime attacks.

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

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

Figure 54 - Active Shooter Incidents – 20 Year Active Shooter Summary

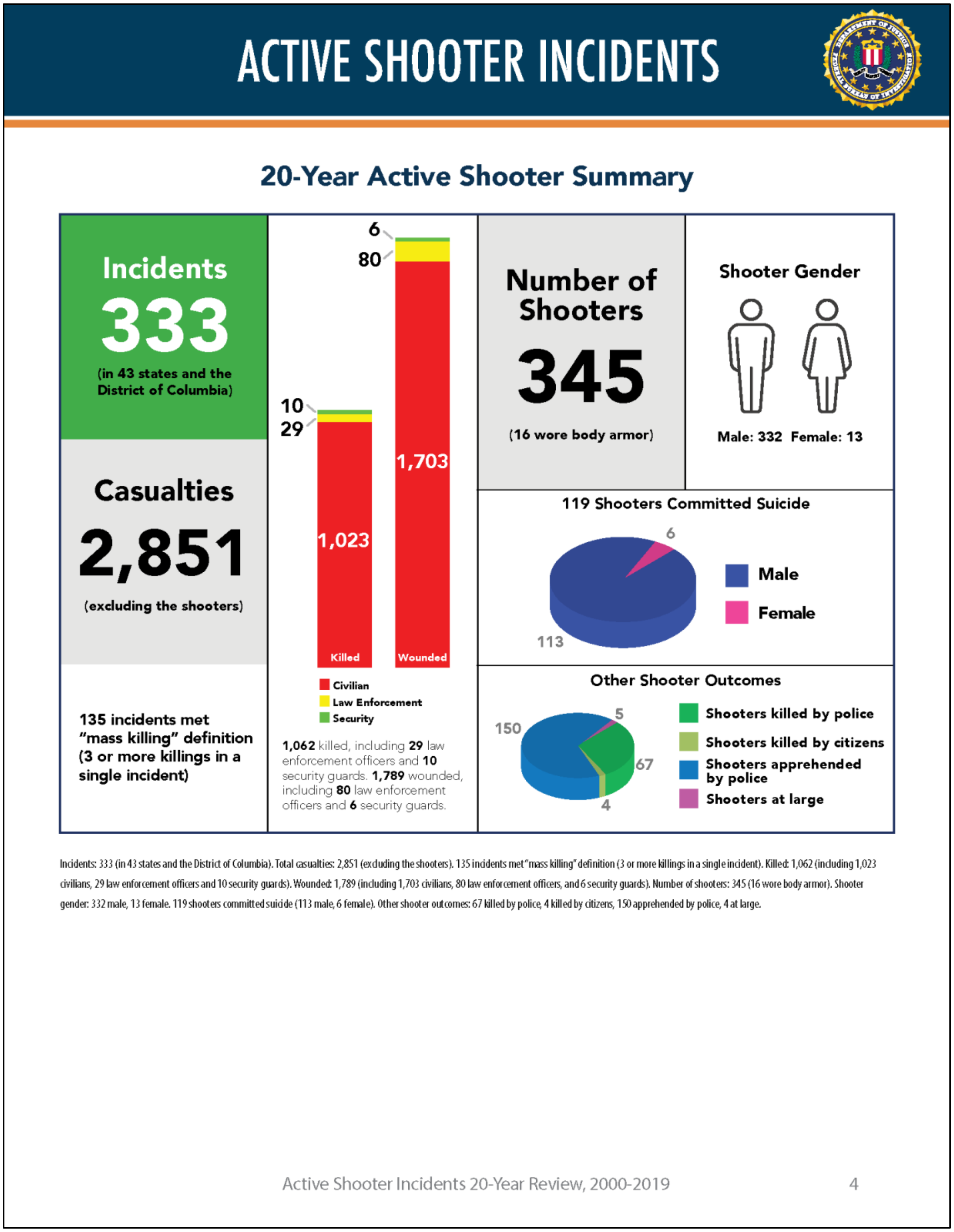


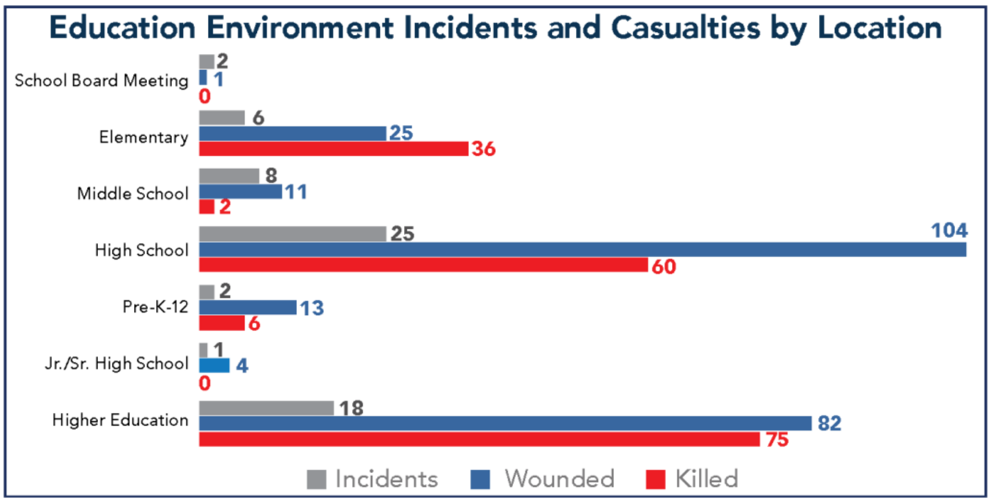
Figure 55 - Education Environments

ACTIVE SHOOTER INCIDENTS

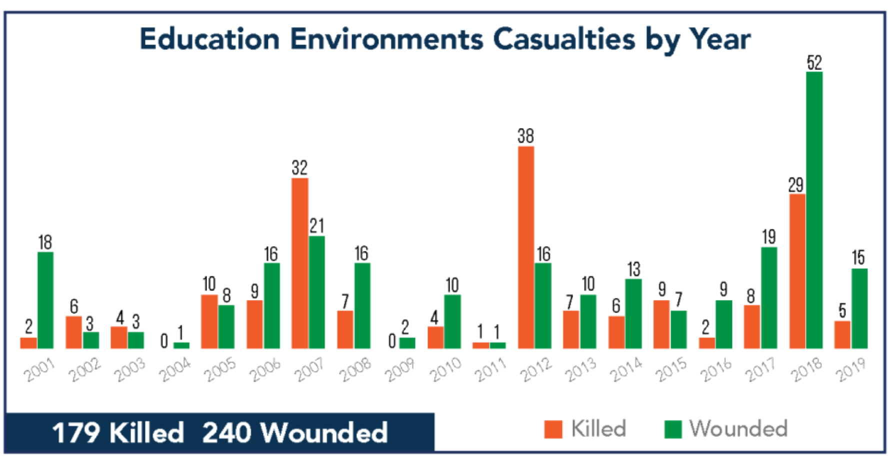
Education Environments

Quick Look:

Sixty-two incidents occurred in public and private educational settings, defined as schools covering pre-kindergarten to 12th grade, institutes of higher education, and school board meetings.



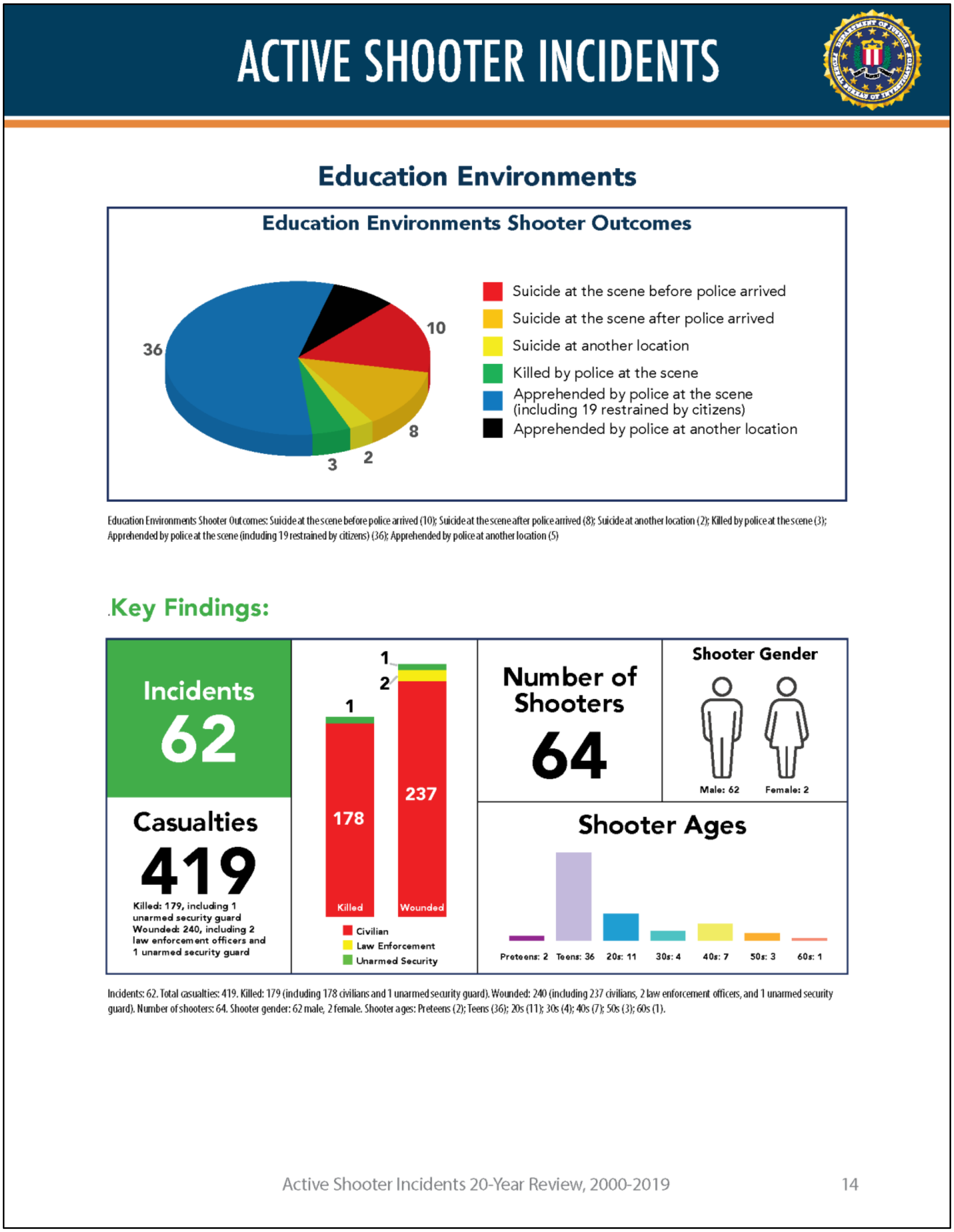
Education Environment Incidents and Casualties by Location: School Board Meeting (2 incidents, 1 wounded, 0 killed); Elementary (6 incidents, 25 wounded, 36 killed); Middle School (8 incidents, 11 wounded, 2 killed); High School (25 incidents, 104 wounded, 60 killed); Pre-K-12 (2 incidents, 13 wounded, 6 killed); Jr./Sr. High School (1 incident, 4 wounded, 0 killed); Higher Education (18 incidents, 82 wounded, 75 killed)



Education Environments Casualties by Year: 2001 (2 killed, 18 wounded); 2002 (6 killed, 3 wounded); 2003 (4 killed, 3 wounded); 2004 (0 killed, 1 wounded); 2005 (10 killed, 8 wounded); 2006 (9 killed, 16 wounded); 2007 (32 killed, 21 wounded); 2008 (7 killed, 16 wounded); 2009 (0 killed, 2 wounded); 2010 (4 killed, 10 wounded); 2011 (1 killed, 1 wounded); 2012 (38 killed, 16 wounded); 2013 (7 killed, 10 wounded); 2014 (6 killed, 13 wounded); 2015 (9 killed, 7 wounded); 2016 (2 killed, 9 wounded); 2017 (8 killed, 19 wounded); 2018 (29 killed, 52 wounded); 2019 (5 killed, 15 wounded)

Active Shooter Incidents 20-Year Review, 2000-2019 13

Figure 56 - Education Environments Continued



4.3.24. Transportation Accidents

4.3.24.1 Location and Extent

Transportation accidents are defined as accidents involving highway, air, and rail travel. These incidents are collectively the costliest of all hazards in the Commonwealth in terms of lives lost, injuries, and economic losses. The sheer amount of roadway, coupled with the high volume of traffic, creates the potential for serious accidents along the roads and bridges. In Crawford County there are 501 state-maintained and 124 locally maintained bridges, according to PennDOT. Major transportation routes in Crawford County include Interstate 79, US 6, US 19, US 322, SR 8, SR 18, and SR 27. Other state routes are also present in the county including SR 98, SR 198, and SR 285. *Figure 57 – Major Transportation Routes* shows the major transportation systems in Crawford County.

Crawford County has one public airport; Port Meadville which was activated in April of 1938. This airport does not have a control tower on site and its runway is 5001’x75’, which can handle most corporate aircraft. There exists a potential extent for air transportation accidents to occur due to the number of commercial air traffic that flyovers the county every day. However, a five-mile radius around the airport can be considered a high-risk area since most aviation incidents occur near take-off and landing sites. *Figure 58 – Airports and Vulnerability Zones.*

There are several freight and passenger rail lines in Crawford County. The rail lines that operate within Crawford County, include Norfolk Southern Freight Main Line, Oil Creek and Titusville Lines, Western New York and Pennsylvania Railroad, and Canadian National. With the ability of these railroads for interchanging with other companies, goods can be transported virtually anywhere via rail from Crawford County. Rail transportation accidents are generally classified as one of these 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 transportation is divided into two major categories: freight and passenger. Each category can be subdivided according to carrier type: major carrier and local/regional carriers. Rail accidents can occur anywhere along the miles of rail located in Crawford County.

There are 2,619 oil and gas wells located in Crawford County. Pipeline infrastructure is seen throughout the county. There are four major pipeline companies that transport hazardous materials in and through Crawford County. Of these four major pipelines, three are for natural gas only and one is for natural gas and propane. *Figure 60 – Utility Pipelines Vulnerability* shows the various pipelines that run through Crawford County.

4.3.24.2 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 even death. The majority of motor vehicle crashes in Pennsylvania are non-fatal, but PennDOT estimates that every hour nine people are injured in a car crash, and every seven hours someone dies as a result of a car crash. Most fatal crashes occur in May and June, but the highest number of crashes overall occur in October, November, and December. Inclement weather and higher traffic volumes and speeds increase the risk for automobile accidents.

Railway and roadway accidents have the potential to result in hazardous materials release. Railroad accidents occur with less frequency than highway accidents. However, when these types of incidents occur, they often cause extensive property damage and have the potential to cause serious injuries or deaths.

The worst-case scenario for a transportation accident impacting the county would be a road or rail accident which results in a hazardous material spill in the City of Meadville, which is the most populous municipality with 13,050 residents according to the 2020 U.S. Census. The City of Meadville is also the county seat of Crawford County and the home to many businesses and county government offices. Such an event would constitute an immediate health hazard to the population and require evacuation and could disrupt daily operations until the event is controlled.

4.3.24.3 Past Occurrence

Table 78 – PennDOT Crash Report for Crawford County shows crash statistics recorded by the Pennsylvania Department of Transportation between 2010 and 2022. Reports for 2023 were not available at the time of this report. The year 2013 had the most total crashes in Crawford County while 2020 had the least total crashes. The number of total crashes has declined from 2021 to 2022 in Crawford County. The only train with vehicle crash that occurred in Crawford County was in 2011 with one crash happening in the county.

Table 78 - PennDOT Crash Report for Crawford County

PennDOT Crash Report for Crawford County								
Year	Vehicle accidents for Crawford County				Vehicle Accident Deaths for Crawford County			Train/Trolley with Motor Vehicle Crashes/ Fatalities
	Total	Fatal Accidents	Injury Crashes	Property Damage Only	Total Vehicle Accident Fatalities	Alcohol-Related Fatalities	Pedestrian Fatalities	
2010	874	14	427	433	14	8	0	0
2011	897	12	435	450	12	5	2	1
2012	874	15	400	459	15	4	2	0
2013	963	27	400	536	29	10	0	0
2014	857	13	340	504	14	5	0	0
2015	872	8	357	507	8	2	2	0
2016	944	12	388	544	12	6	0	0
2017	911	10	340	561	10	4	0	0
2018	946	12	376	558	14	3	2	0
2019	937	8	352	577	9	5	1	0
2020	762	5	284	473	5	2	1	0
2021	908	17	347	544	19	2	1	0
2022	786	15	284	487	16	5	1	0

4.3.24.4 Future Occurrence

Crawford County’s population has decreased over the last decade, so it can be assumed that local traffic has decreased slightly as well. However, with the increasing volume of goods and trucking through the county, transportation accidents will continue to occur routinely. Hazardous material release through transportation accidents is difficult to predict but can be assumed to happen in future events as well. The U.S. Census Bureau reports the mean travel time to work for those aged 16 plus is approximately twenty-four minutes. Automobile accidents occur frequently, and typically occur more frequently than rail or aviation accidents. In the case of highway accidents, PennDOT has taken great strides to reduce the number of highway transportation accidents through programs such as the Pennsylvania Highway Safety Corridor. In this program, PennDOT designates sections of highway where traffic citation fines are doubled in the hopes that higher fines will deter unsafe driving and reduce accidents. Transportation accidents 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 municipal base maps.

4.3.24.5 Vulnerability Assessment

A transportation accident can occur anywhere in Crawford County. However, severe accidents are more likely to occur on the county's major highways due to the heavier traffic volumes which make highways extremely vulnerable. The vulnerability for accidents on either highway, railway, or aviation, are directly related to the population and traffic density within the county. The vulnerability increases if there are hazardous materials involved. Hazards associated with causing transportation accidents can include natural hazards that affect the environment, such as winter storms or heavy rains that cause slippery roadways or mud slides, to windstorms or tornadoes that cause high-profile vehicles or train cars to topple over. Loss of roadway use, and public transportation services would affect commuters, employment, delivery of critical municipal and emergency services, and day-to-day operations within the county.

With highway accidents, there is an added vulnerability that stems from the age and upkeep of bridges throughout the county. Unrepaired, deficient bridges may be more likely to break, thus leading to highway transportation damages or deaths. 13.6% of Crawford County bridges are in poor condition, indicating an increased vulnerability to transportation accidents, while 47.8% remain in fair condition.

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 for response to a release. *Figure 59– Average Daily Traffic on Major Highway Vulnerability* identifies all major highways and railroads within Crawford County.

Figure 57 - Major Transportation Routes

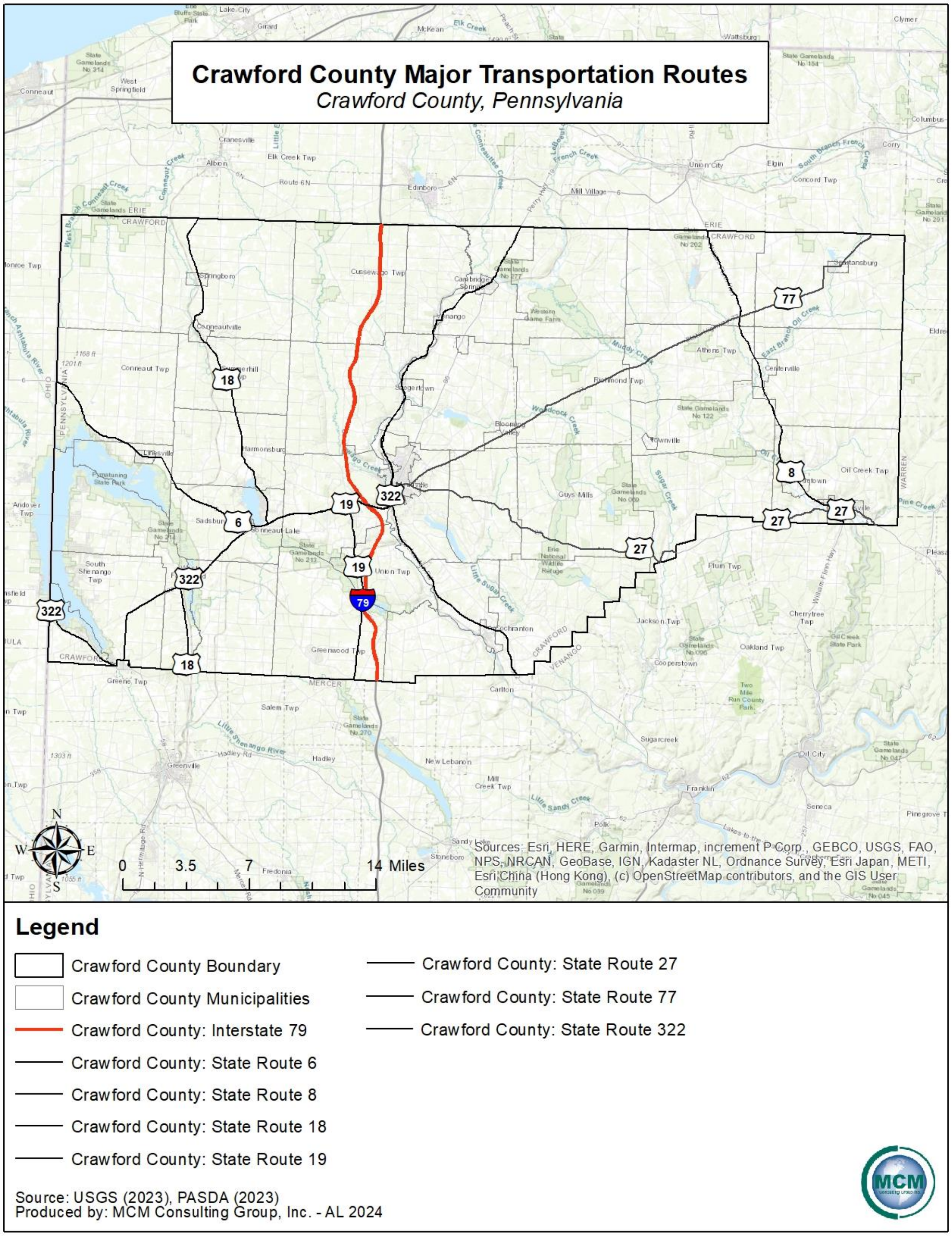


Figure 58 - Airports and Vulnerability Zones

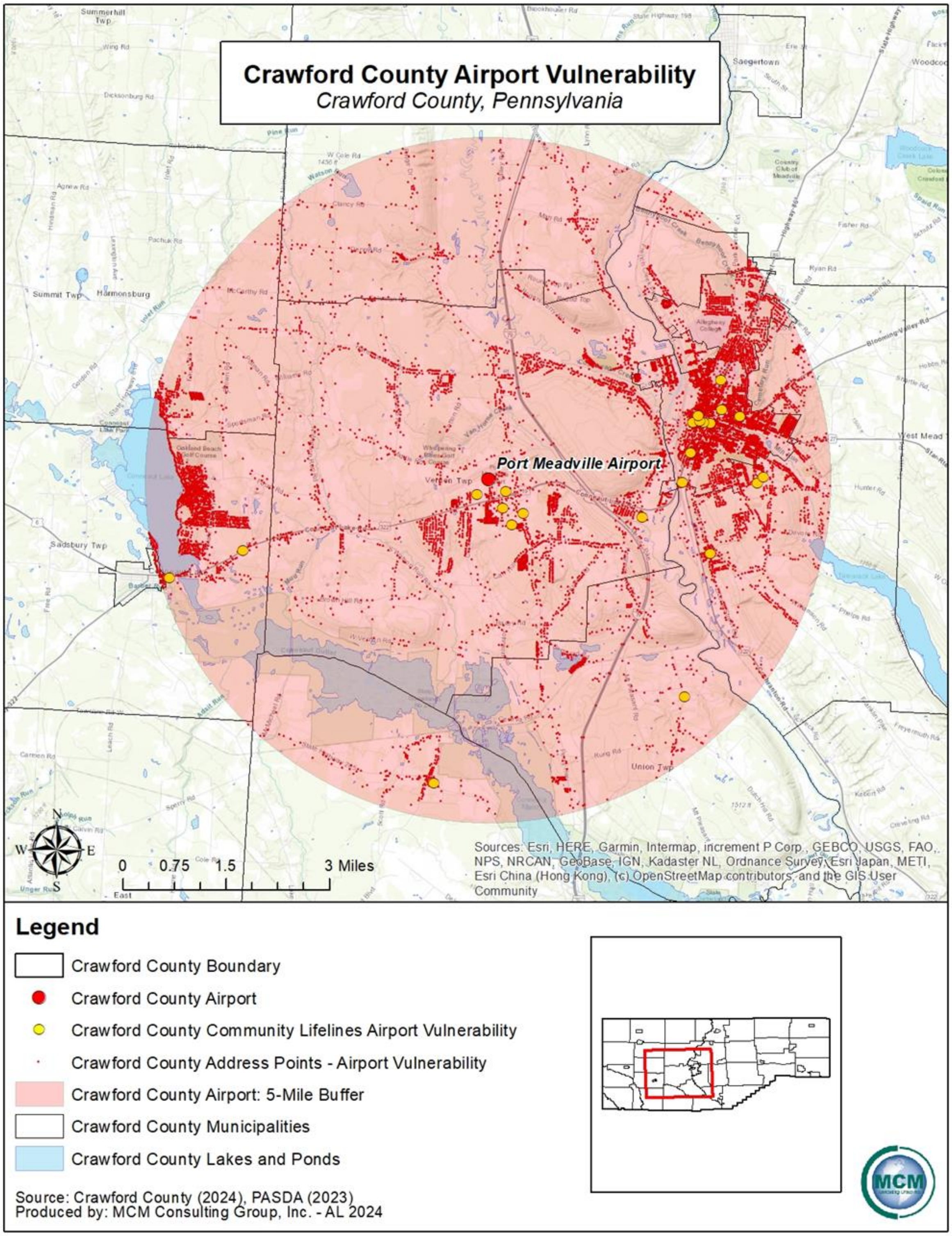


Figure 59 - Average Daily Traffic on Major Highway Vulnerability

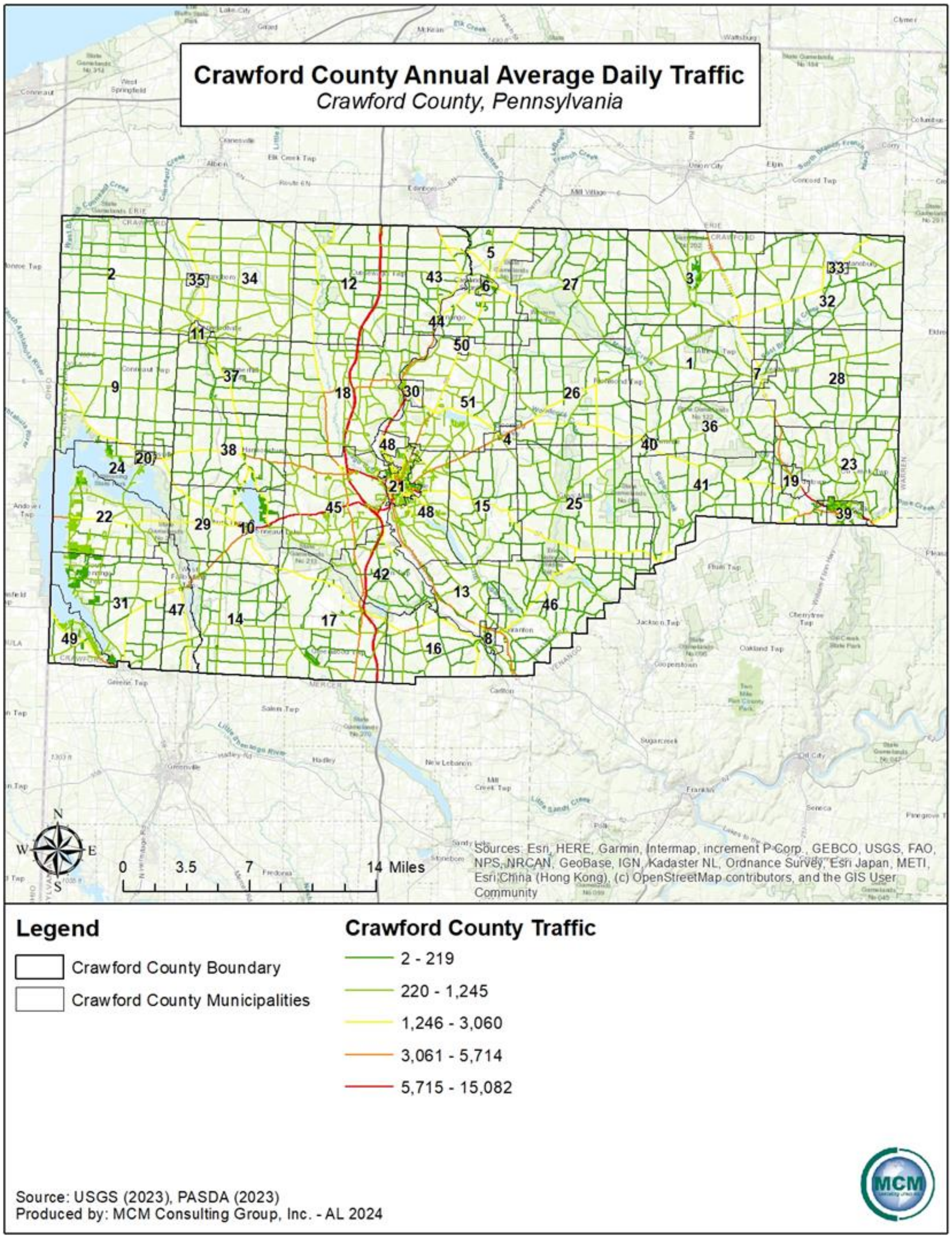
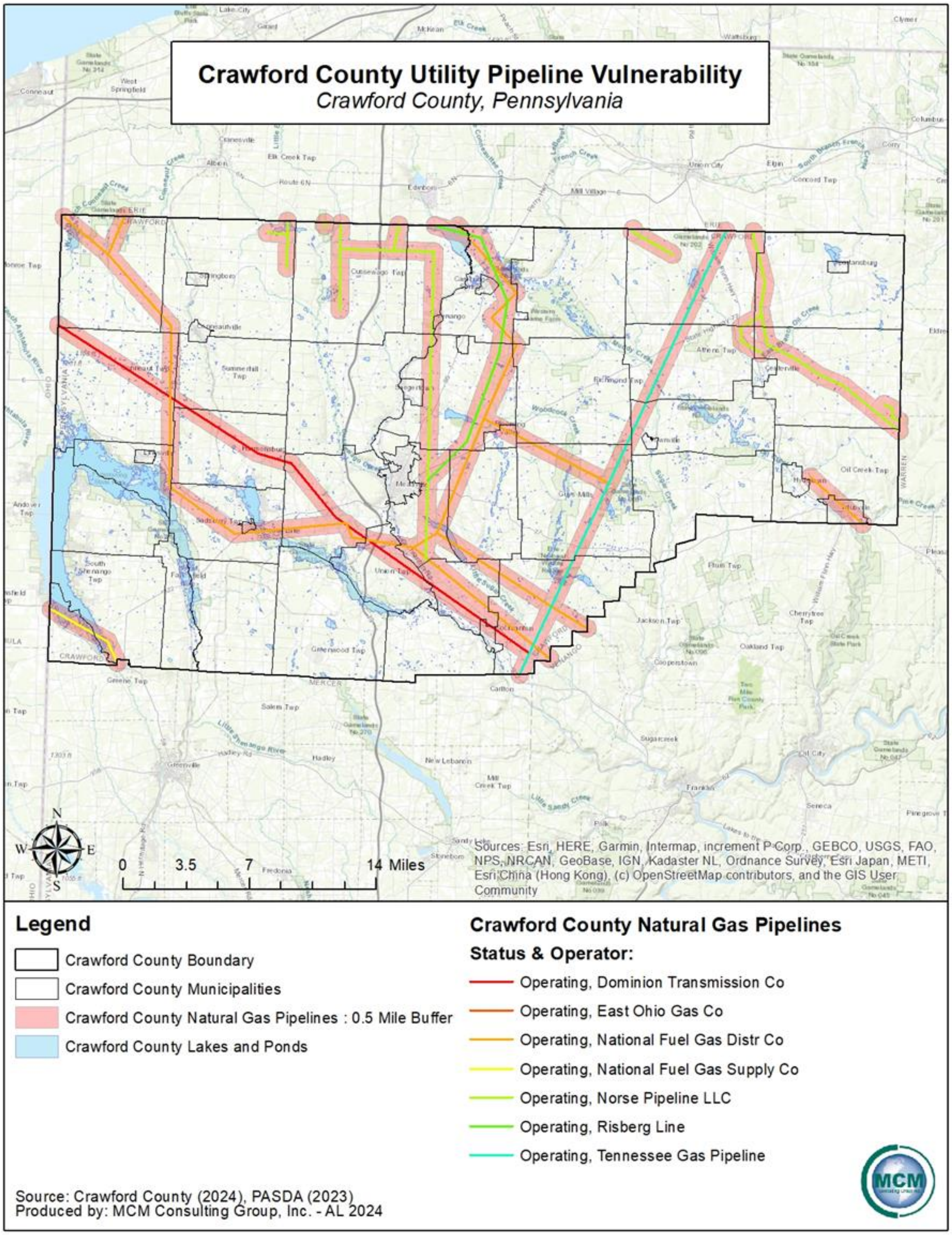


Figure 60 - Utility Pipelines Vulnerability



4.3.25. Urban Fire and Explosion

4.3.25.1 Location and Extent

Urban fire and explosion hazards incorporate vehicle and building/ structure fires, as well as overpressure ruptures, overheat explosions, or other explosions that do not ignite. Statewide, this hazard is most problematic in the denser, and more urbanized areas, occurring most often in residential structures (US Fire Administration, 2009). Urban fires can more easily spread from building to building in denser urban areas.

According to the U.S. Census Bureau, 2022 U.S. Census, Crawford County has approximately 42,234 housing units. Buildings that were constructed fifty or more years ago are at a higher risk of urban fires due to improvement in fire safety engineering practices. Only 9.9% of all housing units in Crawford County were built after 2000, with a majority of housing units, 64.4%, built between 1940 and 1999. 25.7% of housing units in Crawford County were built before 1939. Fires can start from numerous causes including human errors or electrical malfunctions. Most fires are small and have little impact on the greater community other than possibly increasing insurance rates. Oftentimes large urban fires are the result of other hazards such as storms, droughts, transportation accidents, hazardous material spills, arson, or terrorism.

Natural gas exploration and extraction sites can be associated with fires and explosion events. Well flares regularly burn off excess gas, and if improperly managed, such activities can be dangerous for the surrounding areas.

4.3.25.2 Range of Magnitude

Urban fires can occur in any populated area, and fires affecting one structure happen quite often. Urban fires are most threatening when the fire can rapidly spread from one structure to another. Crawford County is largely rural/semi-rural and does not have significant expanses of dense population.

Damages from fire and explosions ranges from minor smoke inhalation and/or water damage to the destruction of buildings. A worst-case scenario for any fire and or explosion would be in injuries and/or death of the occupants of the structures and the potential of injury or death of firefighters.

There are economic consequences related to a fire and explosion hazard, including:

- Loss in wages due to temporarily or permanently closed businesses
- Destruction and damage to business and personal assets
- Loss of tax base

- Recovery costs
- Loss related to the ability of public, private, and non-profit entities to provide post-incident relief.

The secondary effects of urban fire and explosion events relate to the ability of public, private, and non-profit entities to provide post-incident relief. Human services agencies (community support programs, health and medical services, public assistance programs and social services) can be affected by urban fire and explosion events. Effects include causing physical damage to facilities and equipment, disruption of emergency communications, loss of health and medical facilities and supplies, and an overwhelming load of victims who are suffering from the effects of the urban fire, including loss of their home or place of business.

4.3.25.3 Past Occurrence

From 1910 to 1990, the Commonwealth of Pennsylvania experienced 13 major fires in suburban and urban settings, and 10 of them occurred after 1980. Between 1978 and 1982, the average number of deaths per fire was 2.7. After October 1990, the average number of deaths per fire has decreased.

As of December 2023, there were 1,666 active natural gas wells in Crawford County (PA DEP, 2023). These locations should be closely monitored, and safety protocols should be strictly adhered to in order to avoid explosions and starting fires. Crawford County utilizes a database system called WebEOC to track incidents within the county. In the closed incident report from Crawford County there were four fire events that occurred between 2023 and 2024, these events can be seen in the table below (*Table 61 – Fire Events in Crawford County*).

Figure 61 - Fire Events in Crawford County

Fire Events in Crawford County			
Date	**Event Type**	**Municipality**	**Fatalities**
2023	Industrial	15	3
	HazMat	1	
2022	Industrial	21	5
	HazMat	0	
2021	Industrial	18	None
	HazMat	0	
Source: Crawford County, WebEOC Closed Incidents (2024)			

4.3.25.4 Future Occurrence

Small urban fires occur regularly and usually cause little damage. Areas with greater population and an increased rate of population density are at greater risk for future urban fires and explosions. The more urban areas of Crawford County include the City of Meadville, City of Titusville, Vernon Township, and West Mead Township.

Any new construction must comply with PA Department of Labor's statewide uniform construction codes. One requirement in the construction codes is automatic sprinkler requirements for buildings other than one- and two-family dwellings. In most cases, this requirement will contain fires to the point of origin.

4.3.25.5 Vulnerability Assessment

Fire and explosion vulnerability greatly depends on the vulnerability of other hazards. Most fires result from the secondary effect of another hazard. The probability of a fire or explosion occurring increases with population and economic growth. The natural gas industry and exploration is active and growing in Crawford County, and with it comes greater risk for fire and explosion. Urban fire risk also increases as the use of wood burning and kerosene space heaters increases. The elderly (those 65 years and older) tend to be more vulnerable to structure fires than other age groups, and often experience the highest number of deaths per fire. Older structures are more vulnerable to urban fire, and fires can spread faster to each other in areas with higher concentrations of housing. Potential secondary effects of urban fires include utility interruption and hazardous material spills.

4.3.26. Utility Interruptions

4.3.26.1 Location and Extent

Utility interruptions can occur from an internal system failure or as a secondary impact of another hazard, such as windstorm, winter storm, extreme temperatures, or a traffic accident. Strong adverse weather conditions and storms can cause widespread disruptions in electric and telecommunications service due to power lines being brought down by falling tree branches across a region. Strong heat waves may result in rolling blackouts where power may not be available for an extended period, impacting air conditioning across a region. Space weather, specifically solar flares, can also pose a threat to utility service across the globe. Although uncommon, the northeastern seaboard and the north central regions of the United States are particularly susceptible to this hazard.

The age of utility infrastructure also plays a role in interruptions, causing longer periods of outages in a larger area. Natural gas, water, telecommunications, and electric capabilities can all experience disruptions. Worker strikes at power generation facilities have also been known to cause minor and temporary power outages and failures. Other causes for minor power outages include but are not limited to vehicle accidents and wire destruction due to animals or wildlife. Outages can also be caused by blown transformers or tripped circuit breakers in the electric system. Major power outages typically occur on a regional scale and can last both short term and long term.

The list of utility providers in Crawford County is shown in *Table 79 – Crawford County Utility Providers*.

Table 79 - Crawford County Utility Providers

Crawford County Utility Providers	
Utility Type	**Name of Utility Provider**
Electricity	Penelec, Penn Power, Northwestern REC, Ambit Energy
Telephone/911/Wireless	AT&T, Cricket Wireless, Verizon, Metro by T-Mobile, Kinetic Connection Center, Mobilcom, Davis Rural Broadband, Windstream, Armstrong
Natural Gas	National Fuel Gas Supply Corporation, Eastern Gas Transmission and Storage, Pin Oak Midstream LLC, RH Energytrans LLC, Tennessee Gas Pipeline Company, L.L.C., Williams, Ambit Energy

Crawford County Utility Providers	
Utility Type	**Name of Utility Provider**
Water	Bloomingfield Township Sewer Authority, Conneaut Lake Joint Municipal Authority, Fairview Township Sewer Authority, Meadville Area Sewer Authority, Meadville Area Water Authority, Oil Region Authority, Vernon Township Water Authority.
Source: PA Public Utility Commission, 2023	

4.3.26.2 Range of Magnitude

Utility interruptions do not typically lead to large-scale problems by themselves. Typically, human casualties are not a direct result from outages. Many utility interruptions occur during storms or other severe weather events, and they can have secondary consequences. Typical secondary effects from a power outage can include a delay in emergency response and those services arriving in timely manner. A lack of potable drinking water can also become a major issue for areas impacted by utility interruptions.

Electricity:

Interruptions or power failures could have the following impacts:

- Public safety concerns
- Food spoilage
- Loss of heating or air conditioning
- Basement flooding due to sump pump failure
- Loss of indoor lighting
- Loss of internet service
- Stopped and stalled elevators
- Direct economic impact from retail settings

Of all the above listed impacts, the loss of heating or air conditioning poses the greatest risk to the elderly and very young populations during times of extreme temperature. Prolonged power outages also pose a risk to residents that rely on home-based medical equipment such as home-supply oxygen units. Some of the issues that are listed above can be considered more of a nuisance than a hazard, such as food spoilage due to long-term electrical outages. However, significant damage or harm can occur depending on the population affected, the duration, and the severity of the outage.

A worst-case scenario for the utility interruptions would be a county-wide power outage during winter months, forcing the evacuation of vulnerable populations to facilities outside of the county or to warming shelters within the county.

Fuel:

Interruptions of the transportation of gas and other products used for fuel can lead to a loss of heating and manufacturing capabilities. This can adversely affect the economic stability of a region and the production of needed products for consumption.

Telecommunications:

Interruptions to telecommunications systems include impacts to the 9-1-1 capabilities of a region, telephone, and internet service. The greatest risk in losing this utility to interruption is the risk of an emergency not being able to be reported to a public safety answering point (PSAP). Extensive loss of telephone and internet service can be detrimental to government, businesses, and to residents. With much of the country now dependent on wireless networks, signal interruptions can cause a large issue for people who are utilizing wireless telecommunications for work. There are also many concerns regarding safety and internet security due to the increase in people working over wireless networks that occurred during the COVID-19 pandemic. These interruptions and issues can be detrimental for the Crawford County workforce.

4.3.26.3 Past Occurrence

Minor utility interruptions occur annually in Crawford County and occur most often in conjunction with winter weather and/or windstorms. Crawford County utilizes a database system called WebEOC to track incidents within the county. *Table 80 – Utility Interruptions in Crawford County* illustrates the number of interruptions to electric, natural gas, telecommunications, and water services in 2023.

Table 80 - Utility Interruptions in Crawford County

Utility Interruptions in Crawford County		
Date	**Event Type**	**Municipality**
06/09/2023	Boil Water Advisory	Oil Creek Township
03/27/2023	Boil Water Advisory	Vernon Township, Hayfield Township, Union Township
04/21/2023	Water Disruption – supply contamination	Spring Township
Source: Crawford County, WebEOC Closed Incidents (2024)		

The Pennsylvania Public Utility Commission tracks the reliability of electric distribution companies (EDC) and outages. *Table 81 – 2018 Winter Storms Riley and Quinn Power Outages* by EDC compares the customers affected by power outage in Pennsylvania during these storm events and compares the to statistics from Nika from 2014 and Sandy from 2012. Some of the EDCs were not impacted by Winter Storm Quinn. PP&L customers experienced power outages for a duration of eight days with Winter Storm Quinn and Winter Storm Riley, whereas during Sandy in 2012, the duration was nine days. Nika in 2014 had a duration of just over three days.

Table 81 - 2018 Winter Storms Riley and Quinn Power Outages

2018 Winter Storms Riley and Quinn Power Outages			
Electric Distribution Company	**Customers affected by storms Riley and Quinn 2018 (Percentage of total customers)**	**Customers affected by Nika 2014 (Percentage of total customer)**	**Customers affected by Sandy 2012 (Percentage of total customers)**
Met-Ed	272,928 (49.22%)	144,000 (26.00%)	298,300 (54.00%)
PECO	794,969 (46.76%)	723,681 (42.00%)	845,703 (54.20%)
Penelec	90,856 (15.61%)	N/A	96,847 (16.40%)
PCLP	2,101 (47.44%)	N/A	4,487 (100.00%)
PP&L	261,341 (18.67%)	92,283 (7.00%)	523, 936 (37.50%)
Total:	**1,422,195**	**959,964**	**1,769,273**
Source: Winter Storm Riley and Quinn Report 2019			

Other past significant events of utility interruptions in the United States occur on a regional basis and can have varied effects related to number of impacted customers. A large water treatment plant failure occurred in Jackson, Mississippi in August of 2022 after flooding impacted the treatment facility. The city of Jackson was left without safe drinking water for close to two months until the water was deemed safe and potable in October of 2022. This event stood out as a large scale failure of community lifelines and utilities. This event also opened discussions related to equity in infrastructure repairs, as the repairs took a significant amount of time in a vulnerable socio-economic area. An attack on an electrical grid and power substations in North Carolina in December of 2022 left almost 45,000 people without power and reliant heat during the cold temperatures of January.

4.3.26.4 Future Occurrence

Utility Interruptions are difficult to predict, and minor interruptions may occur several times a year to all utilities. Even so, utility interruptions occur more frequently as a secondary factor to severe weather events or transportation accidents.

Space weather is getting more attention as an infrastructure risk due in part to a March 2020 report by the United States Geological Survey (USGS). The report noted that geomagnetic storms caused by the dynamic action of the Sun and solar wind on the space environment surrounding the Earth can generate electric fields in the Earth's crust and mantle. These electric fields can interfere with the operation of grounded electric power-grid systems. Geomagnetic storms occur only occasionally, but when sufficiently energetic they can produce blackouts on a large scale.

As utility infrastructure ages, interruption events could occur more frequently if the maintenance of the infrastructure is not maintained. Utility providers can reduce Crawford County's vulnerability to power outages by implementing improvement plans for utility infrastructure. Total replacement is not a feasible solution to the issue, but compromises can be reached to ensure that the new and old equipment along a utility line can work together efficiently.

Utility interruptions could see direct impacts based on climate change in Crawford County. Prolonged heat waves caused by climate change could stress a power grid that was not specifically designed for increased heat exposure. Increased intensity of winter storms is of particular concern for the Commonwealth of Pennsylvania, as power outages can occur from lines being brought down by ice and snow.

4.3.26.5 Vulnerability Assessment

Resources such as electricity, communications, gas, and water supply are critical to ensure the health, safety, and general welfare of the citizenry. *Figure 62 – Crawford County Utilities* illustrates the approximate locations of service lines and pipelines throughout Crawford County.

Power outages can cause even greater detriment to at-risk and vulnerable populations, such as elderly (e.g., supplemental oxygen power needs) or those with functional and access needs to consider. All critical infrastructure is vulnerable to the effects of a power surge. The probability of a large-scale, extended utility failure is low; however, small-scale failures lasting short periods of time occur annually.

Long-term care facilities, senior centers, hospitals, and emergency medical facilities are all vulnerable to utility interruptions. Often back-up power generators are used at these facilities to offset electrical needs during extreme hot or cold temperature events. However, these back-up power generators must be maintained, and fuel supplies must be secured in advance of the utility interruption to ensure a seamless transition from the everyday, grid power source to the emergency generator. When officials consider maintenance and supplies for a facility, long-term use of back-up generators should be planned.

<u>Electricity:</u>

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

Causes of a regional scale power outage or failure could be from infrastructure failure, sabotage, human error, or worker strikes. Community lifeline facilities are vulnerable to utility interruptions, especially the loss of power. The establishment of reliable backup power at these facilities is extremely important to provide continued support of the health, safety, and well-being of Crawford County residents and visitors.

The occurrence of severe weather related utility interruptions will increase due to climate change in the Commonwealth of Pennsylvania and the United States as a whole. Climate change will cause weather to become more severe on a more frequent basis.

Water:

Water distribution can be affected in three ways.

- The amount of water available (depends on nature)
- The quality of the water (depends on human responsibility)
- The viability of the physical components of the distribution system

Well contamination or water shortages due to drought could pose a high vulnerability to local water distribution. Drought events will continue to occur more frequently as climate change alters that available amount of ground water for consumption. This will result in greater well shortages and water utility interruptions for citizens that have well water.

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

Gas and Liquid Pipelines:

Interruptions to natural gas distribution lines could be affected by:

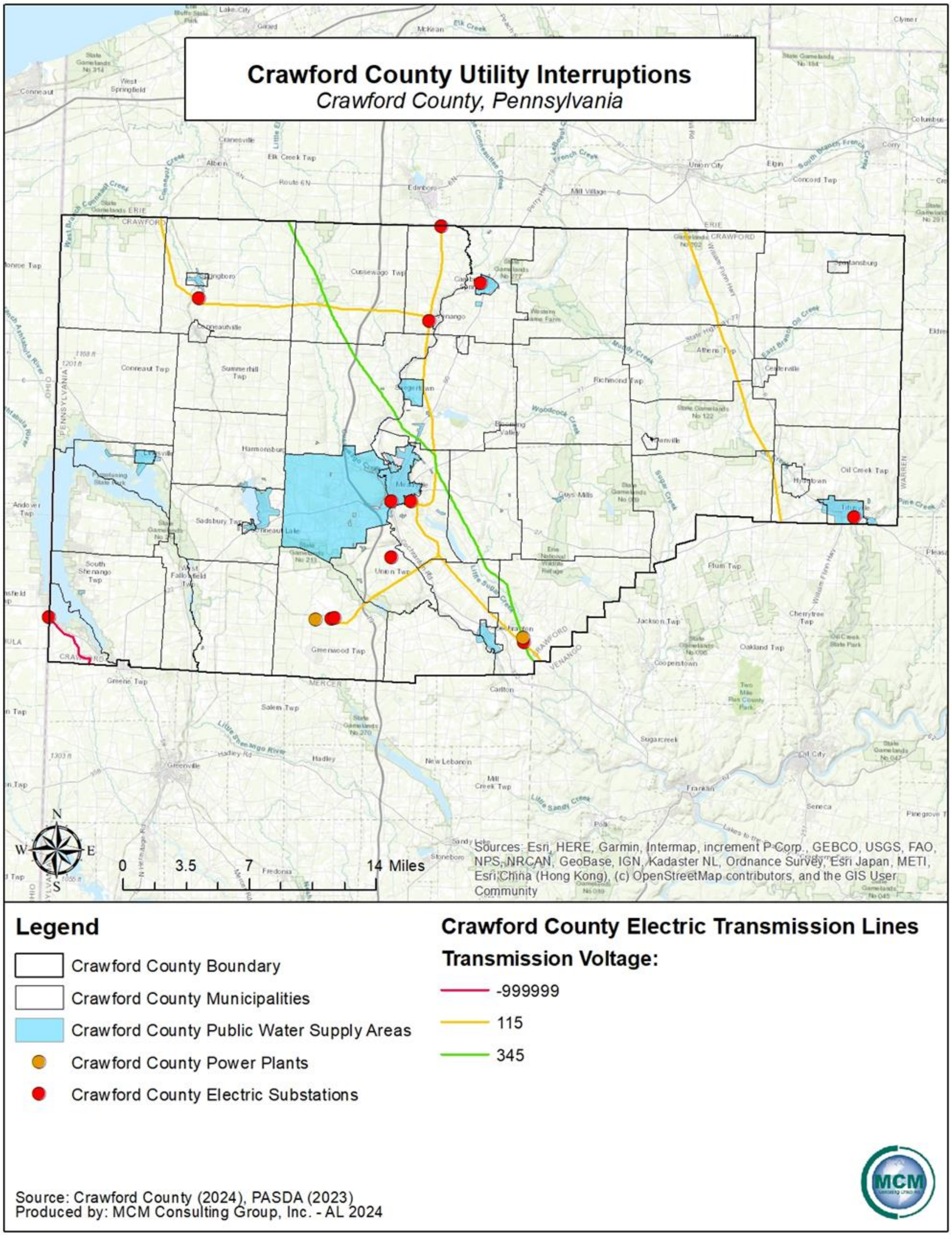
- Deterioration of line and facilities
- Puncturing the distribution lines by humans (either intentional or accidental)
- Coastal or winter storms
- Extreme heat or cold events
- Transportation accidents

Communications:

Interruptions in communications could be caused as a secondary effect of storms or high winds, infrastructure failure, or by humans (intentional or accidental). A loss of communications by emergency services would be devastating to the population of Crawford County if 9-1-1 calls could not be received, or if emergency units could not be dispatched properly and/or timely.

No data regarding economic impacts from utility interruptions in Crawford County are available. However, utility interruptions can cause economic impacts stemming from lost income, spoiled food and other goods, costs to the owners or operators of the utility facilities, and costs to government and community service groups.

Figure 62 - Crawford County Utilities



4.4. Hazard Vulnerability Summary

4.4.1. Methodology

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

RF values were obtained by assigning varying degrees of risk to five categories for each of the hazards profiled in the HMP update. Those categories include *probability*, *impact*, *spatial extent*, *warning time and duration*. Each degree of risk was assigned a value ranging from one to four. The weighting factor agreed upon by the planning team is shown in *Table 82 – Risk Factor Approach Summary* To calculate the RF value for a given hazard, the assigned risk value for each category was multiplied by the weighting factor. The sum of all five categories equals the final RF value, as demonstrated in the following example equation:

Table 82 - Risk Factor Approach Summary

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

Table 83 – Risk Factor Approach Summary summarizes each of the five categories used for calculating a RF for each hazard. According to the weighting scheme applied, the highest possible RF value is 4.0.

Table 83 - Risk Factor Approach Summary

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

4.4.2. Ranking Results

Using the methodology described in Section 4.4.1, *Table 84 – Risk Factor Assessment* lists the risk factor calculated for each of potential thirty hazards identified in the 2025 HMP. Hazards identified as *high* risk have risk factors greater than 2.5. Risk factors ranging from 2.0 to 2.4 were deemed *moderate* risk hazards. Hazards with risk factors 1.9 and less are considered *low* risk.

Table 84 - Risk Factor Assessment

Crawford County Hazard Ranking Based on Risk Factor Assessment Methodology							
Hazard Risk	Hazard Natural (N) or Human Caused (H)	RISK ASSESSMENT CATEGORY					RISK FACTOR (RF)
		Probability	Impact	Spatial Extent	Warning Time	Duration	
HIGH	Pandemic and Infectious Disease	4	4	4	1	4	**3.7**
	Emergency Services	4	3	4	1	4	**3.4**
	Blighted Properties	4	2	4	2	4	**3.2**
	Opioid Epidemic	4	3	3	1	4	**3.2**
	Flash Flood	4	2	3	4	3	**3.1**
	Windstorm	4	2	4	4	1	**3.1**
	Invasive Species	4	2	4	1	4	**3.1**
	Radon Exposure	4	2	4	1	4	**3.1**
	Utility Interruption	4	2	3	4	2	**3**
	Wildfire	4	2	3	4	2	**3**
	Terrorism and Cyber Terrorism	4	2	2	4	4	**3**
	Transportation Accidents	4	3	2	4	1	**3**
	Urban Fire and Explosion	4	3	2	4	1	**3**
	Winter Storm	4	2	4	1	2	**2.9**
	Drought	3	2	4	1	4	**2.8**
	Dam Failure	1	4	3	2	4	**2.7**
	Extreme Temperatures	3	2	4	1	3	**2.7**
	Flood	3	2	3	2	3	**2.6**
	Nuclear Incidents	1	3	3	4	4	**2.6**
	Hazardous Materials – Fixed Facility	3	2	2	4	3	**2.6**

Crawford County Hazard Ranking Based on Risk Factor Assessment Methodology							
Hazard Risk	**Hazard Natural (N) or Human Caused (H)**	**RISK ASSESSMENT CATEGORY**					**RISK FACTOR (RF)**
		Probability	**Impact**	**Spatial Extent**	**Warning Time**	**Duration**	
Moderate	Ice Jam	3	2	2	2	3	**2.4**
	Tornado	3	2	2	4	1	**2.4**
	Lightning Strike	4	1	2	4	1	**2.4**
	Disorientation	4	1	2	4	1	**2.4**
	Hazardous Materials – Transport	4	1	1	4	2	**2.3**
	Hurricane and Tropical Storm	2	2	4	1	2	**2.3**
	Earthquake	2	1	4	4	1	**2.2**
LOW	Landslide	2	1	1	4	1	**1.6**
	Subsidence and Sinkhole	2	1	1	4	1	**1.6**
	Civil Disturbance	1	1	1	4	1	**1.3**

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

A risk assessment result for the entire county does not mean that each municipality is at the same amount of risk to each hazard. *Table 85 – Countywide Risk Factor Assessment* shows the different municipalities in Crawford County and what their risk factor assessment scores are. This table was developed by the consultant based on the findings in the hazard profiles located in sections 4.3.1 through 4.3.26.

Table 85 - Countywide Risk Factor

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Pandemic and Infectious Disease	Emergency Services	Blighted Properties	Substance Use Disorder	Flash Flood	Windstorm	Invasive Species	Radon Exposure	Utility Interruption
	3.7	**3.4**	**3.2**	**3.2**	**3.1**	**3.1**	**3.1**	**3.1**	**3.0**
Athens Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Beaver Township	2.9	3.4	2.6	3.2	2.8	3.2	2.8	1.8	3.1
Bloomfield Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Blooming Valley Borough	2.1	2.5	2.8	2.2	2.8	3.2	2.2	1.6	3.0
Cambridge Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Cambridge Springs Borough	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Centerville Borough	3.7	3.4	3.2	3.2	2.9	3.1	3.1	3.1	3.0
Cochranton Borough	2.6	3.1	2.2	1.3	2.7	2.2	1.8	1.2	2.4
Conneaut Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Conneaut Lake Borough	3.1	3.1	2.4	3.2	2.5	3.1	2.6	2.1	2.6
Conneautville Borough	2.0	3.2	3.2	2.3	2.8	2.6	2.1	1.0	3.4
Cussewago Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
East Fairfield Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
East Fallowfield Township	3.7	3.7	2.9	3.2	2.8	2.7	3.1	3.1	3.3
East Mead Township	2.9	3.4	2.6	3.2	2.8	3.2	2.8	1.8	3.1
Fairfield Township	2.7	3.1	2.7	2.7	2.7	2.7	3.2	2.1	3.4
Greenwood Township	3.1	2.9	2.2	2.7	2.1	2.4	2.9	1.3	2.9
Hayfield Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Hydetown Borough	2.5	3.7	2.7	2.5	2.4	2.7	2.3	1.6	3.5
Linesville Borough	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Pandemic and Infectious Disease	Emergency Services	Blighted Properties	Substance Use Disorder	Flash Flood	Windstorm	Invasive Species	Radon Exposure	Utility Interruption
	3.7	**3.4**	**3.2**	**3.2**	**3.1**	**3.1**	**3.1**	**3.1**	**3.0**
Meadville, City of	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
North Shenango Township	3.7	3.7	2.9	3.2	3	2.7	3.1	3.1	3.3
Oil Creek Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Pine Township	2.8	2.2	2.2	2.2	2.3	2.5	2.8	1.6	3
Randolph Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Richmond Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Rockdale Township	4.0	3.5	2.4	2.1	2.7	3.4	3.1	1.5	3.3
Rome Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Sadsbury Township	3.7	3.7	2.9	3.2	3	3.1	3.1	3.2	3.3
Saegertown Borough	2.0	3.2	2.3	2.3	2.8	2.6	2.1	1.0	3.4
South Shenango Township	2.2	1.6	1.8	1.6	1.6	1.8	1.8	1.0	1.9
Sparta Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Spartansburg Borough	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Spring Township	2.6	2.3	1.6	1.8	1.9	2.9	2.6	2.1	2.5
Springboro Borough	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Steuben Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Summerhill Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Summit Township	2.8	3.4	3.7	2.4	2.8	2.8	2.4	2.4	2.9
Titusville, City of	1.2	2.2	2.1	1.2	2.3	2.6	1.1	1.0	2.7
Townville Borough	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Troy Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Pandemic and Infectious Disease	Emergency Services	Blighted Properties	Substance Use Disorder	Flash Flood	Windstorm	Invasive Species	Radon Exposure	Utility Interruption
	3.7	**3.4**	**3.2**	**3.2**	**3.1**	**3.1**	**3.1**	**3.1**	**3.0**
Union Township	2.0	1.9	1.0	1.0	2.0	2.5	1.6	1.6	1.4
Venango Borough	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Venango Township	2.1	1.9	1.0	1.0	1.2	2.2	2.1	1.3	2.4
Vernon Township	2.5	3.4	3.4	3.1	2.4	2.6	2.3	1.4	3.0
Wayne Township	2.7	3.1	2.7	2.7	2.7	2.7	3.2	2.1	3.4
West Fallowfield Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
West Mead Township	2.6	2.8	2.1	2.7	2.7	3.1	2.6	1.8	3.2
West Shenango Township	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Woodcock Borough	3.7	3.4	3.2	3.2	3.1	3.1	3.1	3.1	3.0
Woodcock Township	2.0	3.2	2.3	2.3	2.8	2.6	2.1	1.0	3.4

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Wildfire	Terrorism and Cyberterrorism	Transportation Accidents	Urban Fire and Explosion	Winter Storm	Drought	Dam Failure	Extreme Temperatures	Flood
	3.0	**3.0**	**3.0**	**3.0**	**2.9**	**2.8**	**2.7**	**2.7**	**2.6**
Athens Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Beaver Township	2.7	2.7	3.0	2.1	3.3	2.9	1.9	3.1	2.9
Bloomfield Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Blooming Valley Borough	2.4	2.1	2.4	2.1	2.9	2.1	1.7	2.5	2.4
Cambridge Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Cambridge Springs Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Centerville Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.3
Cochranton Borough	1.3	1.3	1.9	1.3	2.8	2.4	1.2	2.3	1.6
Conneaut Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Conneaut Lake Borough	2.4	2.6	3.0	2.1	3.0	2.5	2.5	2.8	2.6
Conneautville Borough	1.6	2.5	2.5	2.5	2.5	2.4	2.5	2.5	2.7
Cussewago Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
East Fairfield Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
East Fallowfield Township	2.1	2.9	2.7	1.9	3	2.5	2.9	3	3.3
East Mead Township	2.7	2.7	3	2.1	3.3	2.9	1.9	3.1	2.9
Fairfield Township	2.7	2.4	2.5	2.1	3.1	3.1	1.9	3.3	3.3
Greenwood Township	1.5	2.5	2.2	1.4	3.1	2.5	1.3	2.4	2.2
Hayfield Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Hydetown Borough	1.3	1	1.6	2.1	3.4	1.9	1	2.2	2.1
Linesville Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Meadville, City of	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Wildfire	Terrorism and Cyberterrorism	Transportation Accidents	Urban Fire and Explosion	Winter Storm	Drought	Dam Failure	Extreme Temperatures	Flood
	3.0	**3.0**	**3.0**	**3.0**	**2.9**	**2.8**	**2.7**	**2.7**	**2.6**
North Shenango Township	2.1	2.9	2.7	1.9	3	2.5	1	3	3.1
Oil Creek Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Pine Township	1.6	2.5	2.2	1.3	2.6	2.5	N/A	2.8	1.7
Randolph Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Richmond Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Rockdale Township	3.4	2.6	1.9	1.9	3.1	2.8	2.7	2.8	2.6
Rome Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Sadsbury Township	2.1	2.9	2.7	1.9	3	2.5	1	3	3.1
Saegertown Borough	1.6	2.5	2.5	2.5	2.5	2.4	2.5	2.5	2.7
South Shenango Township	1.9	1.0	1.8	1.7	1.6	1.5	1.0	1.4	1.7
Sparta Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Spartansburg Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Spring Township	2.5	2.5	1.6	1.9	2.2	1.8	1.4	2.4	1.5
Springboro Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Steuben Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.9
Summerhill Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Summit Township	1.9	1.9	2.8	2.1	2.7	2.6	1.9	3.0	2.6
Titusville, City of	1.0	1.0	1.9	2.1	2.3	1.9	1.0	2.3	2.3
Townville Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Troy Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Union Township	2.8	1.0	2.2	1.3	2.5	1.0	1.0	2.3	1.7

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Wildfire	Terrorism and Cyberterrorism	Transportation Accidents	Urban Fire and Explosion	Winter Storm	Drought	Dam Failure	Extreme Temperatures	Flood
	3.0	**3.0**	**3.0**	**3.0**	**2.9**	**2.8**	**2.7**	**2.7**	**2.6**
Venango Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Venango Township	1.3	1.4	1.4	1.4	2.5	2.3	1.3	1.3	1.7
Vernon Township	2.3	2.6	3.2	2.6	2.6	2.3	2.0	2.4	2.4
Wayne Township	2.7	2.4	2.5	2.1	3.1	3.1	1.9	3.3	3.3
West Fallowfield Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
West Mead Township	1.9	2.8	2.8	2.4	2.7	2.5	2.0	2.7	2.6
West Shenango Township	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Woodcock Borough	3.0	3.0	3.0	3.0	2.9	2.8	2.7	2.7	2.6
Woodcock Township	1.6	2.5	2.5	2.5	2.5	2.4	2.5	2.5	2.7

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Nuclear Incidents	Hazardous Materials – Fixed Facility	Ice Jam	Tornado	Lightning Strike	Disorientation	Hazardous Materials - Transportation	Hurricane and Tropical Storm	Earthquake
	3.0	**3.0**	**2.4**	**2.4**	**2.4**	**2.4**	**2.3**	**2.3**	**2.2**
Athens Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Beaver Township	2.6	1.7	2.4	2.9	2.4	2.4	1.7	2.4	1.8
Bloomfield Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Blooming Valley Borough	1.6	1.6	1.7	3.3	2.9	1.5	2.0	2.6	2.2
Cambridge Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Cambridge Springs Borough	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Centerville Borough	2.6	3.8	2.4	2.7	2.4	2.3	2.3	2.8	1.6
Cochranton Borough	1.3	1.2	1.7	2.9	2.2	1.1	1.3	1.3	1.3
Conneaut Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Conneaut Lake Borough	2.5	2.3	2.1	3.7	2.1	2.1	2..2	2.0	2.2
Conneautville Borough	1.5	1.5	3.0	2.6	1.7	1.0	2.3	1.6	2.2
Cussewago Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
East Fairfield Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
East Fallowfield Township	2.6	2	1.4	3.4	2.2	2.4	2.4	2.3	2.2
East Mead Township	2.6	1.7	2.4	2.9	2.4	2.4	1.7	2.4	1.8
Fairfield Township	3.1	3.0	2.2	3.6	2.2	1.6	2.7	1.9	2.1
Greenwood Township	1.6	1.8	1.7	2.6	2.8	1.6	1.5	1.7	1.9
Hayfield Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Hydetown Borough	1	1	1.4	1.9	2.2	1.3	1	1	1
Linesville Borough	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Meadville, City of	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Nuclear Incidents	Hazardous Materials – Fixed Facility	Ice Jam	Tornado	Lightning Strike	Disorientation	Hazardous Materials - Transportation	Hurricane and Tropical Storm	Earthquake
	3.0	**3.0**	**2.4**	**2.4**	**2.4**	**2.4**	**2.3**	**2.3**	**2.2**
North Shenango Township	2.6	2	1.1	3.4	2.2	2.4	2.4	2.3	2.2
Oil Creek Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Pine Township	N/A	1.8	1.3	2.2	2.2	1.3	1.3	N/A	N/A
Randolph Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Richmond Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Rockdale Township	2.6	2.0	2.4	3.5	2.4	1.6	2.3	2.3	1.6
Rome Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Sadsbury Township	2.6	2.0	1.4	3.4	2.5	2.4	2.4	2.3	2.2
Saegertown Borough	1.5	3.4	3.0	2.3	1.7	1.0	2.9	1.6	2.2
South Shenango Township	1.0	1.6	1.0	1.3	1.3	1.7	2.0	1.0	1.0
Sparta Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Spartansburg Borough	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Spring Township	2.0	1.5	1.2	2.4	2.4	1.6	1.7	1.5	1.8
Springboro Borough	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Steuben Township	2.6	2.6	2.4	2.4	2.4	2.4	2.3	2.3	2.3
Summerhill Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Summit Township	2.1	2.6	2.2	3.0	2.9	1.6	2.3	2.2	2.4
Titusville, City of	1.0	2.3	2.1	3.1	1.9	1.7	2.8	1.0	1.0
Townville Borough	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Troy Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Union Township	1.0	1.0	1.0	2.1	1.9	1.0	2.1	1.0	1.0

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Nuclear Incidents	Hazardous Materials – Fixed Facility	Ice Jam	Tornado	Lightning Strike	Disorientation	Hazardous Materials - Transportation	Hurricane and Tropical Storm	Earthquake
	3.0	**3.0**	**2.4**	**2.4**	**2.4**	**2.4**	**2.3**	**2.3**	**2.2**
Venango Borough	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Venango Township	1.6	1.6	1.3	2.3	2.3	1.3	1.3	1.3	1.3
Vernon Township	2.3	2.2	2.3	2.8	2.2	1.9	2.4	1.9	2.2
Wayne Township	3.1	3.0	2.2	3.6	2.2	1.6	2.7	1.9	2.1
West Fallowfield Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
West Mead Township	1.8	2.5	2.2	2.6	2.4	1.9	2.5	2.0	2.2
West Shenango Township	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Woodcock Borough	3.0	3.0	2.4	2.4	2.4	2.4	2.3	2.3	2.2
Woodcock Township	1.5	3.4	3.0	2.3	1.7	1.0	2.9	1.6	2.2

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Landslide	Subsidence and Sinkhole	Civil Disturbance						
	1.6	**1.6**	**1.3**						
Athens Township	1.6	1.6	1.3						
Beaver Township	1.3	1.3	1.5						
Bloomfield Township	1.6	1.6	1.3						
Blooming Valley Borough	2.0	2.3	2.1						
Cambridge Township	1.6	1.6	1.3						
Cambridge Springs Borough	1.6	1.6	1.3						
Centerville Borough	1.6	1.3	1.6						
Cochranton Borough	1.3	1.6	1.3						
Conneaut Township	1.6	1.6	1.3						
Conneaut Lake Borough	1.4	1.2	2.3						
Conneautville Borough	1.0	1.0	2.0						
Cussewago Township	1.6	1.6	1.3						
East Fairfield Township	1.6	1.6	1.3						
East Fallowfield Township	1.3	1.3	1.8						
East Mead Township	1.3	1.3	1.5						
Fairfield Township	2.1	2.2	1.6						
Greenwood Township	1.3	1.8	1.3						
Hayfield Township	1.6	1.6	1.3						
Hydetown Borough	1	1.3	1						
Linesville Borough	1.6	1.6	1.3						
Meadville, City of	1.6	1.6	1.3						

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Landslide	Subsidence and Sinkhole	Civil Disturbance						
	1.6	**1.6**	**1.3**						
North Shenango Township	1.3	1.3	1.8						
Oil Creek Township	1.6	1.6	1.3						
Pine Township	N/A	1.3	1.3						
Randolph Township	1.6	1.6	1.3						
Richmond Township	1.6	1.6	1.3						
Rockdale Township	1.6	1.3	1.3						
Rome Township	1.6	1.6	1.3						
Sadsbury Township	1.3	1.3	1.6						
Saegertown Borough	1.0	1.0	2.0						
South Shenango Township	1.0	1.0	1.6						
Sparta Township	1.6	1.6	1.3						
Spartansburg Borough	1.6	1.6	1.3						
Spring Township	1.2	1.3	1.6						
Springboro Borough	1.6	1.6	1.3						
Steuben Township	1.6	1.3	1.6						
Summerhill Township	1.6	1.6	1.3						
Summit Township	2.2	1.6	2.1						
Titusville, City of	2.4	1.9	2.3						
Townville Borough	1.6	1.6	1.3						
Troy Township	1.6	1.6	1.3						
Union Township	1.6	1.6	1.0						

Calculated Countywide Risk Factor by Hazard and Comparative Jurisdictional Risk									
IDENTIFIED HAZARD AND CORRESPONDING COUNTYWIDE RISK FACTOR									
JURISDICTION	Landslide	Subsidence and Sinkhole	Civil Disturbance						
	1.6	**1.6**	**1.3**						
Venango Borough	1.6	1.6	1.3						
Venango Township	1.3	1.3	1.6						
Vernon Township	2.2	2.1	1.9						
Wayne Township	2.1	2.2	1.6						
West Fallowfield Township	1.6	1.6	1.3						
West Mead Township	1.5	1.5	2.1						
West Shenango Township	1.6	1.6	1.3						
Woodcock Borough	1.6	1.6	1.3						
Woodcock Township	1.0	1.0	2.0						

4.4.3. Potential Loss Estimates

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

Potential loss estimates have four basic components, including:

Replacement Value: Current cost of returning an asset to its pre-damaged condition, using present-day cost of labor and materials.

Content Loss: Value of building's contents, typically measured as a percentage of the building replacement value.

<u>Functional Loss</u>: The value of a building's use or function that would be lost if it were damaged or closed.

<u>Displacement Cost</u>: The dollar amount required for relocation of the function (business or service) to another structure following a hazard event.

4.4.4. Future Development and Vulnerability

The 2020 census population for Crawford County is 83,938 which is 4,827 fewer than the 2010 census. There was an overall decrease of 5.44% in population based on the data. Four municipalities have seen population increases while the remaining forty-seven had decreases in the period between 2010 and the 2020, except for Hydetown Borough which had no reported population change as identified in *Table 86 – 2010 – 2020 Population Change.*

Table 86 - 2010 – 2020 Population Change

Population Change in Crawford County from 2010-2020			
Municipality	**2010 Census**	**2020 Census**	**Percent of Change 2010-2020**
Athens Township	734	638	-13.08
Beaver Township	902	795	-11.86
Bloomfield Township	1,919	1,861	-3.02
Blooming Valley Borough	337	342	+1.48
Cambridge Township	2,595	2,583	-0.46
Cambridge Springs Borough	1,563	1,448	-7.36
Centerville Borough	218	176	-19.27
Cochranton Borough	1,136	1,121	-1.32
Conneaut Township	1,476	1,334	-9.62
Conneaut Lake Borough	653	625	-4.29
Conneautville Borough	774	736	-4.91
Cussewago Township	1,559	1,430	-8.27
East Fairfield Township	922	836	-9.33
East Fallowfield Township	1,620	1,516	-6.42
East Mead Township	1,493	1,321	-11.52
Fairfield Township	1,023	1,011	-1.17
Greenwood Township	1,454	1,424	-2.06
Hayfield Township	2,940	2,776	-5.58
Hydetown Borough	526	526	0
Linesville Borough	1,040	961	-7.60

Population Change in Crawford County from 2010-2020			
Municipality	**2010 Census**	**2020 Census**	**Percent of Change 2010-2020**
Meadville, City of	13,388	13,050	-2.52
North Shenango Township	1,410	1,274	-9.65
Oil Creek Township	1,877	1,702	-9.32
Pine Township	462	432	-6.49
Randolph Township	1,782	1,718	-3.59
Richmond Township	1,475	1,352	-8.34
Rockdale Township	1,506	1,363	-9.50
Rome Township	1,840	1,993	+8.32
Sadsbury Township	2,933	2,752	-6.17
Saegertown Borough	997	869	-12.84
South Shenango Township	2,037	1,831	-10.11
Sparta Township	1,832	1,910	+4.26
Spartansburg Borough	305	277	-9.18
Spring Township	1,548	1,407	-9.11
Springboro Borough	477	376	-21.17
Steuben Township	804	773	-3.86
Summerhill Township	1,236	1,197	-3.16
Summit Township	2,027	1,902	-6.17
Titusville, City of	5,601	5,262	-6.05
Townville Borough	323	326	+0.93
Troy Township	1,235	1,053	-14.74
Union Township	1,010	857	-15.15
Venango Borough	239	210	-12.13
Venango Township	997	941	-5.62
Vernon Township	5,630	5,310	-5.68
Wayne Township	1,539	1,408	-8.51
West Fallowfield Township	605	577	-4.63
West Mead Township	5,249	5,040	-3.98
West Shenango Township	504	435	-13.69
Woodcock Borough	157	140	-10.83
Woodcock Township	2,856	2,756	-3.50
Crawford County	**88,765**	**83,938**	**-5.44**
Source: United States Census Bureau (2023), 2020 Census Data			

The 2019 census estimates indicates that there are approximately 42,234 housing units in Crawford County, Pennsylvania. Of those, 33,191 of the structures are occupied-housing units. The county-wide population changes indicate a potential alteration to overall hazard vulnerability. Municipalities that undergo widespread population reductions may have more difficulty meeting personnel demands than expanding jurisdictions. However, certain municipalities experienced significant resident increases and, thus, may be more vulnerable to certain hazards due to development and residential growth. Although expanding population zones may be especially vulnerable to hazards outlined in section 4.3 of this hazard mitigation plan update, natural and human caused hazards could potentially occur at any time regardless of population change. The Crawford County Hazard Mitigation Local Planning Team will conduct annual reviews of this plan and the impacts all hazards have on the county and new development every year and within a time frame after a disaster or major emergency.

5. Capability Assessment

5.1. Update Process Summary

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

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

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

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

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

5.2. Capability Assessment Findings

All of the fifty-one municipalities in Crawford County completed and submitted a capability assessment survey. The results of the survey were collected, aggregated, and analyzed.

Each plan participant has some ability to expand and improve upon their administrative and technical capabilities following this plan update and during an update process. The municipalities of Crawford County could improve upon these capabilities by first reviewing the capability assessment forms submitted during this update process and identifying areas of growth based off of these forms. A comprehensive review is within the power of each municipality of Crawford County to see what departments, commissions, boards, and staff they have available to assist in each aspect of capability assessments. Each municipality, as a plan participant, should assess if they have the ability to improve in these areas during an annual review process or during the next hazard mitigation plan update. The plan participants should also review their ability to improve the financial capabilities by reviewing funding and funding sources and researching other funding sources for hazard mitigation processes. Each plan participant can improve their education and outreach capabilities by increasing public event participation and education events that they attend in the county.

5.2.1. Planning and Regulatory Capability

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

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

Building Codes

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

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

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

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

The municipalities in Crawford County adhere to the standards of the Pennsylvania Uniform Code (Act 45). Thirty-eight of the fifty-one municipalities in Crawford County have opted-in on the Uniform Construction Code (UCC). Crawford County does not have its own building code enforcement, rather all enforcement is done at the municipal level.

Zoning Ordinance

Article VI of the Municipalities Planning Code (MPC) authorizes municipalities to prepare and enact zoning to regulate land use. Its regulations can apply to the permitted use of land, the height and bulk of structures, the percentage of a lot that may be occupied by buildings and other impervious surfaces, yard setbacks, the density of development, the height and size of signs, and the parking regulations. A zoning ordinance has two parts, including the zoning map that delineates zoning districts and the text that sets forth the regulations that apply to each district.

Subdivision Ordinance

Subdivision and land development ordinances include regulations to control the layout of streets, the planning lots and the provision of utilities and other site improvements. The objectives of subdivision and land development ordinance are to coordinate street patterns, to assure adequate utilities and other improvements are provided in a manner that will not pollute streams, wells and/or soils, to reduce traffic congestions, and to provide sound design standards as a guide to developers, the elected officials, planning commissions, and other municipal officials. Article V of the Municipality Planning Code authorizes municipalities to prepare and enact a subdivision and land development ordinance. Subdivision and land development ordinances provide for the division and improvement of land. Of the fifty-one municipalities in Crawford County, twenty-nine have adopted their own subdivision ordinance, and twenty-seven have adopted their own zoning ordinance. Some have subdivision/land use ordinances, some have zoning regulations – some have both and some have neither (Crawford County Planning Commission, April 2024).

Stormwater Management Plan/Stormwater Ordinance

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

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

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 Code (MPC Act 247 of 1968, as reauthorized and amended) requires counties to prepare and maintain a county comprehensive plan. In addition, the MPC requires counties to update the comprehensive plan every ten years.

Regarding hazard mitigation planning, Section 301.a(2) of the Municipality Planning Code requires comprehensive plans to include a plan for land use, which, among other provisions, suggests that the plan consider 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 that recommends considering storm drainage and floodplain management.

Crawford County adopted their comprehensive plan on August 08, 2024. The previous Crawford County comprehensive plan was adopted in 2014.

Article III of the MPC enables municipalities to prepare a comprehensive plan: however, development of a comprehensive plan is voluntary. Forty-one of the fifty-one municipalities in Crawford County have adopted their own comprehensive plans, with only eleven of the plans being from the year 2000 or later (Crawford County Planning, April 2024).

Capital Improvements Plan

The capital improvements plan is a multi-year policy guide that identifies needed capital projects and is used to coordinate the financing and timing of public improvements. Capital improvements relate to streets, storm water systems, water distribution, sewage treatment, and other major public facilities. A capital improvements plan should be prepared by the respective county's planning department and should include a capital budget. This budget identifies the highest priority projects recommended for funding in the next annual budget. The capital improvements plan is dynamic and can be tailored to specific circumstances.

Participation in the National Flood Insurance Program (NFIP)

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

The Pennsylvania Emergency Management Agency (PEMA) was appointed by legislation in September 2021 to coordinate the Commonwealth NFIP and employ the State NFIP Coordinator. For many years prior, these roles were held by the Pennsylvania Department of Community and Economic Development (DCED), which still offers support to communities through its Floodplain Mitigation Program. PEMA provides communities, based on CFR Title 44, Section 60.3 level of regulations, with a suggested ordinance document to assist municipalities in meeting the minimum requirements of the NFIP along with the Pennsylvania Flood Plain Management Act (Act 166). These suggested or model ordinances contain provisions that are more restrictive than state and federal requirements. Suggested provisions include, but are not limited to, the below.

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

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

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

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

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

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

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

FEMA Region III makes available to communities an ordinance review checklist which lists required provisions for floodplain management ordinances. This checklist helps communities develop an effective floodplain management ordinance that meets federal requirements for participation in the NFIP. PEMA provides communities, based on their 44 CFR 60.3 level of regulations, with a suggested ordinance document to assist municipalities in meeting the minimum requirements of the NFIP and the Pennsylvania Flood Plain Management Act (Act 166). Act 166 mandates municipal participation in and compliance with the NFIP. It also established higher regulatory standards for hazardous materials and high-risk land uses. As new Digital Flood Insurance Rate Maps (DFIRMs) are published, the Pennsylvania State NFIP Coordinator at DCED works with communities to ensure the timely and successful adoption of an updated floodplain management ordinance by reviewing and providing feedback on existing and draft ordinances.

According to the State NFIP Coordinator, all fifty-one municipalities in Crawford County have floodplain regulations in place that meet requirements set forth by the NFIP. Currently, no municipalities have completed or started to complete the CRS program. Additional research will be conducted on the CRS program and mitigation actions will be developed in support of the CRS.

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

Each community within Crawford County should identify their procedures for substantial improvement and substantial damage implementation in their floodplain management ordinance. This is a concern for local municipalities and plan participants if those locations are not aware of where their floodplain management ordinance is located, or what is in the ordinance. Each municipality may have different processes and procedures in place for substantial improvement and substantial damage following an event. Floodplain management ordinance maintenance, access, and implementation can be a challenge for municipalities and local governments, and this also relates to the availability of information on SI/SD.

During this hazard mitigation plan update, a previous National Flood Insurance Program (NFIP) survey was used. This document was utilized and distributed to the municipalities prior to the "Checking In on the NFIP" document being provided to MCM Consulting Group, Inc. The "Checking In on the NFIP" document was not distributed to municipalities, so they did not have two separate versions of the NFIP survey. This new document will be used for future hazard mitigation plan development in Crawford County.

5.2.2. Administrative and Technical Capability

There are fourteen boroughs, thirty-five townships, and two cities within Crawford County. Each of these municipalities conduct daily operations and provide various community services according to local needs and limitations. Some of these municipalities have formed cooperative agreements and work jointly with their neighboring municipalities to provide services such as police protection, fire and emergency response, infrastructure maintenance, and water supply management. Other municipalities choose to operate independently and provide such services internally. Municipalities vary in staff size, resource availability, fiscal status, service provision, constituent population, overall size, and vulnerability to the profile hazards. Technical capability relates to an adequacy of knowledge and technical expertise of local government employees or the ability to contract resources for this expertise in order to effectively execute mitigation activities. Common examples of skill sets, and technical personnel needed for hazard mitigation include: planners with knowledge of land development and 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 education of expertise to assess community vulnerability to hazards, personnel skilled in geographic information systems, resource development staff or grant writers, fiscal staff to handle complex grant application processes.

County Planning Commission

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

Municipal Engineer

A municipal engineer performs duties as directed in the areas of construction, reconstruction, maintenance and repair of streets, roads, pavements, sanitary sewers, bridges, culverts, and other engineering work. The municipal engineer prepares plans, specifications and estimates of the work undertaken by the township. Most municipalities in Crawford County have a municipal engineer under contract to perform these duties.

Personnel Skilled in GIS or FEMA HAZUS Software

A geographic information system (GIS) is an integrated, computer-based system designed to capture, store, edit, analyze, and display geographic information. Some examples of uses for GIS technology in local government are land records management, land use planning, infrastructure management, and natural resources planning. A GIS automates existing operations such as map production and maintenance, saving a great deal of time and money. The GIS also includes information about map features such as the capacity of a municipal water supply or the acres of public land. GIS data is managed, maintained, and developed by a Crawford County GIS Department, which is available to assist all the county's municipalities. GIS data is an important tool to use in hazard mitigation planning and is instrumental in assessing the risk of municipalities to various hazards.

Emergency Management Coordinator

Emergency management is a comprehensive, integrated program of mitigation, preparedness, response, and recovery for emergencies/disasters of any kind. No public or private entity is immune to disasters and no single segment of society can meet the complex needs of a major emergency or disaster on its own. Hence, the National Preparedness Goal of 2011 also defines what it means for the whole community to be prepared for all types of disasters and emergencies and lists five mission areas which support preparedness: prevention, protection, mitigation, response, and recovery – doubling the emphasis on mitigation activities in an emergency management program.

The Pennsylvania Emergency Management Services Code (PA Title 35) requires Crawford County and its municipalities to have an emergency management coordinator.

The Crawford County Department of Public Safety coordinates countywide emergency management efforts. Each municipality has a designated local emergency management coordinator who possesses a unique knowledge of the impact hazardous events have on their community.

A municipal emergency management coordinator is responsible for emergency management – preparedness, response, recovery, and mitigation within his/her respective authority having jurisdiction (AHJ). The responsibilities of the emergency management coordinator are outlined in PA Title 35 §7633.

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

PA Title 35 requires that all municipalities in the Commonwealth have a local emergency operations plan (EOP) which is updated every two years. A majority of Crawford County municipalities have adopted their own EOP.

Federal Agency Assistance

There are many federal agencies that can provide technical assistance for mitigation activities, and these include, but are not limited to:

- United States Army Corps of Engineers (USACE)
- Department of Housing and Urban Development (HUD)
- Department of Agriculture (DOA)
- Economic Development Administration
- Emergency Management Institute (EMI)
- Environmental Protection Agency (EPA)
- Federal Emergency Management Agency (FEMA)
- Small Business Administration (SBA)

State Agency Assistance

There are many commonwealth agencies that can provide technical assistance for mitigation activities, and these include but are not limited to:

- Pennsylvania Emergency Management Agency (PEMA)
- Pennsylvania Department of Community and Economic Development
- Pennsylvania Department of Conservation and Natural Resources
- Pennsylvania Department of Environmental Protection

In addition to the institutional capability of the municipal government structure described above, the county itself can engage in mitigation activities. The county has its own staff, resources, budget, and objectives, which may or may not be like those of its constituent municipalities. Therefore, the county has its own capabilities to mitigate the profiled hazards through planning and coordination of local mitigation efforts. The Crawford County GIS Department can provide needed skills in the analysis of geographic data. Other local organizations that can and do act as partners include the Crawford County Planning Commission, the Crawford County Conservation District, the Crawford County Active Aging, Inc., the Crawford County Fire Commission, business development organizations, and historical or cultural agencies.

Existing Limitations

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

5.2.3. Financial Capability

Fiscal capability is significant to the implementation of hazard mitigation activities. Every jurisdiction must operate within the constraints of limited financial resources. The decision and capacity to implement mitigation-related activities is often strongly dependent on the presence of financial resources. While some mitigation actions are less costly than others, it is important that money is available locally to implement policies and projects. Financial resources are particularly important if communities are trying to take advantage of state or federal mitigation grant funding opportunities that require local-match contributions. The following information pertains to various financial assistance programs relevant to hazard mitigation.

State and Federal Grants

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

Grant programs that may be utilized to accomplish hazard mitigation objectives include the: Pennsylvania Department of Community and Economic Development Community Development Block Grant (CDBG); Land Use Planning and Technical Assistance (LUPTAP); Shared Municipal Services (SMS); Community Revitalization (CR) and Floodplain Land Use Assistance Programs; the PA DEP's Growing Greener; Act 167 Stormwater Management; Source Water Protection; and Flood Protection Programs. The Flood Protection Programs include the PA DCNR's Community Conservation Partnership Program, PEMA's Pre-Disaster Mitigation (PDM) Grant, Flood Mitigation Assistance Grant Programs (FMA), and Hazard Mitigation Grant Program.

Below are some of the other state programs that may provide financial support for mitigation activities:

- DCED Flood Mitigation Program
- DCED H2O PA Flood Control Projects
- DCED H2O PA High Hazard Unsafe Dam Projects
- DCED H2O PA Water Supply, Sanitary Sewer and Storm Water Projects
- DCED PA Small Water and Sewer
- DCNR Community Conservation Partnerships Program
- DCNR Pennsylvania Heritage Areas Program
- DCNR Pennsylvania Recreational Trails Program
- DCNR Land and Water Conservation Fund

Below are some of the federal programs that may provide financial support for mitigation activities:

- FEMA Community Assistance Program – State Support Services Element (CAP-SSSE)
- FEMA Community Disaster Loan Program
- FEMA Community Rating System
- FEMA Emergency Management Performance Grants (EMPG)
- FEMA Environmental Planning and Historic Preservation Program (EHP)
- FEMA Flood Mitigation Assistance Program
- FEMA Hazard Mitigation Grant Program (HMGP)
- FEMA Individuals and Households Program (IHAP)
- FEMA National Dam Safety Program
- FEMA National Flood Insurance Program

- FEMA Pre-Disaster Mitigation Program
- FEMA Public Assistance Program (PA)
- FEMA Regional Catastrophic Preparedness Grant Program
- FEMA Repetitive Flood Claims Program (RFC)
- FEMA Severe Repetitive Loss Grant Program
- USACE Continuing Authorities Program
- USACE Flood Plain Management Services Program (FPMS)
- USACE Inspection of Completed Works Program (ICW)
- USACE National Levee Safety Program
- USACE Planning Assistance to States
- USACE Rehabilitation and Inspection Program (RIP)

Capital Improvement Financing

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

Indebtedness through General Obligation Bonds

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

Municipal Authorities

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

Sewer Authorities

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

Water Authorities

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

U.S. Department of Agriculture Circuit Riding Program (Engineer)

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

5.2.4. Education and Outreach

The Crawford County Department of Public Safety conducts public outreach at public events to update the citizens and visitors of the county on natural and human-caused hazards. The county conservation district also conducts outreach on various activities and projects in the county.

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

Newly appointed emergency management coordinators are trained in both duties and responsibilities and damage assessment – which includes a discussion on mitigation; this training can be translated into teaching municipal employees or local emergency services to assist them during a disaster.

The county also has several websites and social media accounts that can educate residents about hazard mitigation and risk while also communicating information in the event of a disaster:

Crawford County Department of Public Safety Webpage:
https://www.crawfordcountypa.net/PublicSafety/Pages/home.aspx

Crawford County Department of Public Safety Facebook:
https://www.facebook.com/CrawfordCounty911/

The Crawford County GIS Department website has an education and outreach capability, particularly with the county map viewer, which could be updated to include hazard mitigation data. The websites of the Crawford County Department of Public Safety and the Crawford County Planning Commission also post information to educate residents, particularly in disaster preparedness, floodplain management, and zoning requirements. The Crawford County Planning Commission currently provides access to planning documents and educational brochures about the benefits of planning and helpful guides. The Department of Public Safety also holds quarterly Local Emergency Planning Committee (LEPC) meetings that are open to the public, which serve as another means to conduct outreach and educate the public about hazard mitigation.

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

5.2.5. Plan Integration

Plan integration recognizes that hazard mitigation is most effective when it works in efficient coordination with other plans, regulations, and programs. Plan integration promotes safe, resilient growth, effective management, an overall reduction of risk, by ensuring that the goals and actions established in the Hazard Mitigation Plan are included in the comprehensive planning efforts so they can affect future land use and development. Some of the most important areas of planning and regulatory capabilities which hazard mitigation goals and actions should be integrated include comprehensive plans, the hazard mitigation plans from all surrounding or encompassing areas, EOPs, building codes, floodplain ordinances, subdivision, land development ordinances, stormwater management plans and ordinances, and zoning ordinances. All of these tools provide mechanisms for the implementation of adopted mitigation strategies.

Crawford County Comprehensive Plan (Crawford Inspired)

Overview

Comprehensive plans establish the overall vision, goals, and objectives for a community's growth. The Crawford County Comprehensive Plan was adopted by the Crawford County Commissioners in 2014. The plan is a collaborative effort between communities and populations in Crawford County and contains both regional priorities and action plans for each community in the county. The plan establishes countywide goals and objectives, describes environmental and demographic characteristics, identifies potential capital improvement projects, and inventories existing planning initiatives and tools in the county.

As part of the update process, the goals and objectives in the 2014 Comprehensive Plan were reviewed, and those that are currently supportive of hazard mitigation goals and principles were identified. The plan also identified opportunities to integrate goals and objectives from the Hazard Mitigation Plan into the next update of the comprehensive plan.

Recommendations for Continued and Future Integration

As discussed, many of the goals and objectives outlined in the Crawford County Comprehensive Plan are related to the hazard mitigation risks and goals established in the HMP. Several could be revised to include updated information from this HMP. Additionally, the comprehensive plan can identify the places of higher vulnerability that are identified in this plan for all the high-risk hazards, and include objectives aimed at reducing the risk to these vulnerable areas. For example, an objective of the comprehensive plan could be to encourage elevation and flood proofing of structures in the Special Flood Hazard Area (SFHA) by seeking Flood Mitigation Assistance (FMA) grants and strictly enforcing floodplain management ordinances in certain communities (See Section 4.3.3 for Flooding and Flash Flooding information). Similarly, an objective for communities that are most vulnerable to subsidence and land failure could be to educate property owners about mine subsidence, associated risks, and actions to take in the event of an emergency. These types of objectives could also be created for medium-risk hazards when appropriate.

Another key opportunity for further integration of hazard mitigation into planning and regulatory tools is to incorporate hazard mitigation goals and objectives into the ongoing Crawford County Comprehensive Plan update. The Crawford County Comprehensive Plan also ties into the Crawford County Hazard Mitigation Plan when mitigation strategy is considered. The mitigation principles outlined in this hazard mitigation plan are used and reviewed in long-range planning throughout Crawford County.

Recommendations for Continued and Future Integration

While Crawford County does not have its own long range transportation plan, the county does participate and engage with the Northwest Regional Planning Organization and the Transportation Advisory Committee. The Northwest PA Commission 2050 Long-Range Transportation Plan was recently adopted by the committee on March 26, 2024. Crawford County Planning holds a seat on the Long-Range Transportation Plan Steering Committee and the Northwest RPO Transportation Advisory Committee. There are several opportunities to integrate hazard mitigation into the long-range transportation plan (LRTP). The plan could discuss hazards that may potentially impact transportation systems, such as extreme weather and other natural hazards. The plan could also inventory vulnerable assets, identify evacuation routes, and discuss the need for redundancy in the transportation network in the event of hazard or hazard event. Additionally, hazard mitigation could be discussed in more detail in the plan. Instead of solely discussing mitigation of environmental impacts of transportation projects in this section, this section could also describe how reducing impacts on the environment can mitigate hazards. For example, integrating stormwater management improvements into roadway projects not only reduces pollution in nearby waterways, but it can also alleviate the impacts of floods. Likewise, mitigating hazard impacts will help preserve transportation infrastructure throughout Crawford County.

Integration of Hazard Mitigation into Local Mechanisms

Integration of hazard mitigation principles into local mechanisms can be efficient for Crawford County. With fifty-one municipalities, local mitigation mechanisms can directly interface with the Crawford County HMP. These potential integration items include municipal comprehensive plans, municipal flood plans, or development plans for transportation and community resources. The municipalities should review the completed HMP and utilize items identified in the risk assessment, mitigation strategy, and capability assessment sections. Previously, hazard mitigation information from the Crawford County plans has been integrated into other planning mechanisms. All municipalities can also utilize portions of the hazard mitigation plan into their planning mechanisms, but this can be completed under the authority of Crawford County. These planning mechanisms could include comprehensive plans, flood plans, or development plans for transportation. Previous successful mitigation and plan integration has occurred in the development of comprehensive plans at the local level and this information and integration should continue through the formal update process of all plans in Crawford County.

Further discussion on plan integration can be found in section 7.3 of this hazard mitigation plan.

6. Mitigation Strategy

6.1. Update Process Summary

Mitigation goals are general guidelines that explain what the county wants to achieve. Goals are usually expressed as broad policy statements representing desired long-term results. Mitigation objectives describe strategies or implementation steps to attain the identified goals. Objectives are more specific statements than goals; the described steps are usually measurable and can have a defined completion date. There were five goals, and nine objectives identified in the 2020 hazard mitigation plan. The 2025 Crawford County Hazard Mitigation Plan Update has five goals and sixteen objectives. Objectives have been added and arranged in order to associate them with the most appropriate goal. These changes are noted in *Table 87 – 2020 Mitigation Goals and Objectives Review*. These reviews are based on the five-year hazard mitigation plan review worksheet, which includes a survey on existing goals and objectives completed by the local planning team. Municipal officials then provided feedback on the changes to the goals and objectives via a mitigation strategy update meeting. Copies of these meetings and all documentation associated with the meetings are located in Appendix C.

Actions provide more detailed descriptions of specific work tasks to help the county, and its municipalities achieve prescribed goals and objectives. There were eighty-nine actions identified in the 2020 mitigation strategy. A review of the 2020 mitigation actions was completed by the local planning team. The results of this review are identified in *Table 88 – 2020 Mitigation Actions Review*. Actions were evaluated by the local planning team with the intent of carrying over any actions that were not started or continuous for the next five years.

Table 87 - 2020 Mitigation Goals and Objectives Review

Crawford County 2020 Mitigation Goals and Objectives		
Goal/Objective	**Description**	**Comment**
Goal 1	**Protect lives, property, environmental quality, and resources of the Commonwealth, including high risk properties.**	**2025 Review Comment:** The verbiage was updated to include the unserved, underserved, and the socially vulnerable.

Crawford County 2020 Mitigation Goals and Objectives		
Goal/Objective	**Description**	**Comment**
Objective A	Ensure adequate training and resources for emergency organizations and personnel by developing and distributing public awareness materials about natural hazard risks, preparedness, mitigation, and emergency response.	**2025 Review Comment:** The verbiage was updated to include resource availability for all levels of government. This objective was integrated into new Objective 1.1
Objective B	Target owners of properties within identified hazard areas for additional outreach regarding mitigation and disaster preparedness actions 19, 20, 28, 39, and 48.	**2025 Review Comment:** Verbiage updated. This objective was integrated into new Objective 1.2.
Goal 2	**Enhance consistent coordination, collaboration, and communications among stakeholders to improve response and recovery.**	**2025 Review Comment:** The verbiage was updated to focus on flood-related issues.
Objective A	Mitigate existing structures and infrastructure located in high hazard areas.	**2025 Review Comment:** The verbiage was updated to incorporate language on demolition and reconstruction. This action was integrated into new Objective 2.1.
Objective B	Evaluate and update existing floodplain ordinances to meet or exceed the NFIP standards actions.	**2025 Review Comment:** This objective was retired as an objective and was integrated into new Action 2.2.1.
Objective C	Improve the enforcement of existing floodplain regulations.	**2025 Review Comment:** This verbiage was updated to become more comprehensive and was integrated into new Objective 2.2.
Goal 3	**Provide framework for active hazard mitigation planning and implementation including the Whole Community.**	**2025 Review Comment:** This verbiage was updated to focus on reducing the impacts of identified hazards.

Crawford County 2020 Mitigation Goals and Objectives		
Goal/Objective	**Description**	**Comment**
Objective A	Assess vulnerability of transportation systems and assets located in hazard areas.	**2025 Review Comment:** This objective was retired as an objective and integrated into new Action 3.1.1.
Objective B	Conduct a hazardous materials survey to better understand the nature and extent of hazardous materials risk throughout the county.	**2025 Review Comment:** This objective was retired as an objective and integrated into new Action 3.1.1.
Goal 4	Build legislative and other organizational support and leverage funding for mitigation efforts.	**2025 Review Comment:** This goal was retired as a goal and integrated new Objective 3.2.
Objective A	The county will work with their state agencies and legislature to support grant funding efforts to benefit hazard mitigation projects identified in the plan.	**2025 Review Comment:** This objective was retired as an objective an integrated into new Actions 3.2.1, 3.2.3, 3.3.2, and 5.2.4.
Goal 5	**Increase awareness, understanding, and preparedness across all sectors.**	**2025 Review Comment:** This verbiage was updated and integrated into new Goal 4.
Objective A	Partner with news media, schools, and businesses to promote mitigation and preparedness in the community.	**2025 Review Comment:** The verbiage was updated and integrated into new Objective 4.1.

Table 88 - 2020 Mitigation Actions Review

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	*Status*					*Review Comments*
	No Progress/ Unknown	In Progress/Not Yet Complete	Continuous	Completed	Discontinued	
Table 8.4-1.1 To install a system in the center of the borough that all residents in the borough can hear in an emergency.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.2 Rehabilitate the dam per NRCS design and recommendations. Design phase kicked off in the early fall of 2020.		X				**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.3 Provide personal protective equipment and barriers to critical employees.				X		**2025 Review Comment:** This action was completed.
Table 8.4-1.4 Road needs to be widened2. Trees need to be removed 3. Actual landscaping needs to be altered to cut back on the blindness of the corner.4. Bank needs to be so you can at least see what is coming.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.5 The action we would like to take to mitigate the Canadohta Lake Dam is either repair or replacement.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.6 Remove sediment and fallen tree branches, support the bank where it is eroding and increase the size of the pipe under State Street so that the storm water flows freely and doesn’t back up causing flooding.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Table 8.4-1.7 Our town hall building is large with 2 levels, 2 kitchenettes, 2 bathrooms, plenty of tables and chairs and within walking distance for most borough residents. This makes it a good location for a warming center in the event of a extended power outage or other type of emergency where a shelter is required. We would like to install a Generac type generator for the building that would power the building in the event that the power would be out for an extended period.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.8 Install Structures upstream that would prevent an ice jam from forming in locations were flooding could have a serious financial impact.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.9 Hire contractors to perform roadside tree trimming and tree removals.			X			**2025 Review Comment:** This action was discontinued and integrated into Goal 3.
Table 8.4-1.10 Mitigation should include an engineering study to design and implement bank stabilization, dredging of the stream bed and inspection and repair and / or replacement of the Breed Street Bridge.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	*Status*					*Review Comments*
	No Progress/ Unknown	In Progress/Not Yet Complete	Continuous	Completed	Discontinued	
Table 8.4-1.11 For the 1st problem, tree cutting companies will be contacted and estimates will be requested. The affected sections of the roads mentioned will be shown to them and quotations will be obtained. After quotes have been received, a determination will be made as to the affordability that this service can be obtained. For the 2nd problem, the affected municipal services will be contacted to request input and cost estimates. In addition, separate estimates will be required from contractors with large excavation equipment, capable of removing and replacing this size of culvert pipe. All materials and partial labor will be provided by the township for this phase. After all costs have been obtained a decision will be made regarding this project.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.12 The preferred alternative would be an ice boom or weir to catch and control ice above town in areas with less damage potential.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	**Status** No Progress/ Unknown	In Progress/Not Yet Complete	Continuous	Completed	Discontinued	*Review Comments*
Table 8.4-1.13 Buy a 10 minute escape breathing device...the plant operator said he did not need a 30 minute tank like the firemen would need Page 1483SDSSpecsSummaryMore Like ThisJust For YouPart#: 50254Weight: 11.0 lbsBrand: Scott Health & Safety(HM) ELSA 10 Min. Emergency Escape Breathing Device Escape quickly and safely with 5 or 10 minute units Provides 360° visibility Refillable cylinders Price:$659.95Need Help? Call 800-548-1234The ELSA Emergency Escape Breathing Device gives you the protection to buy a 10 minute escape, breathing device from bluebook.com	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.14 Significant evaluation (condition assessment/videoing, pipe size field verification, watershed modeling, etc.) of this portion of the City's stormwater system is needed to address regular flooding.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.15 A prior condition assessment has revealed that complete replacement is recommended.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.16 Provide Meadville and other Crawford County municipalities with resources to adequately protect municipal data. Perhaps establish a County-wide IT security consortium that provides consulting to initially evaluate IT security risk.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.17 Purchase a three phase mobile generator that can be used at either water well.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Table 8.4-1.18 Distribute public information over social media and news media of winter storm forecasts and updated situational awareness.			X			**2025 Review Comment:** The verbiage was updated to be all-hazards in application. This action was integrated into new Action 4.3.1.
Table 8.4-1.19 Work with the land owner to install better drainage on the land to divert the water.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.20 PennDOT needs to update its infrastructure, drainage pipes and storm sewer underdrainage prior to installation of new blacktop roadway now in the engineering stages. West Mead Township will be involved as some swales and drainage easements and maintenance may be necessary involving private property owners.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.21 Encourage municipalities to enforce zoning and building codes to not have structures built in landslide areas.			X			**2025 Review Comment:** The verbiage was updated and integrated into new Action 2.2.2.
Table 8.4-1.22 We would like to trim the trees that have a high probability of falling on power lines if there is a storm.					X	**2025 Review Comment:** This action was removed from the plan and integrated into new Action 3.1.5.
Table 8.4-1.23 Develop a new municipal water well.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.24 We would like to install a dry hydrant in the lake that is easily accessible to the responding fire departments. This would give us year-round accessibly.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.25 Trim Trees in the ROW as needed throughout the township.					X	**2025 Review Comment:** The verbiage was updated and integrated into new Action 2.2.2.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Table 8.4-1.26 Condition assessment with planned section replacement in order of priority at the recommendation of the City's Engineer.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.27 The soil that the dam was built with does not meet the current federal requirements and is in need of repairs.					X	**2025 Review Comment:** This action was discontinued and removed from the 2025 mitigation action plan.
Table 8.4-1.28 The project to mitigate stormwater through stormwater improvements will be extremely costly and a tremendous financial hardship on West Fallowfield Township as a very small municipality. Proposed improvements being considered consist of the construction of a new stormwater management detention basin and storm sewer, stabilization of the open ditches with check dams to control stormwater runoff velocity, repair, restore and armor the roadway edge of pavement, roadway resurfacing, and pavement markings. The intent of the project is to provide a long-term solution for the safety of the travelling public, the management of stormwater runoff along the roadway, and to provide a significant improvement for the property owners and residents located on this roadway by restoring and reopening the original egress and ingress that was previously used by the property owners located on Rocky Glen Road.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	*Status*					*Review Comments*
	No Progress/ Unknown	In Progress/Not Yet Complete	Continuous	Completed	Discontinued	
Table 8.4-1.29 Enlarge and realign the drainage pipe and replace head and wing walls. Remove gravel bars, stabilize the stream banks with vegetation and grade and profile outlet area.			X			**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.30 Encourage municipalities to enforce zoning and building codes to prohibit building in earthquake areas.					X	**2025 Review Comment:** This action was discontinued and integrated into new Action 2.2.2.
Table 8.4-1.31 Remove two buildings and turn properties into green space.				X		**2025 Review Comment:** This action was completed.
Table 8.4-1.32 We would like to replace this pipe with a 30" pipe and to clear the area at the end for more effective drainage.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.33 Provide program for homeowners to install rain barrels and/or dry wells to help control storm water runoff from houses.					X	**2025 Review Comment:** This action was discontinued and integrated into new Action 2.2.1.
Table 8.4-1.34 Make culvert pipe larger, longer. and deeper depending on the water direction. More control on pipe entrances to handle the water.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.35 Trim trees in the vicinity of utility lines throughout the Township, with the co-operation of the electric & phone companies.					X	**2025 Review Comment:** This action was discontinued and integrated into new Action 3.1.5.
Table 8.4-1.36 Council will authorize the removal of trees that pose a possible issue near powerlines within the Borough limits.					X	**2025 Review Comment:** This action was discontinued and integrated into new Action 3.1.5.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	*Status*					*Review Comments*
	No Progress/ Unknown	In Progress/Not Yet Complete	Continuous	Completed	Discontinued	
Table 8.4-1.37 Remove trees so the road can dry out. Enhance storm water runoff.					X	**2025 Review Comment:** This action was discontinued and integrated into new Action 3.1.5.
Table 8.4-1.38 Coordinate with utility companies and property owners to conduct tree trimming/removal projects throughout the township where necessary.					X	**2025 Review Comment:** This action was discontinued and integrated into new Action 3.1.5.
Table 8.4-1.39 Replacement of the existing culvert with a substantially larger 5' x 12' precast concrete box culvert capable of handling the appropriate water volume based on hydraulic calculations performed by a certified engineer. Create inlet and outlet protection surrounding the new culvert. Make stormwater improvements to stabilize the ditches on the north and south side of the culvert. Replace roadway asphalt in the location of the culvert replacement. The estimated project roadway corridor length is approximately 1,400 lineal feet.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.40 Contact information for utility companies and road crew on Township website. Cooperation with the fire department on clean up. No other action planned.					X	**2025 Review Comment:** This action was discontinued and integrated into new Action 4.3.1.
Table 8.4-1.41 We are planning to replace a section of the old drainage pipe that has had some problems in the past.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.42 Obtaining permit to be in the creek; using excavator to remove bar and realign creek.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	*Status*					*Review Comments*
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Table 8.4-1.43 Gaswell Rd - Add crossover pipes to control erosion of banks and ditches.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.44 Replace Stone Culvert with proper sizing of culvert pipe and road improvement and covering.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.45 Repair the approaches and abutments and further stabilization of the under girth of the bridge structure itself.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.46 Installation of guide rails. Make further repairs to stabilize the bridge of the under girth of the bridge structure itself. Both ends of the bridge approaches needs repaired.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.47 Remove existing pipes and replace with one large arch pipe big enough to handle all the water.	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.48 At this time, we do not have an immediate solution as this is a private property issue but in need of attention. We have requested assistance over many years to help mitigate the problem. We have been unable to secure any assistance from FEMA/PEMA or any state or local agencies at this time.					X	**2025 Review Comment:** This action was discontinued and removed from the plan.
Table 8.4-1.49 Crawford County should conduct another hazardous materials commodity flow study to evaluate what hazardous materials are stored, used, and transported in Crawford County.				X		**2025 Review Comment:** This action was completed through the 2023 Crawford County Commodity Flow Study.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Table 8.4-1.50 Update the Crawford County Department of Public Safety, Planning, and GIS web-sites with updated information to protect the public.			X			**2025 Review Comment:** This action was integrated into new Actions 4.3.1, 5.1.1, and 5.2.3.
Table 8.4-1.51 Culverts - replace culvert with up-to-date pipe and build a substantial headwall to support new trending weather patterns tree removal - set budget for hiring tree service and possible equipment rental for township employees allotments- some allotments in the township only have one way in and one way out. get easements and right aways granted to put new roadways in. some of the allotments include (douthett, lakeview, littlefawn acres, shenango lakes 1, shenango lakes 2).	X					**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.52 Printing out Flyers to distribute or hang at office. Tree trimming, ditching along roadways and culverts.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.53 Upgrade storm sewer infrastructure and add retention areas.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.54 Upgrade storm water infrastructure and add retention areas.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.55 Upgrade storm water infrastructure.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.56 Upgrade storm water infrastructure and add retention area.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions (2020 HMP)	*Status*					*Review Comments*
	No Progress/ Unknown	In Progress/Not Yet Complete	Continuous	Completed	Discontinued	
Table 8.4-1.57 Upgrade storm water infrastructure and add retention area.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.58 Upgrade storm water infrastructure and add retention area.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.59 Upgrade storm water infrastructure, add retention area, stabilize bank of Willow Run from Rt 18 to Conneaut Lake.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.60 Add retention area to control storm water.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.61 Add retention area to control storm water. This would slow water as it traverses to Conneaut Lake and help diminish flooding downstream.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.62 Upgrade storm water infrastructure.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.63 Add new storm water infrastructure.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.64 Upgrade storm water infrastructure.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.65 To hire a company to clean catch basins and associated piping.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.66 Help educate businesses and residents on how to protect against cyber-attacks through education and training.			X			**2025 Review Comment:** This action was integrated into new Action 3.3.1.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	***Status*** No Progress/ Unknown	In Progress/Not Yet Complete	Continuous	Completed	Discontinued	***Review Comments***
Table 8.4-1.67 Kinsack Rd - Daylighting to let sunlight onto this road surface.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.68 Foote Rd also needs daylighting to dry up shaded areas.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.69 Remove beaver dams- We have built “beaver deceivers” in the past and they work, but the beavers always find another way! Gravel Bar in Woodcock Creek- Obtain proper permits to mitigate gravel bar.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.70 New, wider bridge put in.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.71 Completely and safely demolish the house. Remove the cars.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.72 Need to come up with grant funds and sources to try and help with the replacement cost of the bridge.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.73 Remove and replace culvert pipes. Elevation, Acquisition, Demolition & Reconstruction.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	*Status*					*Review Comments*
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Table 8.4-1.74 A new generator is needed. Since the Conneaut Lake Borough Water Authority and Sadsbury Twp. each use a portion of the sewage plant and Sadsbury is going to replace their generator, the borough would like to contribute to the purchase as a less expensive option and then be able to share the generator with Sadsbury. The estimated contribution would be aprox. $50,000.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.75 Ditch work.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.76 Borough Council plans to have an electric contractor install a generator for backup power that will supply all electrical needs.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.77 No planned action.					X	**2025 Review Comment:** This action was discontinued and removed from the plan.
Table 8.4-1.78 We are in constant awareness of the plugging of culverts, and are correcting any issues with replacing as needed.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.79 Ongoing road improvements to combat road flooding.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.80 Assist municipalities to create drought emergency plans.	X					**2025 Review Comment:** This action was integrated into new Action 3.1.7.
Table 8.4-1.81 Conduct educational programs and distribute educational flyers near waterways.	X					**2025 Review Comment:** This action was integrated into new Action 4.3.1.

Crawford County Mitigation Actions Review Worksheet						
Existing Mitigation Actions *(2020 HMP)*	***Status***					***Review Comments***
	No Progress/ Unknown	**In Progress/Not Yet Complete**	**Continuous**	**Completed**	**Discontinued**	
Table 8.4-1.82 More Culvert Pipes and more turn outs.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.83 Ditching to control erosion of roadway					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.84 Ditching to control erosion.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.85 Venango Borough has been actively trimming trees around the borough. This concern will be addressed by council every year.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.86 Replace & Upsize Culvert Pipes as Needed Throughout the Township					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.87 Township is considering arranging for private trapping however it may not be possible outside of the road right-of-way. Township will continue attempts to negotiate with the landowner to access in order to prevent road damage and excessive manpower or resources to be expended.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.88 Grading roads and keeping the ditches open and cleaned out.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.
Table 8.4-1.89 Improving road drainage, culverts.					X	**2025 Review Comment:** This action was discontinued and integrated into project opportunities.

6.2. Mitigation Goals and Objectives

Based on results of the goals and objectives evaluation exercise and input from the local planning team, a list of five goals and sixteen corresponding objectives were developed. *Table 89 – 2025 Goals and Objectives* details the mitigation goals and objectives established for the 2025 Crawford County Hazard Mitigation Plan.

Table 89 - 2025 Goals and Objectives

Crawford County 2025 Goals and Objective	
Goal/Objective	**Description**
Goal 1	**Protect lives, property, infrastructure, environmental quality, natural resources, and populations of the county, including the unserved, underserved, and socially vulnerable.**
New Objective 1.1	Ensure adequate training, education, and technical assistance tools and resources are made available to all levels of government, public safety, and other stakeholders.
New Objective 1.2	Target owners of properties within identified hazard areas for additional outreach regarding mitigation and disaster preparedness.
New Objective 1.3	Investigate cost-effective ways of bolstering existing broadcast and communication systems to continuously monitor warning information and to disseminate warnings as appropriate.
New Objective 1.4	Protect the county's natural resources through the implementation of recreation and storm water management planning.
Goal 2	**Seek methods by which to reduce current and future flood damage in Crawford County.**
New Objective 2.1	Identify, acquire, relocate, demolish, or demolish/reconstruct structures located in the special flood hazard area to mitigate risks to home and property owners.
New Objective 2.2	Encourage municipalities to review and regulate the enforcement of existing flood regulations and prohibit designated growth areas from being in the flood hazard area by redirecting it away from high hazard areas by reviewing, and ensuring adequacy of, existing regulation to reduce the amount of future development in any vulnerable flood, flash flood, and ice jam flood areas.
New Objective 2.3	Educate all stakeholders on the National Flood Insurance Program (NFIP), and encourage them to continue to meet the requirements.

Crawford County 2025 Goals and Objective	
Goal/Objective	**Description**
Goal 3	**Reduce the potential impact of identified natural and human-caused hazards on the whole community.**
New Objective 3.1	Conduct hazard-specific vulnerability assessments and develop and maintain planning and regulatory tools to mitigate those hazards.
New Objective 3.2	Build legislative and other organizational support and leverage funding for mitigation efforts.
New Objective 3.3	Protect the county's vulnerable populations (including the unserved, underserved, and socially vulnerable population), buildings, and community lifeline facilities with the acquisition of equipment (e.g. generators, busses, etc.)
Goal 4	**Protect public health, safety, and welfare across all sectors by increasing individual and public awareness of, and preparedness to, hazards identified in the hazard mitigation plan.**
New Objective 4.1	Partner with news media, schools, and businesses to promote mitigation and preparedness in the community.
New Objective 4.2	Coordinate with Crawford County stakeholders on public events and other education opportunities.
New Objective 4.3	Develop and foster outreach, education, and awareness to underserved and socially vulnerable communities to increase input into the hazard mitigation planning process.
Goal 5	**Participate in FEMA's High-Hazard Potential Dam Program (HHPD).**
New Objective 5.1	Educate all stakeholder regarding FEMA's HHPD program.
New Objective 5.2	Reduce long-term vulnerabilities from eligible high-hazard potential dams that pose an unacceptable risk to the public.
New Objective 5.3	Identify, by area, locations that could potentially be impacted by FEMA's HHPD program.

Goal 5 and Objective 5.1, Objective 5.2, and Objective 5.3 relate to multiple mitigation actions in *Table 91 – 2025 Mitigation Action Plan*. Objective 5.1 relates to any mitigation actions that have a prefix of 5.1. Objective 5.2 relates to any mitigation actions that have a prefix of 5.2. Finally, Objective 5.3 relates to any mitigation actions that have a prefix of 5.3. All three of the mitigation actions are covered by Goal 5 of the goals and objectives for the 2025 Hazard Mitigation Plan. These mitigations reduce the vulnerability of county populations and structures by educating the public on the HHPD program, enhancing local policies and procedures for

HHPD planning, and digitizing dam inundation areas for future analysis and prevention of losses.

6.3. Identification and Analysis of Mitigation Techniques

This section includes an overview of alternative mitigation actions based on the goals and objectives identified in Section 6.2. There are four general mitigation strategy techniques to reducing hazard risks.

- Planning and regulations
- Structure and infrastructure
- Natural systems protection
- Education and awareness

Planning and Regulations: These actions include government authorities, policies or codes that influence the way land and buildings are developed and built. The following are some examples.

- Comprehensive plans
- Land use ordinances
- Subdivision regulations
- Development review
- Building codes and enforcement
- National Flood Insurance Program and Community Rating System
- Capital improvement programs
- Open space preservation
- Stormwater management regulations and master plans

The planning and regulations technique will protect and reduce the impact of specific hazards on new and existing buildings by improving building code standards and regulating new and renovation construction. The improved building codes will decrease the impact of risk hazards. Subdivision and land development enhancements will also augment this process. Ensuring that municipalities participate in the National Flood Insurance Program and encourage participation in the Community Rating System will decrease the impact as well.

Structure and infrastructure implementation: These actions involve modifying existing structures and infrastructure or constructing new structures to reduce hazard vulnerability. The following are examples:

- Acquisitions and elevations of structures in flood prone areas
- Utility undergrounding
- Structural retrofits

- Floodwalls and retaining walls
- Detention and retention structures
- Culverts
- Safe rooms

Structure and infrastructure implementation is a technique that removes or diverts the hazard from structure or protects the structure from a specific hazard. The new or renovated structures are therefore protected or have a reduced impact of hazards.

Natural Systems Protection: These are actions that minimize damage and losses and also preserve or restore the functions of natural systems. They include the following:

- Erosion and sediment control
- Stream corridor restoration
- Forest management
- Conservation easements
- Wetland restoration and preservation

Natural resource protection techniques allow for the natural resource to be used to protect or lessen the impact on new or renovated structures through the management of these resources. Utilization and implementation of the examples above will protect new and existing buildings and infrastructure.

Education and Awareness: These are actions to inform and educate citizens, elected officials and property owners about hazards and potential ways to mitigate them and may also include participation in national programs. Examples of these techniques include the following.

- Radio and television spots
- Websites with maps and information
- Real estate disclosure
- Provide information and training
- NFIP outreach
- StormReady
- Firewise communities

The education and awareness technique will protect and reduce the impact of specific hazards on new and existing buildings through education of citizens and property owners on the impacts that specific hazards could have on new or renovated structures. This information will allow the owner to make appropriate changes or enhancements that will lessen or eliminate the impacts of hazards.

Table 90 – Mitigation Strategy Technique Matrix provides a matrix identifying the mitigation techniques used for all low, moderate, and high-risk hazards in the county. The specific actions associated with these techniques are included in *Table 91 – 2025 Mitigation Action Plan*.

Table 90 - Mitigation Strategy Technique Matrix

Crawford County Mitigation Strategy Technique Matrix				
Hazard	MITIGATION TECHNIQUE			
	Planning and Regulations	Structure and Infrastructure	Natural Systems Protection	Education and Awareness
Blighted Properties	X			X
Civil Disturbance	X			X
Dam Failure	X	X	X	X
Disorientation	X			X
Drought	X			X
Earthquake	X			X
Emergency Services	X			X
Environmental Hazards	X			X
Extreme Temperature	X			X
Flood, Flash Flood, and Ice Jam Flood	X	X		X
Hurricane and Tropical Storms	X			X
Invasive Species	X			X
Landslides	X			X
Lightning Strike	X			X
Nuclear Incidents	X			X
Opioid Epidemic	X			X
Pandemic, Epidemic, Endemic, and Infectious Disease	X			X
Radon Exposure	X			X
Subsidence and Sinkhole	X			X
Terrorism and Cyber Terrorism	X			X
Tornado and Windstorm	X			X
Transportation Accidents	X	X		X
Urban Fire and Explosion	X			X
Utility Interruptions	X	X		X
Wildfire	X		X	X

Crawford County Mitigation Strategy Technique Matrix				
Hazard	MITIGATION TECHNIQUE			
	Planning and Regulations	Structure and Infrastructure	Natural Systems Protection	Education and Awareness
Winter Storm	X			X

6.4. Mitigation Action Plan

The Crawford County Hazard Mitigation Local Planning Team (LPT) immediately began work on the mitigation strategy section of the 2025 hazard mitigation plan (HMP) update after the risk assessment section was completed. The LPT started this section by reviewing the 2020 HMP mitigation strategy section. A review of the previous goals, objectives, actions, and project opportunities documented in the 2020 HMP was conducted. The next step the LPT completed was the brainstorming of possible new actions based on new identified risks. The LPT compiled all this information for presentations to the municipalities.

MCM Consulting Group, Inc. completed municipality meetings at various time periods via virtual platforms or in-person meetings. During all these meetings, an overview of mitigation strategy was presented, and the municipalities were informed that they needed to have at least one hazard-related mitigation action for their municipality. All municipalities were invited to attend these meetings. Municipalities that were not able to join conference calls were contacted individually.

The municipalities were notified of draft mitigation actions and encouraged to provide new mitigation actions that could be incorporated into the plan. Municipalities were provided copies of their previously submitted mitigation opportunity forms and asked to determine if the projects were still valid. Municipalities were solicited for new project opportunities as well. All agendas, sign in sheets, and other support information from these meetings is included in Appendix C.

Mitigation measures for the 2025 Crawford County HMP are listed in the mitigation action plan. *Table 91 – 2025 Mitigation Action Plan* is the 2025 Crawford County Mitigation Action Plan. This plan outlines mitigation actions and projects that comprise a strategy for Crawford County. The action plan includes actions, a benefit and cost prioritization, a schedule for implementation, any funding sources to complete the action, a responsible agency or department and an estimated cost. All benefit and cost analysis were completed using the Pennsylvania Emergency Management Agency recommended analysis tool. The completed analysis is located in Appendix H. *Table 91 – 2025 Mitigation Action Plan* is a matrix that identifies the county and/or municipalities responsible for mitigation actions in the new mitigation action plan. *Table 92 – Municipal Hazard Mitigation Actions Checklist* shows which actions tie to specific municipalities for responsibilities. *Table 93 – Objective to Action Checklist* shows that each mitigation objective has a mitigation action item related to it. *Table 94 – Actions Tied to Hazards* illustrates the specific actions that are tied to each hazard outlined in the hazard mitigation plan.

Funding acronym definitions:

FMA:	Flood Mitigation Assistance Grant Program, administered by the Federal Emergency Management Agency
HMGP:	Hazard Mitigation Grant Program, administered by the Federal Emergency Management Agency
BRIC:	Building Resilient Infrastructure and Communities (BRIC) Program, administered by the Federal Emergency Management Agency
EMPG:	Emergency Management Performance Grant, administered by the Federal Emergency Management Agency
HSGP:	Homeland Security Grant Program, administered by the Federal Emergency Management Agency
HMEP:	Hazardous Material Emergency Planning Grant, administered by the Pennsylvania Emergency Management Agency
HMRF:	Hazardous Material Response Fund, administered by the Pennsylvania Emergency Management Agency
HMERP:	Hazard Mitigation Emergency Response Program administered by the Pennsylvania Emergency Management Agency
HHPD:	Rehabilitation of High-Hazard Potential Dams Grant Program, administered by the Federal Emergency Management Agency

Evaluate and Prioritize Mitigation Actions

Mitigation Action Evaluation:

Evaluating mitigation actions involves judging each action against certain criteria to determine whether or not it can be executed. The feasibility of each mitigation action is evaluated using the ten evaluation criteria set forth in the Mitigation Action Evaluation methodology as outlined in the Commonwealth of Pennsylvania's All-Hazard Mitigation Planning, Standard Operating Guide. The methodology solicits input on whether each action is highly effective or feasible and ineffective or not feasible for the criteria. These criteria are listed below and aid in determining the feasibility of implementing one action over another.

- Life Safety: Will the action be effective in promoting public safety?
- Property Protection: Will the action be effective in protecting public or private property?
- Technical: How effective will the action be in avoiding or reducing future losses?
- Political: Does the action have public and political support?
- Legal: Does the community have the authority to implement the proposed measure?
- Environmental: Will the action provide environmental benefits, and will it comply with local, state, and federal environmental regulations?
- Social: Will the action be acceptable by the community, or will it cause any one segment of the population to be treated unfairly?
- Administrative: Is there adequate staffing and funding available to implement the action in a timely manner?
- Local Champion: Is there local support for the action to help ensure its completion?
- Other Community Objectives: Does the action address any current or future community objectives either through municipal planning or community goals?

To evaluate the mitigation actions, each action is identified as highly effective or feasible, ineffective, or not favorable and no cost or benefit. For each criterion, the prioritization methodology assigns a "+" if the action is highly effective or feasible, a "-" if the action was ineffective or not feasible, and a "N" if no cost of benefit could be associated with the suggested action or the action was no applicable to the criteria.

Mitigation Action Prioritization:

Actions should be compared with one another to determine a ranking or priority by applying the multi-objective mitigation action prioritization criteria. Scores are assigned to each criterion using the following weighted, multi-objective mitigation action prioritization criteria:

- Effectiveness (weight: 20% of score): The extent to which an action reduces the vulnerability of people and property.
- Efficiency (weight: 30% of score): The extent to which time, effort, and cost is well used as a means of reducing vulnerability.
- Multi-Hazard Mitigation (weight: 20% of score): The action reduces vulnerability for more than one hazard.

- Address High Risk Hazard (weight: 15% of score): The action reduces vulnerability for people and property from a hazard identified as high risk.
- Address Critical Communications/Critical Infrastructure (weight: 15% of score): The action pertains to the maintenance of critical functions and structures such as transportation, supply chain management, and data circuits, etc.

Scores of 1, 2, or 3 are assigned for each multi-objective mitigation action prioritization criterion where 1 is a low score and 3 is a high score. Actions are prioritized using the cumulative score assigned to each. Each mitigation action is given a priority ranking (Low, Medium, and High) based on the following:

- Low Priority: 1.0 – 1.8
- Medium Priority: 1.9 – 2.4
- High Priority: 2.5 – 3.0

The cumulative results of the prioritization of mitigation actions is identified in the mitigation action evaluation and prioritization tool. The results for the mitigation action evaluation and prioritization are located in Appendix H of this plan.

Table 91 - 2025 Mitigation Action Plan

Crawford County 2025 Mitigation Action Plan									
Action Number	Mitigation Actions		Hazard Vulnerability	Prioritization			Implementation		
	Category	Description/ Action Items		High	Medium	Low	Schedule	Funding	Local Champion
1.1.1	Education and Awareness	Continue to provide three annual HazMat operations refresher courses.	Environmental Hazards	X			Annual	HMEP	LEPC
1.1.2	Education and Awareness	Provide, or participate in, quarterly training for EMCs throughout the county.	All Hazards	X			Quarterly	EMPG	County EMA Municipalities

Crawford County 2025 Mitigation Action Plan									
Action Number	Mitigation Actions		Hazard Vulnerability	Prioritization			Implementation		
	Category	Description/ Action Items		High	Medium	Low	Schedule	Funding	Local Champion
1.1.3	Education and Awareness	Provide Skywarn spotter training.	Natural Hazards	X			Bi-Annual	EMPG	County EMA and NWS
1.1.4	Planning and Regulations	Offer technical assistance to municipalities to develop, address, or enforce floodplain zoning, hillside development regulations, subdivision and development regulations, design review standards, and environmental review standards.	Landslide, Flood, Subsidence and Sinkhole	X			2025-2030	Local	County and local planning
1.2.1	Education and Awareness	Utilize FIRMs/DFIRMs to provide outreach for flood insurance to properties owners of structures within the SFHA, specifically property owners without a mortgage.	Flood, Flash Flood, and Ice Jam Flood	X			2025-2030	Local	County and local planning
1.3.1	Planning and Regulations	Maintain Genasys warning system and allow residents to sign up to receive emergency alerts from the Department of Public Safety.	All Hazards	X			2025-2030	911 funding	County DPS
1.4.1	Planning and Regulations	Develop a park, recreation, and open spaces (PROS) plan.	Environmental Hazards		X		2025-2030	CDBG and Local	County planning
2.1.1	Planning and Regulations	Perform routine review of repetitive loss properties.	Flood, Flash Flood, and Ice Jam Flood		X		2025-2030	EMPG and local	County and local planning and EMA

Crawford County 2025 Mitigation Action Plan									
Action Number	Mitigation Actions		Hazard Vulnerability	Prioritization			Implementation		
	Category	Description/ Action Items		High	Medium	Low	Schedule	Funding	Local Champion
2.1.2	Planning and Regulations	Develop an inventory list of blighted properties throughout the county.	Blighted Properties		X		2025-2030	CDBG and Act 13	County planning
2.1.3	Planning and Regulations	Assign all municipalities into one of thirteen planning districts throughout the county to streamline all-hazards planning and enhance capability.	All Hazards	X			2025-2030	Local	County EMA and County Planning
2.2.1	Planning and Regulations	Enforce the municipal floodplain ordinance regulations.	Flood, Flash Flood, and Ice Jam Flood		X		2025-2030	Local	Municipalities
2.2.2	Planning and Regulations	Enforce uniform construction code at the municipal level.	Flood, Flash Flood, and Ice Jam Flood	X			2025-2030	Local	Municipalities
2.2.3	Planning and Regulations	Improve upon existing floodplain regulation enforcement.	Flood, Flash Flood, and Ice Jam Flood		X		2025-2030	Local	Municipalities
2.3.1	Planning and Regulations	Applicable municipalities to review and update their floodplain ordinances to be sure that they are in full compliance with the NFIP.	Flood, Flash Flood, and Ice Jam Flood		X		2025-2030	Local	Municipalities
3.1.1	Planning and Regulations	Conduct a hazardous materials commodity flow study.	Environmental Hazards	X			2028	HMEP	LEPC

Crawford County 2025 Mitigation Action Plan									
Action Number	**Mitigation Actions**		**Hazard Vulnerability**	**Prioritization**			**Implementation**		
	Category	**Description/ Action Items**		**High**	**Medium**	**Low**	**Schedule**	**Funding**	**Local Champion**
3.1.2	Planning and Regulations	Review the areas of social vulnerability in each municipality and determine where those areas of vulnerability directly overlap with high-risk radon areas.	Radon Exposure		X		2025-2030	Local	PA DEP
3.1.3	Planning and Regulations	Conduct SARA planning facility assessments and update the emergency plan on an annual basis.	Environmental Hazards		X		Annually	EMPG	LEPC
3.1.4	Education and Awareness	Conduct an invasive species public education and outreach campaign to mitigate mosquito, ticks, and vectors of disease.	Invasive Species			X	2025-2030	Local and State	DEP, Conservation and Penn State Extension Office
3.1.5	Education and Awareness	Continue to educate arborists on hazards pertaining to forestry.	Invasive Species			X	2025-2030	State	Penn State Extension Office
3.1.6	Natural Systems Protection	Review the feasibility of a community wildfire protection plan. Implement mitigation programs and educations programs outlined in that type of plan.	Wildfire		X		2025-2030	State and Federal	DCNR
3.1.7	Planning and Regulations	Develop drought plans to address water usage and recommendations in times of low precipitation and drought declarations.	Drought	X			2025-2030	County and State	DEP and County and Local EMA
3.2.1	Planning and Regulations	Secure funding and conduct a substance use disorder mitigation campaign.	Substance Use Disorder			X	2025-2030	County and State	County Drug and Alcohol

Crawford County 2025 Mitigation Action Plan									
Action Number	Mitigation Actions		Hazard Vulnerability	Prioritization			Implementation		
	Category	Description/ Action Items		High	Medium	Low	Schedule	Funding	Local Champion
3.2.2	Planning and Regulations	Maintain the fire and EMS commissions to collaborate on resource shortage related capability items.	Emergency Services	X			2025-2030	Local, County and State	County Commissioners
3.2.3	Structure and Infrastructure	Identify potential funding sources to assist with insufficient bridge and culvert areas and projects.	Transportation Accidents and Flooding	X			2025-2030	Local, County and State	County Planning
3.3.1	Planning and Regulations	Assist municipalities in conducting facility threat vulnerability assessments.	Terrorism, Cyber Terrorism, Civil Disturbance	X			2025-2030	Federal	Department of Homeland Security
3.3.2	Structure and Infrastructure	Secure funding to install protective systems to prevent and/or mitigate financial losses due to the impact of hazards on electrical and mechanical systems.	Utility Interruption	X			2025-2030	Local	County EMA
3.3.2	Planning and Regulations	Assist municipalities in submitting project opportunity forms during hazard mitigation plan updates and during subsequent annual reviews.	All Hazards	X			2025-2030	Local	County planning, EMA and Conservation District Municipalities

Crawford County 2025 Mitigation Action Plan									
Action Number	Mitigation Actions		Hazard Vulnerability	Prioritization			Implementation		
	Category	Description/ Action Items		High	Medium	Low	Schedule	Funding	Local Champion
4.1.1	Education and Awareness	Continue to provide four annual presentations and discussions on Storm ready certification.	Flood, Flash Flood, Ice Jam Flood, Windstorm, Winter Storm, Tornado, Lightning Strike, Hurricane, and Tropical Storm	X			Quarterly	EMPG	County EMA
4.1.2	Education and Awareness	Provide public education on drugs and alcohol and provide education sessions on Narcan and Narcan administration.	Substance Use Disorder			X	2025-2030	Local and State	County Drug and Alcohol
4.2.1	Education and Awareness	Crawford County will conduct community outreach on preventative measures for Lyme Disease.	Pandemic and Infectious Disease			X	2025-2030	State	DOH
4.3.1	Education and Awareness	Distribute pamphlets and other media during county and municipal events on hazards and hazard vulnerability for citizens and visitors to Crawford County.	All Hazards		X		2025-2030	Local and State	County EMA Municipalit ies

Crawford County 2025 Mitigation Action Plan									
Action Number	Mitigation Actions		Hazard Vulnerability	Prioritization			Implementation		
	Category	Description/ Action Items		High	Medium	Low	Schedule	Funding	Local Champion
5.1.1	Education and Awareness	Distribute educational materials about the HHPD program to municipalities, communities, and county residents.	Dam Failure		X		2024-2030	HHPD, Local	Crawford County EMA Crawford County GIS
5.2.1	Education and Awareness	Provide education on local mitigation policies and programs that address high-hazard potential dams to municipalities and county residents.	Dam Failure		X		2024-2030	HHPD, Local	Crawford County EMA Crawford County GIS
5.2.2	Planning and Regulations	Ensure continued collaboration with both private and public dam owners, to ensure that their input is included in the local planning team, and the planning process for continued hazard mitigation planning.	Dam Failure	X			2024-2030	HHPD, Local	Crawford County EMA Crawford County LPT
5.2.3	Natural Systems Protection	Research the feasibility of installing flood protection measures in areas around Crawford County that would be adversely impacted by flooding from a high-hazard potential dam failure, including natural spaces, local parks, and outdoor areas.	Dam Failure	X			2024-2030	HHPD, Local	Crawford County EMA Crawford County Conservation

Crawford County 2025 Mitigation Action Plan										
Action Number	**Mitigation Actions**		**Hazard Vulnerability**	**Prioritization**			**Implementation**			
	Category	**Description/ Action Items**		**High**	**Medium**	**Low**	**Schedule**	**Funding**	**Local Champion**	
5.2.4	Structure and Infrastructure	If funding becomes available, perform acquisitions, elevations, relocations, and foundation stabilization on homes and structures within areas of potential impact from a failure of a high-hazard potential dam in Crawford County.	Dam Failure	**X**			2024-2030	HHPD, Local	Crawford County EMA Crawford County Conservat ion Crawford County LPT	
5.2.5	Structure and Infrastructure	Review the early warning systems in place for dams in Crawford County. If no early warning systems are in place, research the feasibility of constructing or implementing those systems.	Dam Failure	**X**			2024-2030	HHPD, Local	Crawford County EMA Crawford County LPT	
5.2.6	Planning and Regulations	Review or develop evacuation plans for the Crawford County high-hazard dams.	Dam Failure	**X**			2024-2030	HHPD, Local	Crawford County EMA Crawford County LPT	
5.3.1	Education and Awareness	Acquire or maintain digitized dam inundation GIS polygons to determine at risk populations for dams designated high-hazard potential dams by FEMA.	Dam Failure	**X**			2025-2030	HHPD, Local	Crawford County EMA Crawford County GIS	

Table 92 - Municipal Hazard Mitigation Actions Checklist

Municipal Hazard Mitigation Actions Checklist							
Municipality	1.1.1	1.1.2	1.1.3	1.1.4	1.2.1	1.3.1	1.4.1
Athens Township		X					
Beaver Township		X					
Bloomfield Township		X					
Blooming Valley Borough		X					
Cambridge Township		X					
Cambridge Springs Borough		X					
Centerville Borough		X					
Cochranton Borough		X					
Conneaut Township		X					
Conneaut Lake Borough		X					
Conneautville Borough		X					
Cussewago Township		X					
East Fairfield Township		X					
East Fallowfield Township		X					
East Mead Township		X					
Fairfield Township		X					
Greenwood Township		X					
Hayfield Township		X					
Hydetown Borough		X					
Linesville Borough		X					
Meadville, City of		X					
North Shenango Township		X					
Oil Creek Township		X					
Pine Township		X					
Randolph Township		X					
Richmond Township		X					
Rockdale Township		X					
Rome Township		X					
Sadsbury Township		X					
Saegertown Borough		X					
South Shenango Township		X					
Sparta Township		X					
Spartansburg Borough		X					
Spring Township		X					
Springboro Borough		X					
Steuben Township		X					
Summerhill Township		X					
Summit Township		X					
Titusville, City of		X					

Municipal Hazard Mitigation Actions Checklist							
Municipality	1.1.1	1.1.2	1.1.3	1.1.4	1.2.1	1.3.1	1.4.1
Townville Borough		X					
Troy Township		X					
Union Township		X					
Venango Borough		X					
Venango Township		X					
Vernon Township		X					
Wayne Township		X					
West Fallowfield Township		X					
West Mead Township		X					
West Shenango Township		X					
Woodcock Borough		X					
Woodcock Township		X					
Crawford County	X	X	X	X	X	X	X

Municipal Hazard Mitigation Actions Checklist							
Municipality	2.1.1	2.1.2	2.1.3	2.2.1	2.2.2	2.2.3	2.3.1
Athens Township				X	X	X	X
Beaver Township				X	X	X	X
Bloomfield Township				X	X	X	X
Blooming Valley Borough				X	X	X	X
Cambridge Township				X	X	X	X
Cambridge Springs Borough				X	X	X	X
Centerville Borough				X	X	X	X
Cochranton Borough				X	X	X	X
Conneaut Township				X	X	X	X
Conneaut Lake Borough				X	X	X	X
Conneautville Borough				X	X	X	X
Cussewago Township				X	X	X	X
East Fairfield Township				X	X	X	X
East Fallowfield Township				X	X	X	X
East Mead Township				X	X	X	X
Fairfield Township				X	X	X	X
Greenwood Township				X	X	X	X
Hayfield Township				X	X	X	X
Hydetown Borough				X	X	X	X
Linesville Borough				X	X	X	X
Meadville, City of				X	X	X	X
North Shenango Township				X	X	X	X

Municipal Hazard Mitigation Actions Checklist							
Municipality	**2.1.1**	**2.1.2**	**2.1.3**	**2.2.1**	**2.2.2**	**2.2.3**	**2.3.1**
Oil Creek Township				X	X	X	X
Pine Township				X	X	X	X
Randolph Township				X	X	X	X
Richmond Township				X	X	X	X
Rockdale Township				X	X	X	X
Rome Township				X	X	X	X
Sadsbury Township				X	X	X	X
Saegertown Borough				X	X	X	X
South Shenango Township				X	X	X	X
Sparta Township				X	X	X	X
Spartansburg Borough				X	X	X	X
Spring Township				X	X	X	X
Springboro Borough				X	X	X	X
Steuben Township				X	X	X	X
Summerhill Township				X	X	X	X
Summit Township				X	X	X	X
Titusville, City of				X	X	X	X
Townville Borough				X	X	X	X
Troy Township				X	X	X	X
Union Township				X	X	X	X
Venango Borough				X	X	X	X
Venango Township				X	X	X	X
Vernon Township				X	X	X	X
Wayne Township				X	X	X	X
West Fallowfield Township				X	X	X	X
West Mead Township				X	X	X	X
West Shenango Township				X	X	X	X
Woodcock Borough				X	X	X	X
Woodcock Township				X	X	X	X
Crawford County	X	X	X				

Municipal Hazard Mitigation Actions Checklist							
Municipality	**3.1.1**	**3.1.2**	**3.1.3**	**3.1.4**	**3.1.5**	**3.1.6**	**3.1.7**
Athens Township							
Beaver Township							
Bloomfield Township							
Blooming Valley Borough							
Cambridge Township							

Municipal Hazard Mitigation Actions Checklist							
Municipality	**3.1.1**	**3.1.2**	**3.1.3**	**3.1.4**	**3.1.5**	**3.1.6**	**3.1.7**
Cambridge Springs Borough							
Centerville Borough							
Cochranton Borough							
Conneaut Township							
Conneaut Lake Borough							
Conneautville Borough							
Cussewago Township							
East Fairfield Township							
East Fallowfield Township							
East Mead Township							
Fairfield Township							
Greenwood Township							
Hayfield Township							
Hydetown Borough							
Linesville Borough							
Meadville, City of							
North Shenango Township							
Oil Creek Township							
Pine Township							
Randolph Township							
Richmond Township							
Rockdale Township							
Rome Township							
Sadsbury Township							
Saegertown Borough							
South Shenango Township							
Sparta Township							
Spartansburg Borough							
Spring Township							
Springboro Borough							
Steuben Township							
Summerhill Township							
Summit Township							
Titusville, City of							
Townville Borough							
Troy Township							
Union Township							
Venango Borough							
Venango Township							

Municipal Hazard Mitigation Actions Checklist							
Municipality	**3.1.1**	**3.1.2**	**3.1.3**	**3.1.4**	**3.1.5**	**3.1.6**	**3.1.7**
Vernon Township							
Wayne Township							
West Fallowfield Township							
West Mead Township							
West Shenango Township							
Woodcock Borough							
Woodcock Township							
Crawford County	X	X	X	X	X	X	X

Municipal Hazard Mitigation Actions Checklist							
Municipality	**3.2.1**	**3.2.2**	**3.2.3**	**3.3.1**	**3.3.2**	**3.3.3**	**4.1.1**
Athens Township					X		
Beaver Township					X		
Bloomfield Township					X		
Blooming Valley Borough					X		
Cambridge Township					X		
Cambridge Springs Borough					X		
Centerville Borough					X		
Cochranton Borough					X		
Conneaut Township					X		
Conneaut Lake Borough					X		
Conneautville Borough					X		
Cussewago Township					X		
East Fairfield Township					X		
East Fallowfield Township					X		
East Mead Township					X		
Fairfield Township					X		
Greenwood Township					X		
Hayfield Township					X		
Hydetown Borough					X		
Linesville Borough					X		
Meadville, City of					X		
North Shenango Township					X		
Oil Creek Township					X		
Pine Township					X		
Randolph Township					X		
Richmond Township					X		
Rockdale Township					X		

Municipal Hazard Mitigation Actions Checklist							
Municipality	3.2.1	3.2.2	3.2.3	3.3.1	3.3.2	3.3.3	4.1.1
Rome Township					X		
Sadsbury Township					X		
Saegertown Borough					X		
South Shenango Township					X		
Sparta Township					X		
Spartansburg Borough					X		
Spring Township					X		
Springboro Borough					X		
Steuben Township					X		
Summerhill Township					X		
Summit Township					X		
Titusville, City of					X		
Townville Borough					X		
Troy Township					X		
Union Township					X		
Venango Borough					X		
Venango Township					X		
Vernon Township					X		
Wayne Township					X		
West Fallowfield Township					X		
West Mead Township					X		
West Shenango Township					X		
Woodcock Borough					X		
Woodcock Township					X		
Crawford County	X	X	X	X	X	X	X

Municipal Hazard Mitigation Actions Checklist							
Municipality	4.1.2	4.2.1	4.3.1	5.1.1	5.2.1	5.2.2	5.2.3
Athens Township			X				
Beaver Township			X				
Bloomfield Township			X				
Blooming Valley Borough			X				
Cambridge Township			X				
Cambridge Springs Borough			X				
Centerville Borough			X				
Cochranton Borough			X				
Conneaut Township			X				
Conneaut Lake Borough			X				

Municipal Hazard Mitigation Actions Checklist							
Municipality	**4.1.2**	**4.2.1**	**4.3.1**	**5.1.1**	**5.2.1**	**5.2.2**	**5.2.3**
Conneautville Borough			X				
Cussewago Township			X				
East Fairfield Township			X				
East Fallowfield Township			X				
East Mead Township			X				
Fairfield Township			X				
Greenwood Township			X				
Hayfield Township			X				
Hydetown Borough			X				
Linesville Borough			X				
Meadville, City of			X				
North Shenango Township			X				
Oil Creek Township			X				
Pine Township			X				
Randolph Township			X				
Richmond Township			X				
Rockdale Township			X				
Rome Township			X				
Sadsbury Township			X				
Saegertown Borough			X				
South Shenango Township			X				
Sparta Township			X				
Spartansburg Borough			X				
Spring Township			X				
Springboro Borough			X				
Steuben Township			X				
Summerhill Township			X				
Summit Township			X				
Titusville, City of			X				
Townville Borough			X				
Troy Township			X				
Union Township			X				
Venango Borough			X				
Venango Township			X				
Vernon Township			X				
Wayne Township			X				
West Fallowfield Township			X				
West Mead Township			X				
West Shenango Township			X				

Municipal Hazard Mitigation Actions Checklist							
Municipality	**4.1.2**	**4.2.1**	**4.3.1**	**5.1.1**	**5.2.1**	**5.2.2**	**5.2.3**
Woodcock Borough			X				
Woodcock Township			X				
Crawford County	X	X	X	X	X	X	X

Municipal Hazard Mitigation Actions Checklist					
Municipality	**5.2.4**	**5.2.5**	**5.2.6**	**5.3.1**	
Athens Township					
Beaver Township					
Bloomfield Township					
Blooming Valley Borough					
Cambridge Township					
Cambridge Springs Borough					
Centerville Borough					
Cochranton Borough					
Conneaut Township					
Conneaut Lake Borough					
Conneautville Borough					
Cussewago Township					
East Fairfield Township					
East Fallowfield Township					
East Mead Township					
Fairfield Township					
Greenwood Township					
Hayfield Township					
Hydetown Borough					
Linesville Borough					
Meadville, City of					
North Shenango Township					
Oil Creek Township					
Pine Township					
Randolph Township					
Richmond Township					
Rockdale Township					
Rome Township					
Sadsbury Township					
Saegertown Borough					
South Shenango Township					
Sparta Township					

Municipal Hazard Mitigation Actions Checklist					
Municipality	**5.2.4**	**5.2.5**	**5.2.6**	**5.3.1**	
Spartansburg Borough					
Spring Township					
Springboro Borough					
Steuben Township					
Summerhill Township					
Summit Township					
Titusville, City of					
Townville Borough					
Troy Township					
Union Township					
Venango Borough					
Venango Township					
Vernon Township					
Wayne Township					
West Fallowfield Township					
West Mead Township					
West Shenango Township					
Woodcock Borough					
Woodcock Township					
Crawford County	X	X	X	X	

Table 93 - Objective to Action Checklist

Objective	Number of Actions
Objective 1.1	4
Objective 1.2	1
Objective 1.3	1
Objective 1.4	1
Objective 2.1	3
Objective 2.2	3
Objective 2.3	1
Objective 3.1	7
Objective 3.2	3
Objective 3.3	3
Objective 4.1	2
Objective 4.2	1
Objective 4.3	1
Objective 5.1	1

Objective	Number of Actions
Objective 5.2	6
Objective 5.3	1

Table 94 - Actions Tied to Hazard

Actions Tied to Hazard	
Hazard	**Actions Related**
Blighted Properties	1.1.2, 1.3.1, 2.1.2, 2.1.3, 3.3.3, 4.3.1,
Civil Disturbance	1.1.2, 1.3.1, 2.1.3, 3.3.1, 3.3.3, 4.3.1
Cyberterrorism	1.1.2, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Dam Failure	1.1.2, 1.3.1, 2.1.3, 3.3.3, 4.3.1, 5.1.1, 5.2.1, 5.2.2, 5.2.3, 5.2.4, 5.2.5, 5.2.6, 5.3.1
Disorientation	1.1.2, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Drought	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.1.7, 3.3.3, 4.3.1
Earthquake	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Emergency Services	1.1.2, 1.3.1, 2.1.3, 3.2.2, 3.3.3, 4.3.1
Environmental Hazards: Fixed Facility	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.3, 3.1.1, 3.1.3, 3.3.3, 4.3.1
Environmental Hazards: Transportation	1.1.1, 1.1.2, 1.3.1, 1.4.1, 2.1.3, 3.1.1, 3.1.3, 3.3.3, 4.3.1
Extreme Temperature	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Flood	1.1.2, 1.1.3, 1.1.4, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 3.2.3, 3.3.3, 4.1.1, 4.3.1
Flash Flood	1.1.2, 1.1.3, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 3.3.3, 4.1.1, 4.3.1
Hurricane	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.1.1, 4.3.1
Ice Jam Flood	1.1.2, 1.1.3, 1.2.1, 1.3.1, 2.1.1, 2.1.3, 2.2.1, 2.2.2, 2.2.3, 2.3.1, 3.3.3, 4.1.1, 4.3.1
Invasive Species	1.1.2, 1.1.3, 1.3.1, 2.1.3, 2.1.3, 3.1.4, 3.1.5, 3.3.3, 4.3.1
Landslide	1.1.2, 1.1.3, 1.1.4, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Lightning Strike	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.1.1, 4.3.1
Nuclear Incidents	1.1.2, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Opioid Epidemic	1.1.2, 1.3.1, 2.1.3, 3.2.1, 3.3.3, 4.3.1
Pandemic, Epidemic, and Infectious Disease	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.2.1, 4.3.1
Radon Exposure	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.1.2, 3.3.3, 4.3.1

Actions Tied to Hazard	
Hazard	**Actions Related**
Subsidence and Sinkhole	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.1.2, 4.3.1
Terrorism	1.1.2, 1.3.1, 2.1.3, 3.3.1, 3.3.3, 4.3.1
Tornado	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.1.1, 4.3.1
Transportation Accidents	1.1.2, 1.3.1, 2.1.3, 3.2.3, 3.3.3, 4.3.1
Tropical Storm	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.1.1, 4.3.1
Urban Fire and Explosion	1.1.2, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Utility Interruption	1.1.2, 1.3.1, 2.1.3, 3.3.3, 4.3.1
Wildfire	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.1.6, 3.3.2, 3.3.3, 4.3.1
Windstorm	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.1.1, 4.3.1
Winter Storm	1.1.2, 1.1.3, 1.3.1, 2.1.3, 3.3.3, 4.1.1, 4.3.1

7. Plan Maintenance

7.1. Update Process Summary

Monitoring, evaluating, and updating this plan is critical to maintaining its value and success in Crawford County's hazard mitigation efforts. Ensuring effective implementation of mitigation activities paves the way for continued momentum in the planning process and gives direction for the future. This section explains who will be responsible for maintenance activities and what those responsibilities entail. It also provides a methodology and schedule of maintenance activities including a description of how the public will be involved on a continued basis. This HMP update also defines the municipalities' role in updating and evaluating the plan. Finally, the 2025 HMP update encourages continued public involvement and how this plan may be integrated into other planning mechanisms in the county.

7.2. Monitoring, Evaluating and Updating the Plan

Hazard mitigation planning in Crawford County is a responsibility of all levels of government (i.e., county, and local), as well as the citizens of the county. The Crawford County Local Planning Team will be responsible for maintaining this multi-jurisdictional HMP. The local planning team will meet annually and following each emergency declaration to review the plan. The emergency management coordinator and the operations and training officer with the Crawford County Department of Public Safety will be the primary individuals responsible for reviewing and updating the plan at least once every five years. Every municipality that has adopted this plan will also be afforded the opportunity to provide updated information or information specific to hazards encountered during an emergency or disaster. Each review process will ensure that the hazard vulnerability and risk analysis reflect the current conditions of the county, that the capabilities assessment accurately reflects local circumstances and that the hazard mitigation strategies are updated based on the county's damage assessment reports and local mitigation project priorities. The HMP must be updated on a five-year cycle. An updated HMP must be completed and approved by the end of the five-year period. The monitoring, evaluating, and updating of the plan every five years will rely heavily on the outcomes of the annual HMP planning team meetings.

The Crawford County Local Planning Team will complete a hazard mitigation progress report to evaluate the status and accuracy of the multi-jurisdictional HMP and record the local planning team's review process. The annual plan review will be distributed to appropriate representatives at both PEMA and FEMA. The following items will be completed during the annual review and reporting process:

- Review the risk assessment section and identify occurrences of hazards within the last year. Identify date, time, damage, fatalities, and other specific information of the events. Also identify any new hazards that have occurred or increased risk with the county.
- Complete a review and update of the capability assessment section. Identify any capability weaknesses since the last review. The capability assessment surveys from the previous hazard mitigation plan will be reviewed and new capability assessment forms can be distributed to the municipalities during the annual review process.
- Complete a review of the mitigation strategy section. Review the goals and objectives identified in the 2025 HMP and determine if any updates are needed. Provide all mitigation actions and opportunities to the county and municipalities that are applicable. Have all entities complete an action review matrix and document all results in the report. Also, add any new actions that are identified. Complete a review of each mitigation opportunity and identify the status of each opportunity on the opportunity review spreadsheet. All information will be included in the annual review report.

The Crawford County Department of Public Safety will maintain a copy of these records and place them in Appendix I of this plan. Crawford County will continue to work with all municipalities regarding hazard mitigation projects, especially those municipalities that did not submit projects for inclusion in this plan.

The Crawford County local planning team should also be reviewed annually to address any changes to the membership that may have occurred over the past calendar year. The LPT can be expanded and updated with new stakeholders to address potential changes in guidance by the Commonwealth of Pennsylvania and the Federal Emergency Management Agency.

7.3. Continued Public Involvement

The Crawford County Department of Public Safety will ensure that the 2025 Crawford County Hazard Mitigation Plan is posted and maintained on the Crawford County website and will continue to encourage public review and comment on the plan. The Crawford County website that the plan will be located at is as follows:
https://www.crawfordcountypa.net/PublicSafety/Pages/home.aspx

The public will have access to the 2025 Crawford County HMP through their local municipal office, the Crawford County Department of Public Safety, or the Crawford County Planning Department. Information on upcoming events related to the HMP or solicitation for comments will be announced via newsletters, newspapers, mailings, and the county website.

The citizens of Crawford County are encouraged to submit their comments to elected officials and/or members of the Crawford County HMP Local Planning Team. To promote public participation, the Crawford County Local Planning Team will post a public comment form as wells as the Hazard Mitigation Project Opportunity Form on the county's website. These forms will offer the public various opportunities to supply their comments and observations. All comments received will be maintained and considered by the Crawford County Hazard Mitigation Planning Team.

Once the Crawford County 2025 Hazard Mitigation Plan is adopted by the Crawford County Board of County Commissioners, the plan will be disseminated to various county agencies and local municipalities that develop and implement specific plans and ordinances. Each participating municipality will be responsible for implementing the specific recommendations in section 5.2.5, plan integration, of the capability assessment into their local planning documents including comprehensive plans, zoning ordinances, land development, and subdivision regulations. Whenever possible, the Crawford County Department of Public Safety will serve as a liaison to assist with these integrations and updates. As discussed above in section 7.2, progress on multi-jurisdictional plan integration will be addressed as part of the annual review conducted by the Crawford County Local Planning Team.

8. Plan Adoption

8.1. Resolutions

In accordance with federal and state requirements, the governing bodies of each participating jurisdiction must review and adopt by resolution, the 2025 Crawford County Hazard Mitigation Plan. Copies of the adopting resolutions are included in this plan in Appendix J. FEMA Region III in Philadelphia, Pennsylvania is the final approval authority for the Hazard Mitigation Plan. PEMA also reviews the plan before submission to FEMA.

9. Appendices

APPENDIX A:	**References**
APPENDIX B:	**FEMA Local Mitigation Review Tool**
APPENDIX C:	**Meetings and Support Documents**
APPENDIX D:	**Municipal Flood Maps**
APPENDIX E:	**Critical and Community Lifeline Facilities**
APPENDIX F:	**2025 HAZUS Reports**
APPENDIX G:	**2025 Mitigation Project Opportunities**
APPENDIX H:	**2025 Mitigation Action Evaluation & Prioritization**
APPENDIX I:	**Annual Review Documentation**
APPENDIX J:	**Crawford County & Municipal Adoption Resolutions**